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Transport Policy and Social Inclusion

Editors

Miriam Ricci, Graham Parkhurst and Juliet Jain

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Editorial

Transport Policy and Social Inclusion

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Abstract
'Transport-related Social inclusion' is a specific naming of the complex set of interrelationships within which accessibility plays an important role in whether a citizen achieves the level of participation in socioeconomic life that he or she seeks. It has its origins in the United Kingdom of the early 2000s, but the diversity of theoretical perspectives, research methods and practical focus shown by the contributions to the present issue on this theme bears witness to the evolution and translation this concept and term has undergone over more than a decade. Nine papers are presented, concerning applications of the concept in three continents, and including some of the poorest and richest per capita income countries on the globe. As well as developing and applying the multi-faceted theories of the processes of exclusion and techniques for the quantitative identification of inclusion, they consider important topics such as the treatment of the less abled and more frail members of society when on the move and the potential for new technological design methods and practical solutions either to enhance inclusion or deepen inequality in our societies. Collectively their conclusions reinforce the message that social exclusion remains multi-dimensional, relational and dynamic, located both in the circumstances of the excluded individual as well as in the processes, institutions and structures that permeate wider society.

Keywords
accessibility; cycling; disabled; gender; mobility; public transport; shared mobility; social exclusion; social inclusion; transport policy

Issue
This editorial is part of the issue "Transport Policy and Social Inclusion", edited by Miriam Ricci, Graham Parkhurst and Juliet Jain (University of the West of England, UK).

1. Introduction

'Social inclusion', together with 'social exclusion', was a central concept in transport policy analysis in the wealthy democracies in the 2000s, following the principle that mobility was a key resource enabling participation in society in its broadest sense by providing access to life chances. Those who are deprived of access to life-enhancing opportunities because of transport-related problems are thus at risk of social exclusion (Jain & Guiver, 2001; Lucas, 2012; Ricci, 2016). In the UK the link between transport and social exclusion was made explicit with the publication of a comprehensive report by the Social Exclusion Unit (SEU) in 2003, which stated that "problems with transport provision and the location of services can reinforce social exclusion. They prevent people from accessing key local services or activities, such as jobs, learning, healthcare, food shopping or leisure. Problems can vary by type of area (for example urban or rural) and for different groups of people, such as disabled people, older people or families with children." (SEU, 2003, p. 1).

Since the early 2000s the international discourse around social inclusion has seen important develop-

ments as well as evolution. The United Nations' (UN) 8 Millennium Development Goals to 2015 focussed on poverty, but economic inequality is now integrated within the 17 successor Sustainable Development Goals: a holistic conception of inclusion and participation that is also reflected and supported by several of the papers in this themed issue. Notwithstanding these political developments, however, and some practical progress, the last decade has though been a turbulent one for social equity. Global economic recession from 2008 gave a new lease of life to neoliberal assertions that individual sacrifice is the necessary price of 'purging' the market of inefficiencies, leading to national and international policies of 'inevitable austerity', which in turn spawned a series of street protests around the world, such as 'Occupy'. Protests of this nature and extent had not been seen since 1968. In rejecting Schumpeterian 'creative destruction' as benefiting "the 1%" they successfully co-opted a mantra in proclaiming 'we are *not* all in this together'. Whilst the "99%" also of course represents an enormous range of socioeconomic status, this was perhaps a modern high point in the recognition that an individual's circumstances reflect not only his or her personal qualities and potentials, but also his or her position in interlocked social, economic and environmental systems over which the individual may have little influence, let alone control.

Key to the spontaneous nature of the global protests was a key technological change since the turn of the millennium, and which also has the potential to alter, and in some circumstances positively influence, social inclusion. For example, the proliferation of Information and Communication Technologies (ICTs) such as mobile phones in rural African contexts in which fixed-line phones are absent and despite electrical power sources being scarce has been transformative (Porter, 2015). Such developments change the dynamic of accessibility through substituting physical with virtual access to information, goods and services, so travel for utility purposes is less necessary. However, inclusion also needs an element of social and environmental interaction achieved by the richness of 'being there'—co-present with others and experiencing the shared locale first-hand—that positively influences mental and emotional well-being (Cass, Shove, & Urry, 2005; Parkhurst et al., 2014). However, in many areas of the world, access to education, health care and other essential services remains a challenge, as some of the contributions in this themed issue illustrate.

Translating the recommendations of a growing body of academic research into the implementation of socially-inclusive schemes and processes in practice presents many challenges both in the developed and developing world, and is a powerful reminder of the intrinsic elusiveness of the concept of social inclusion, and how it is measured and benchmarked. Defining social exclusions and implementing solutions is subject to political decision-making and prioritisation. Clearly this is a contested area of inquiry, as Schwanen et al. (2015) posit. Although social inclusion, and exclusion, should be regarded as a process rather than a fixed state, operational understandings often overlook its dynamic, relational and multi-scalar nature, and neglect the inequality gradients in access to material resources, participation and life opportunities evident in the publications in this themed issue.

For this themed issue on Transport Policy and Social Inclusion we sought contributions from a variety of geographical contexts, disciplinary approaches, and research methodologies examining the following key topics:

- The appropriateness and future role of the concept of 'social inclusion' in advancing the theory and practice of transport policy in both affluent and less affluent societies, and for both current and future generations.
- The opportunities and challenges to social inclusion and equity of access associated with the rise of new transport technologies and practices to address sustainability challenges, for example collective or shared mobility schemes.
- The merits and shortcomings of different regulatory contexts of transport decision-making, infrastructure delivery and operations in relation to inclusion in society, participation in decision making processes and the rationale for subsidising transport services.

2. Overview of the Papers Included in this Themed Issue

Overall, nine manuscripts are included in this special collection, reporting on research from three different continents and considering a range of modes of travel, digital tools, and the political context. While the majority have a European focus, with four papers addressing transport and social inclusion in UK (Clark & Curl, 2016; Marshall et al., 2016; Pooley, 2016; Velho, Holloway, Symonds, & Balmer, 2016), one in Sweden (Lättman, Friman, & Olsson, 2016) and one in France (Purwanto, 2016), three explore different elements of the African (Alando & Scheiner, 2016; Kett & Deluca, 2016) and Asian (Thynell, 2016) contexts.

From a methodological perspective, the papers present a variety of approaches (qualitative, quantitative, mixed methods and a computer software simulation) drawn from a wide range of disciplinary areas, including sociology, history, gender and development studies, economics, science and technology studies, accessibility planning, engineering and transport studies. This demonstrates the extent to which the topic of transport policy and social inclusion lends itself to, and clearly benefits from, a cross-disciplinary examination.

The papers engage with a variety of transport users providing useful insights into the experiences of interest groups such as women (Thynell, 2016), disabled children (Kett & Deluca, 2016) and wheel-chair users (Velho et al., 2016).

Marshall et al. (2016) present a software design tool named HADRIAN, which can evaluate designs (e.g. of buses and their associated infrastructure) for their qualities of physical accessibility, through the use of a virtual user group developed as the embodiment of over a hundred people. The paper highlights the issues encountered by standing passengers, of different ages and with varying levels of dexterity and physical ability, when trying to 'hold on' inside a standard UK bus whilst traversing the moving vehicle to get a seat. The experiences of the virtual users are further explored through correlation with data from the Disability Follow-up Survey of Great Britain, which allowed the authors to estimate the potential exclusion of certain individuals due to poor public transport design.

The accessibility of British public transport, i.e. London buses, is also the focus of the mixed-method research study reported by Velho et al. (2016). The authors contend that, despite improvements to the design of London buses, wheelchair users still encounter accessibility barriers. They combine objectively measured biomechanical data and subjectively reported user-experience to identify the physical challenges associated with propelling a wheelchair up ramps to access the bus. In addition to these barriers, participants reported anxiety and social isolation as consequences of sub-optimal public transport infrastructure design.

Still on the bus, Lättman et al. (2016) contribute to the debate around transport and social inclusion by exploring the concept of perceived accessibility using a quantitative survey of 705 Swedish bus passengers. In their study, perceived accessibility refers to the extent to which participants find it easy to lead a satisfactory and socially inclusive life by using the bus as a means of transport. Perception of quality, in particular concerning reliability/functionality of travel and courtesy/simplicity during the journey, was found to be a key determinant of perceived accessibility, captured through the Perceived Accessibility Scale. Moreover, safety was found to have both a direct and an indirect mediating effect on the overall perceived accessibility scores. An advantage of this methodology, the authors claim, is the possibility to capture the distinctive perceptions of different age and/or social groups living in the same areas and using the same bus services, which would not be possible with traditional methods using objective measurements of accessibility. These findings are a reminder that the subjective experience should be as important as objective indicators when planning for a socially inclusive transport system.

Moving on to other transport modes, two papers in this special collection examine the role of cycle-based transport in providing access to life opportunities. Both of these papers are based on research studies conducted in sub-Saharan Africa, where non-motorised transport is prevalent and absolute poverty is widespread. Alando and Scheiner (2016) report that, in these countries, the most vulnerable women, children, older and disabled people are often prevented from making journeys because of poor road conditions, unaffordability, lack of private transport, and poor and/or unreliable public transport. This is a major cause of social exclusion. In their analysis of transport policy (the Integrated National Transport Plan) and economic development strategy (Kenya Vision 2030) in the context of the city of Kisumu in Kenya, the authors find that major transport infrastructure projects aimed at improving safety, connectivity and accessibility have created street-spaces that exclude cycling, with negative implications for the poor majority who rely precisely on cycle-based mobility, e.g. bike taxi services, to access life chances. They discover that, although both economic and transport strategies have the potential to make the streets of Kimusu more cycle-friendly and inclusive, there are crucial elements of discordance that need addressing. Their study recommends that the policy documents should be harmonised, take social inclusion as a goal in itself rather than a means to participation in the economy, and recognise cycling as a right to be protected by the state.

The second of these two papers focuses on providing accessible transport to school for children with disabilities in Zimbabwe (Kett & Deluca, 2016). The authors report on a participatory, community-led project that helped a number of schools in Mashonaland West Province to identify, procure and operate a bespoke transport service for school children with disabilities: trailers pulled by tricycles, produced locally and affordable for the communities involved. This contribution sheds light on the links between access to education, transport and children with disabilities in the context of a developing economy in the Global South, which is key to expand the literature that so far has predominantly been concerned with more affluent societies in the Global North. Perhaps unsurprisingly, their findings on the community-led transport intervention point to additional barriers faced by disabled children in Zimbabwe, beyond the realm of transport, that would require a more systematic and radical societal transformation. However, the authors argue that localised measures such as the ones developed for the project could make education more inclusive in conjunction with additional life skills training for the children, training for the drivers, improvements to local roads and their continued maintenance.

Remaining in a non-Western context but focusing her inquiry on mobility and gender, Thynell (2016) develops a critique of the policies of some of the most influential global economic and political actors, namely

the World Bank, other major development banks and the UN, using the lens of development and gender studies. In doing so, she reaffirms the constraints faced by women in rapidly growing Asian cities such as New Delhi, Mumbai, Jakarta and many others. Women disproportionately lack private motorised means of transport, heavily rely on walking and/or cycling and, if they can afford it, use formal and informal public transport, which is often in a poor condition, unsafe and unreliable. Although inclusive and equitable mobility is indeed a goal for the UN and other major international actors, Thynell argues that this has not fundamentally improved the conditions for women as transport users and the quest for gender equality in the mobility arena is still ongoing. She recommends the use of feminist epistemology and development research as key disciplinary perspectives offering effective methods to study and understand the social structures as well as the geographical, cultural and economic factors that shape transport systems in growing Asian cities.

Shared mobility, such as car sharing (in the UK 'car clubs') and bike sharing, has become a growing area of interest among academic scholars and features in one of the papers included in this collection. Focusing on the car and bike sharing provision in Glasgow, Scotland (UK), Clark and Curl (2016) address the question of whether and to what extent these schemes are socially inclusive. To achieve this, they consider bike-sharing stations and car club parking bays as 'destinations', and use accessibility planning and equality impact assessment. The findings suggest that shared mobility is only available to 10-15 percent of the resident population and that the market imperative might prevent its diffusion to areas of the city most at risk of social exclusion. These results highlight the continuing tension between supporting the economic sustainability of shared mobility business models on the one hand, and reducing inequalities in access to shared transport options on the other.

In a contrasting approach to the other papers, although with interesting parallels with the transport conditions in some developing country contexts today, Pooley (2016) adopts a historical perspective to look at how people accessed everyday transport in the UK over the past two centuries, using evidence drawn from life writing and oral testimonies. He argues, in line with other scholars in the field of mobilities, that currently, at least in the most industrially developed societies, there is an expectation that travel over long and short distances should be unrestricted. In the past, travel options were fewer and most of the population in the UK travelled in much the same way. The oral and written evidence provided shows that people from different backgrounds and social status had to make relatively uncomfortable and long journeys in order to engage in their day-to-day activities, judged from our current modern standards, but this didn't prevent them from engaging in such activities. In other words, Pooley suggests, expectations in the past were lower and travel experiences more uniform across much of the population, so much so that in the past social inclusion might have been perceived to be greater than it is today.

Likewise the final paper adds a different dimension. Purwanto (2016) uses an econometric methodology, namely the method of concentration index decomposition, to examine the link between income inequality and mobility inequality by analysing French survey data at several points in time over the last two decades of the twentieth century, characterised by a rise in social and economic inequalities. His research demonstrates that understanding both the static and dynamic relationships between different indicators of socio-economic inequality on one side, and mobility inequality on the other, is indeed a very complex subject, as mobility can be regarded both as a dependent and as an independent variable in relation to income. Considering the relationship at one specific point in time, inequality in the distribution of per capita income and per capita car ownership are the two main factors explaining observed mobility inequality. Dynamically, the evolution of the inequality indexes of these two factors contributed to reducing mobility inequalities between 1983 and 1997. Purwanto concludes that the key concept is the evolution of the elasticity between mobility and income and recommends that transport policies aim at reducing the effects of such elasticity.

3. Conclusions

The diversity of contributions to the present themed issue confirms that the concept of Social Inclusion applied to transport and mobility problems continues to have relevance within the industrialised democracies within which it emerged but that is has also been adapted to offer explanatory power and practical purpose across a wider range of global social contexts. The concept also survives through ongoing socioeconomic transition, including economic recession as one reason why the social inclusion debate shifts in and out of favour in different political arenas, and technological transition, notably the proliferation of ICTs, which requires the consideration of inclusion as not limited to physical participation.

Yet, as articulated by methodical analysis by a number of the papers, transport-related social exclusion continues to be identified in new configurations, although many different initiatives are being implemented and evaluated for effectiveness. Here, the themed issue contributes in providing for relevant knowledge exchange from the Global South to the Global North, as well as vice versa.

However, despite local successes, by no means is all political development currently oriented towards re-

ducing exclusion, and overall the conclusions of the contributing authors are a helpful reminder that transport-related social exclusion is indeed multi-dimensional, relational and dynamic, for example, located both in the circumstances of the disabled child who faces barriers to accessing education, as well as in the processes, institutions and structures that permeate wider society.

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Conflict of Interests

The authors declare no conflicts of interest.

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Article

Supporting a Design Driven Approach to Social Inclusion and Accessibility in Transport

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Abstract
This paper presents research into the area of public transport and accessibility, addressing the support of practitioners in achieving socially inclusive solutions to the mobility issues of diverse populations. For decades, social policy has been underpinned by a stereotyping of populations into simplified sub groups: old, young, disabled, etc. and thus solutions often fail to properly address the richness of human variability. These shortcomings are often 'managed' through the ability for people to adapt, however, this is not a sustainable way in which to build a socially inclusive transport infrastructure. A software design tool called HADRIAN is presented. This tool provides a means to evaluate designs for their physical inclusiveness through the use of a virtual user group. This virtual user group is the embodiment of over 100 people that can be used to assess an existing or proposed design and to gain an understanding of what may be done to improve its accommodation. A case study exploring the use of the tool is described together with work in exploring the correlation of the individuals within the HADRIAN system with data on the UK population as a whole and how the inclusion or exclusion of individuals with specific characteristics can be used to inform a more representative view of the inclusiveness of a design.

Keywords
accessibility; design change; digital human modelling; HADRIAN; mobility issues; SAMMIE; simulation; social inclusion; transport

Issue
This article is part of the issue "Transport Policy and Social Inclusion", edited by Miriam Ricci, Graham Parkhurst and Juliet Jain (University of the West of England, UK).

1. Introduction

It is often stated that transport can have a direct positive impact on social inclusion by providing people with access to services such a healthcare and shopping, to help them get to a place of work, and to increase their interaction with others both on the transport itself and at their destination (Mackett, Achuthan, & Titheridge, 2008). Transport also appears to be of particular importance to older users and the ageing population has

the potential to significantly affect public transport planning in future years (Barnes et al., 2015; Green, Jones, & Roberta, 2014). The inverse is also true in that social exclusion as a result of transport exclusion is a major concern, particularly as people age and potentially lose access to personal transport as they have to give up driving, as their mobility decreases, as they retire and potentially have reduced income, these factors are also prevalent in those that have disabilities (Green et al., 2014; Mackett & Thoreau, in press). In a survey by the Department for Transport (2001) that considered the needs of older travellers over a third of respondents aged 60 or over said they would like to travel more and also identified both transport related and health related barriers to this occurring. Successive governments in the UK have explicitly recognised these links and have put in place policies intended to improve the lives of older people through access to transport. For example concessionary travel on buses has been offered to children, older people and people with disabilities for many years. Currently referred to as the concessionary travel pass (CTP), free bus travel appears to have resulted in an increase in the bus usage of older people and to have provided an increase to services. However, the success of the aims of the policy to provide free travel are not necessarily clear. For example, for many of those who are eligible for free travel, the availability of the CTP would have coincided with retirement and thus may have increased their bus usage regardless of free travel (Mackett, 2014). Another issue concerns safety, whilst public transport is generally considered to be safe, more than 5000 people are injured on buses and more than 300 killed or seriously injured in the UK each year and older people are over represented as bus/coach casualties (Department for Transport, 2013).

These issues highlight one of the core difficulties in policy generation, in that it is often very difficult to predict the outcome of a policy change or to investigate the detailed causal factors behind some of the observed population trends. In the case of concessionary travel there is much evidence to suggest it has addressed its aims, however there is also evidence to suggest that such policies have other unforeseen effects and potentially do little to address social inclusion due to the presence of other barriers not associated with cost (Musselwhite & Haddad, 2010; Rye & Mykura, 2009). For some considerable time it has been well recognised that the journey from public policy to a design solution is problematic and ideally should include causation, evaluation and instrumentation (Linder & Peters, 1984). Furthermore it appears that policy makers, particularly in the case of local authorities involved in transport planning, do not tend to innovate, but rather rely on pre-conceived solutions that focus on supply rather than demand (May, Kelly, Shepherd, & Jopson, 2012).

One means of aiding policy makers, planners and designers to gain a greater understanding of any planned change on social inclusion, or to retrospectively evaluate a situation to inform change, is to utilise modelling and simulation tools. There have been a number of modelling and simulation approaches that have been explored that utilise mapping tools such as GIS (geographic information systems) for example, CAPITAL (Church, Frost, & Sullivan, 2000), LUPTAI (Yigitcanlar et al., 2007) and AMELIA (Mackett et al., 2008) amongst others (Ford, Barr, Dawson, & James, 2015; Karou & Hull, 2012). However the majority of these approaches have limited capability to address individual user needs within a broader population based approach. As such, the richness of end user requirements can be lost in the generalisation and homogenisation of groups within the population.

This paper presents ongoing research into 3D modelling and simulation and the use of digital human modelling (DHM) tools to explore and inform accessibility and inclusion. Through the use of a unique database on older and disabled people that forms a virtual user group, together with an existing DHM tool called SAMMIE (Porter, Marshall, Freer, & Case, 2004), a prototype tool called HADRIAN has been developed. A case study of the use of the tool is presented together with research into exploring how inclusivity explorations with individuals can be used to inform a broader understanding about accessibility for populations.

2. HADRIAN

HADRIAN is an inclusive design tool aimed at supporting practitioners in inclusive design practice, be they designers, architects, town planners etc., through the exploration of the accessibility of their ideas prior to implementation. The tool is the output of iterative research and development initially funded by the Engineering and Physical Sciences Research Council (EPSRC) as part of their Extending Quality Life (EQUAL) Programme. This process began with a stakeholder review of requirements (Gyi, Porter, & Case, 2000; Oliver, Gyi, Porter, Marshall, & Case, 2001), followed by a pilot study exploring data collection methods (Marshall, Case, Oliver, Gyi, & Porter, 2002), and then progressed into the structural development of a software task analysis tool and the creation of a user database through the collection of a wealth of data on 102 individuals, the majority of whom are older and/or disabled (Marshall, Case, Porter, Sims, & Gyi, 2004; Porter et al., 2004). The resulting prototype tool (Marshall et al., 2010) addressed two main concerns: 1. the applicability of the data used to inform designers and simulation tools in inclusive design practice, notably data on human variability, joint range of motion, behaviour and coping strategies; and 2. a means of accessing simulation

functionality that is more attuned to the working methods of designers.

Figure 1 shows a prototype of the database of individuals. A significant amount of data is available including: age, gender, occupation, any registered disabilities, anthropometry (body measurements), joint range of motion, task capability and behaviour video's, reach range, and a selection of questionnaire responses regarding views on transport use. The data themselves form a potentially useful resource for practitioners, particularly in fostering an understanding and empathy with users and providing insights into the effects of ageing and the significant variability in disability.

The data in the database can also be used to support DHM application. HADRIAN works together with the SAMMIE DHM system by providing data on the creation of human models for simulation purposes. In this manner HADRIAN provides a virtual user group for user trials conducted in the digital environment. Interaction points, workplaces, and environments can all be 3D modelled and then evaluated with the virtual users as shown in Figure 2. Using a task-based methodology tasks can be defined and assessed for each individual as a virtual analogue of the real-world equivalent.

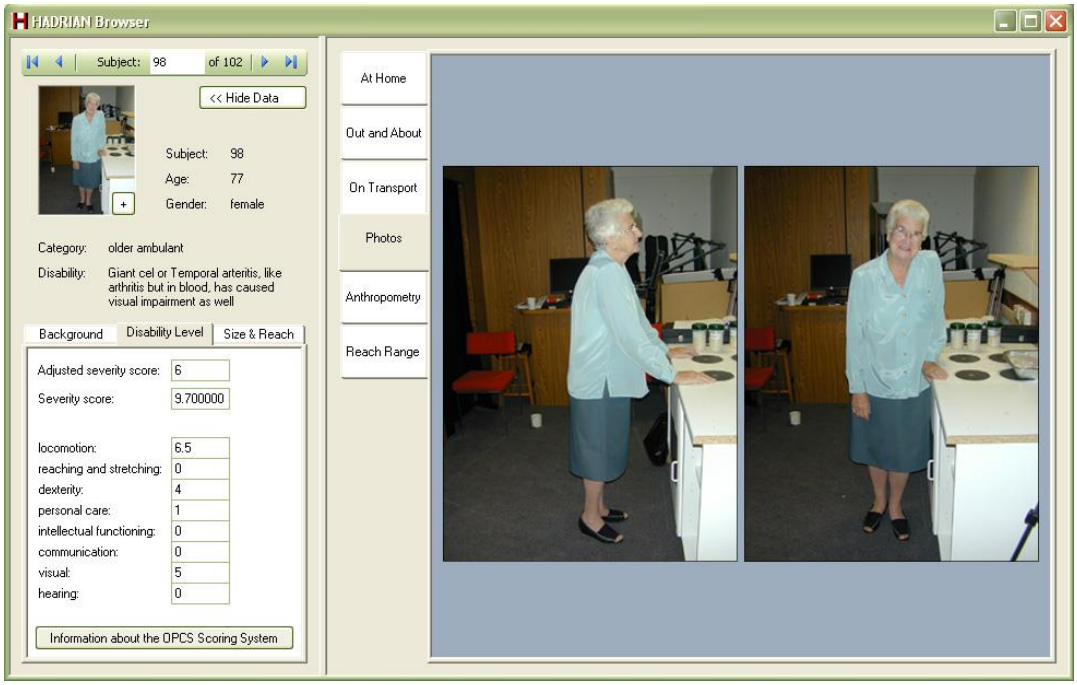

Figure 1. HADRIAN database interface showing overview information on the individual (left) and a range of detailed information in this instance photos for empathy (right).

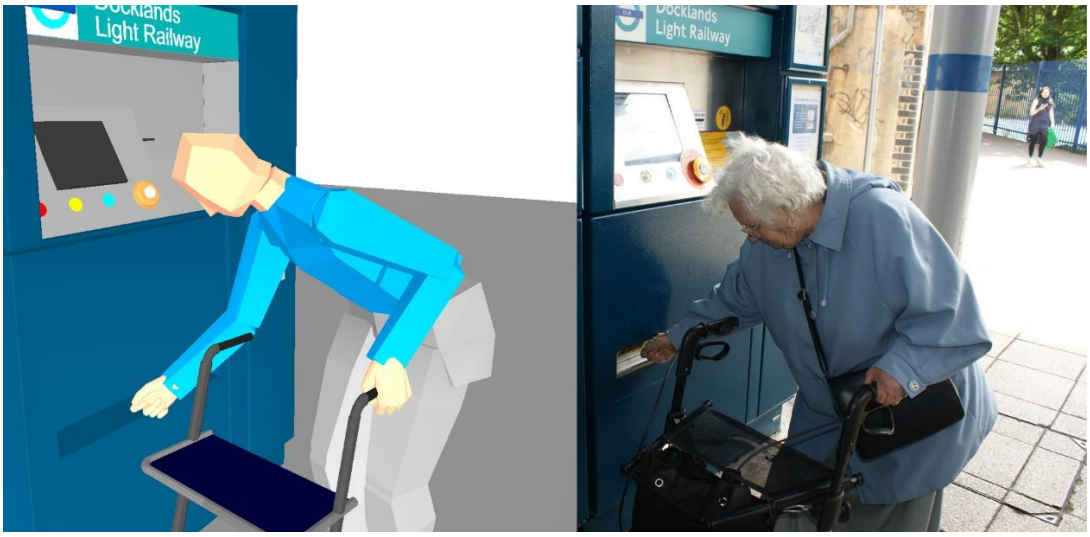

Figure 2. HADRIAN–SAMMIE simulation of interacting with a ticket machine (left) and real-world validation (right) during trials at the DLR station in Greenwich, London.

3. The Use of HADRIAN Data in a Public Transport Inclusion Case Study

Informed by concerns regarding the prevalence of bus travel with older users and the number of injuries and fatalities that occur each year, feasibility research has been conducted aimed at improving safety for older public transport users (OPTU). Funded by the Medical Research Council under their Lifelong Health and Wellbeing programme, part of the OPTU project focused on the use of a human modelling approach as a means of exploring issues and evaluating design interventions. Based upon an analysis of the police accident database STATS_19 exemplar case studies were identified (Barnes et al., 2015). To illustrate the process, one of those case studies is outlined here. This case study focused on the use of a typical bus design operated in the UK and any causal factors associated with accidents to standing passengers that represent 41% of older casualties (Barnes et al., 2013).

To perform the evaluation a representative bus model was required. A typical example of a large bus was identified from a local operator and permission sought to access the vehicle whilst not in service. To capture the vehicle geometry in an expedient manner a FARO LS 3D Scene scanning system (FARO, 2015) was used to digitally capture the interior of the bus. The system utilises a 360-degree laser scanner mounted on a tripod that digitally encodes everything in the line of sight. The tripod was positioned in three locations along the length of the bus and scans were captured. Each scan takes approximately 60 seconds however with associated set-up time and planning of the data capture the complete scan time on site was approximately one hour. The scans initially take the form of a point cloud consisting of hundreds of thousands of data points. Using specialist software in the form of Geomagic (3D Systems, 2015) the three scans were merged into a single dataset, noise and unwanted scan geometry were removed to produce a coherent point cloud.

The point cloud was then decimated to reduce the complexity down to a manageable level and finally tessellated to turn the points into a triangular mesh of surfaces as shown in Figure 3. Further work was required to break the complete bus model down into functional elements such as seats, handles, rails etc. Holes were patched and geometry missed due to line-of-sight occlusion was modelled manually. To complete the process the geometry was imported into the SAMMIE DHM system where simple external geometry was added and textures applied. The original bus and the resulting models are shown in Figure 4.

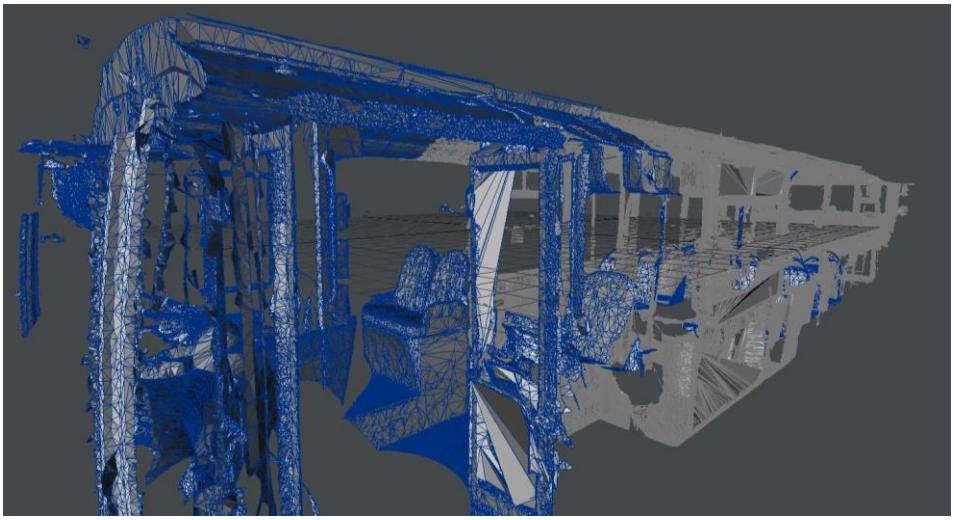

Figure 3. Tessellated 'point cloud' resulting from three scans combined to create the bus geometry.

Figure 4. Bus used for the modelling activity, a 42 seat Kinchbus No 12 (left) and the resulting model in SAMMIE (right).

The use of a digital modelling process to evaluate this type of scenario has many advantages including the ability to model a broad range of users, to explore representative scenarios in a manner that does not face the real world issues of participant recruitment, ethics and safety and problems associated with taking a bus out of service for an extended period. However the DHM approach is not without its limitations. DHM tools typically support static evaluations of key-frame postures and tasks. However, accidents are invariably dynamic events and so there is a requirement for some hypothesis in the recreation of the accident event. Dynamic modelling technology is available but was deemed beyond the remit of this research. Taking a static approach still provides the potential to evaluate key design parameters that may prove to be causal factors in accidents and identify potential design countermeasures.

Figure 5 shows the resulting setup of the model within the SAMMIE DHM system. The bus has been populated to provide a realistic case study environment and to provide the potential to explore the impact of passengers on accessibility, particularly to hand holds that may be obstructed by passengers seated or standing.

The methodology for the case study focuses on the ability for a standing passenger to be able to hold on to the vehicle whilst traversing along the vehicle. Standing passengers are at greatest risk when the vehicle moves off or comes to a stop e.g. whilst passengers are making their way to a seat, or whilst they are stood with a view to making their way to the front to alight. Whilst causation of any particular accident in these conditions has many contributing factors, the approach taken was to assume that passengers should be able to hold on and brace themselves against any acceleration or deceleration at all times whilst on the vehicle.

Using HADRIAN in its intended manner all 102 participants in the virtual user group would be evaluated. However, for expediency a single participant was used to demonstrate the principle. The analysis explored the scenario using participant number 13 (P13) in the HADRIAN database. P13 is a 69 year old female with good mobility who lives independently. A female participant was selected as STATS_19 showed that 78% of accidents occurred to female passengers, in addition P13 had a relatively small stature (1537mm = 10th %ile UK Female) with average joint range of motion (mobility), see Figure 6. P13 provides a relatively extreme case in their ability to traverse along the vehicle whilst maintaining a hand hold due to having short arms. Other participants in the HADRIAN user group would provide alternative challenges such as limited mobility and/or the need to use a stick or a frame.

The analysis involved positioning and posturing of the digital human model to explore the opportunity to hold onto at least one of the hand holds throughout the length of the vehicle. Where hand holds were out of reach the analysis would identify the failure of the task and highlight the possible need to explore design interventions. Wherever possible a constant grip of a hand hold was maintained such that the human model would essentially always be holding on with at least one hand hold to give themselves some chance of bracing if required (Figure 7).

The analysis highlighted a number of potential issues that would be faced by someone such as P13. Figure 8 and Figure 9 show that when a passenger has to move beyond the forward facing seating area to the transverse seating area, the ability to maintain a hand hold becomes problematic. Once the passenger commits to holding onto the left hand curved handle and steps forward there is no convenient handle on the right hand side. The next handle on the right is out of reach for P13.

Figure 5. Bus interior modelled and populated in the SAMMIE DHM system.

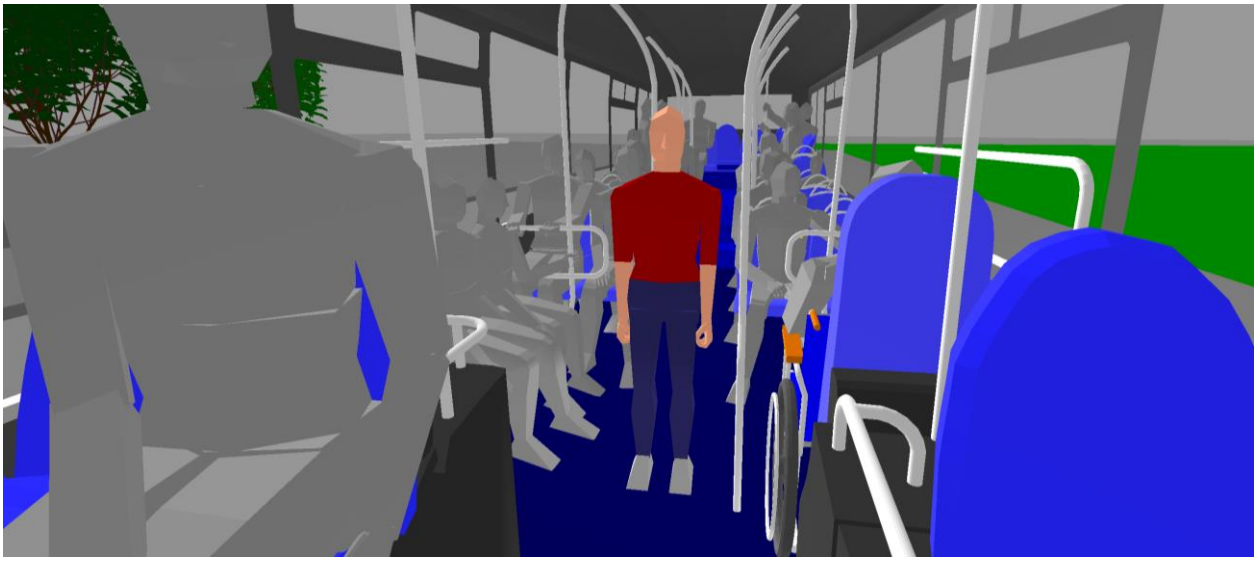

Figure 6. HADRIAN P13, UK Female digital human model within the bus.

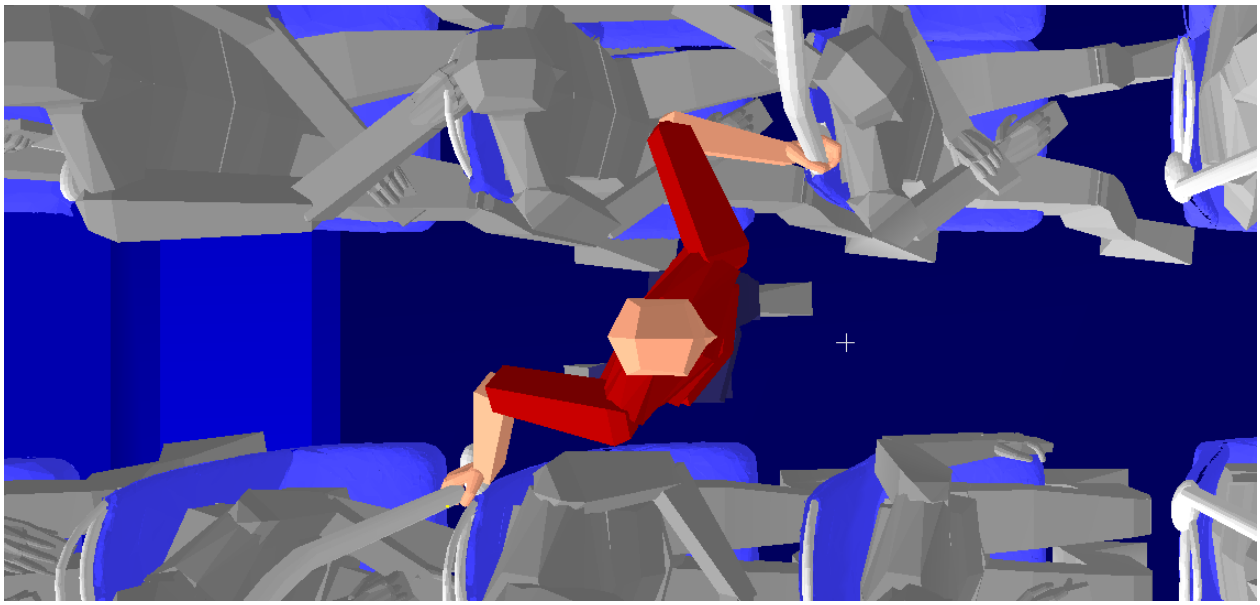

Figure 7. Human models would hold on to at least one hand hold within the vehicle whilst traversing.

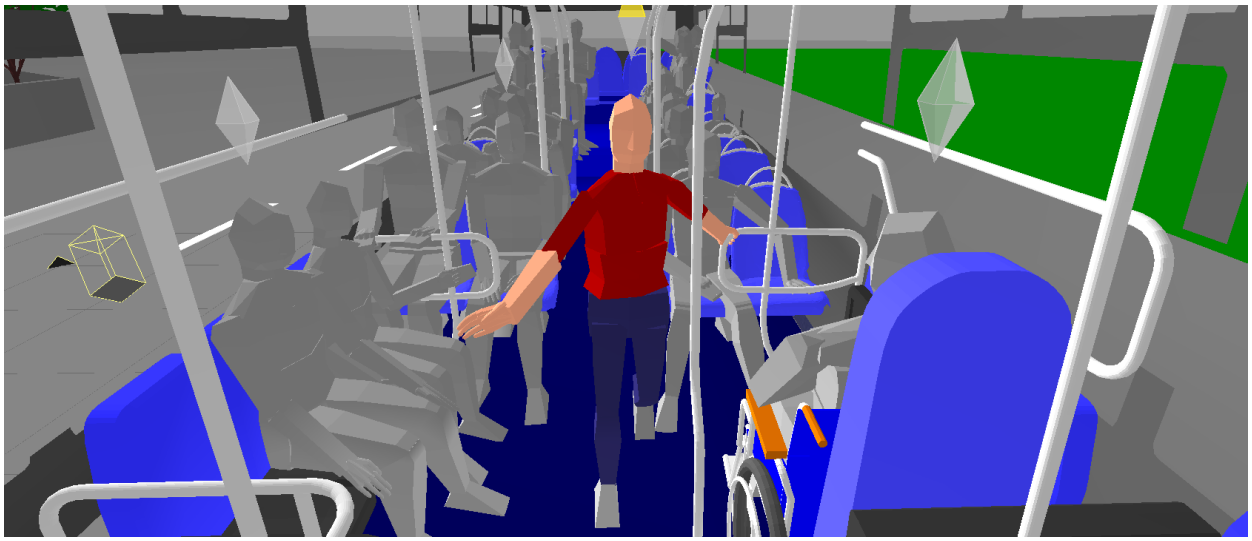

Figure 8. P13 moves forwards maintaining grip of the left hand handle but finds there is no conveniently placed right hand handle.

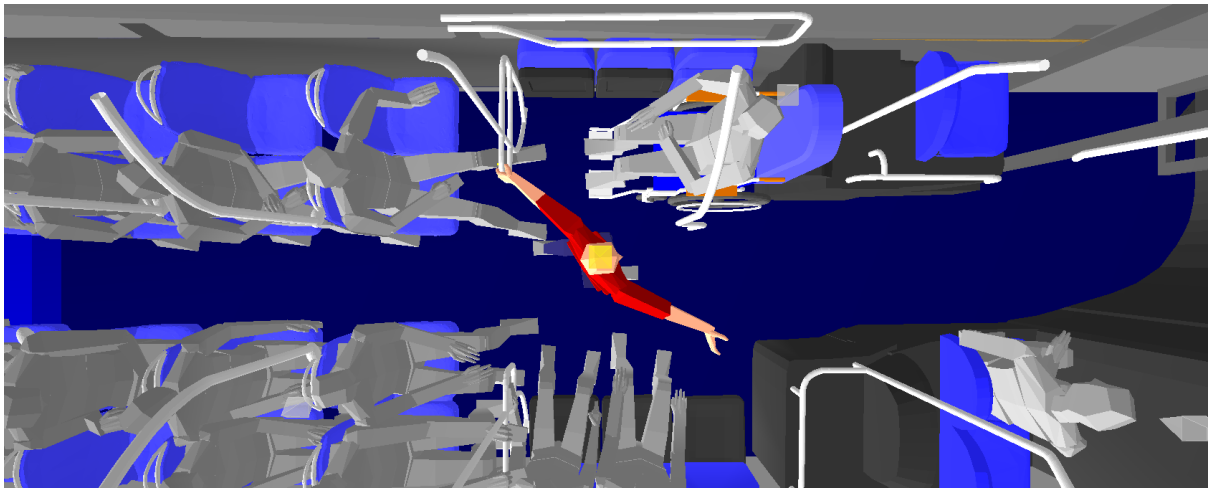

Figure 9. Plan view of P13 showing no conveniently located right hand grip.

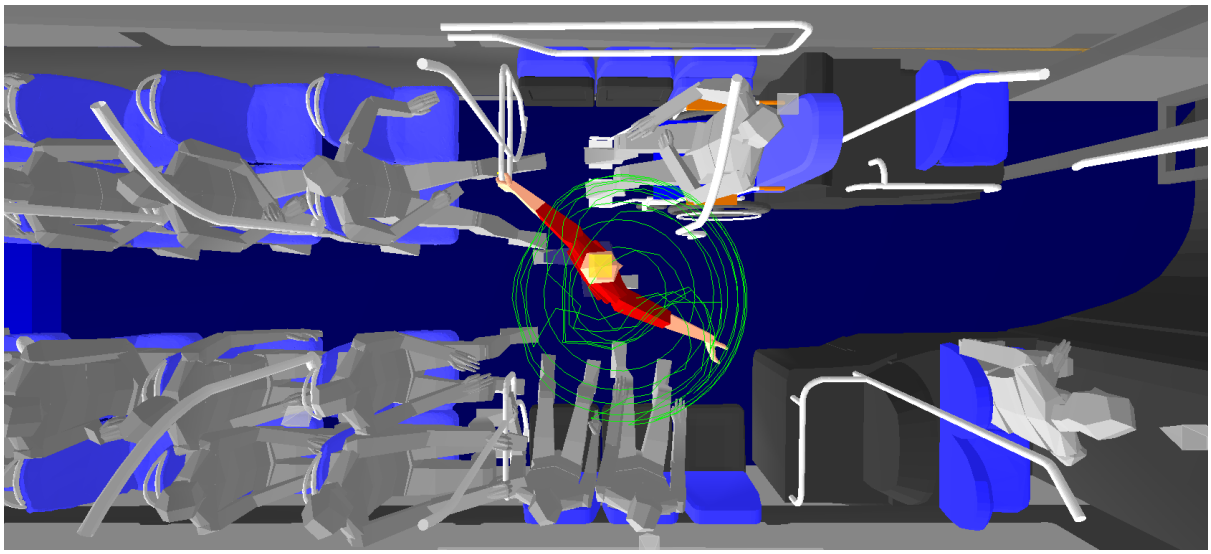

Figure 10. Reach contour for P13 confirming the lack of right hand handle, but also indicating the availability of the next left hand upright.

Figure 11. P13 moves forwards gripping the next left hand upright with the right hand.

Figure 10 shows 'reach contours' for the right hand with a palm grip. This reach evaluation tool gives an idea of the reachable volume of space afforded to the human model in the posture shown. This highlights what hand holds may be within reach. In this case no handholds to the right are within reach, however P13 could potentially reach for the hand hold to their left.

Figure 11 and Figure 12 show the posture required to move forward through this area, maintaining grip. Due to the lack of a suitable handhold to the right, the left hand upright could be gripped with the right hand. Beyond this point the passenger would need to bring their left hand forward to join the right hand, both holding onto the left hand upright as shown in Figure 13. Moving further forward an alternate right-left grip could be resumed.

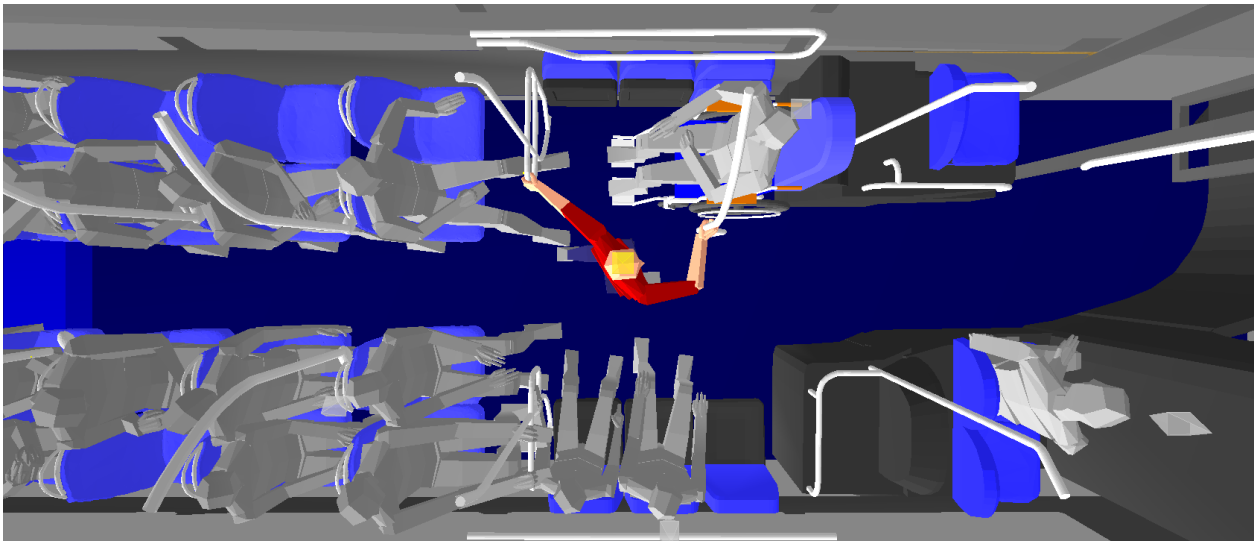

Figure 12. Plan view of the P13 showing the grip of the two left hand handles.

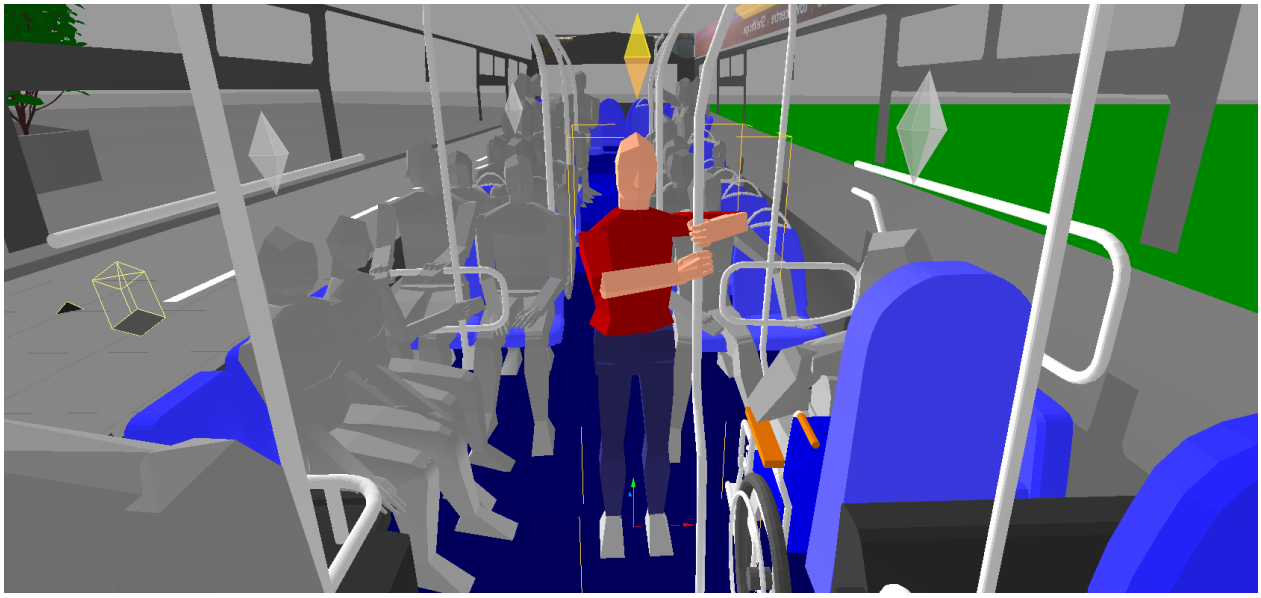

Figure 13. P13 moves forwards resulting a double handed grip of the left hand upright.

The results of the analysis with one exemplar task and user described here, shows how the use of human modelling can be used to explore issues with transport designs and infrastructure. Whilst beyond the scope of this paper the research also explored other scenarios such as seated passengers and also possible design interventions. In brief, there were three main findings:

- The transverse seating area has a reduced availability of hand holds for passengers standing or traversing through this area. The use of digital modelling and simulation could be used to explore the addition of more upright handholds to improve the situation for standing passengers but also to explore any effect on wheelchair and pushchair user needs in an attempt to provide a universal solution

- The assessment performed has highlighted that the current configuration may need a two handed grip at certain points during the traversal through the vehicle. In many instances this would be impractical or impossible due to the number of potential travelers who would be holding a personal items such as a bag, stick, umbrella or other encumbrance (see Barnes et al., 2013, for further detail of this scenario)
- The seat back handholds are important in the forward facing seating area but are probably secondary for most passengers as the uprights provide improved, unobstructed access. The use of digital modelling and simulation could be used to explore the implication of providing redesigned seat back mounted handles to allow access that is unobstructed by other seated passengers

More broadly the use of digital human modelling technologies combined with improved data on a broader range of the population has the ability to support a more inclusive approach to transport design and planning. Designers, engineers, and planners are often faced with data on accessibility issues but do not always have the ability to explore the nature of the barrier to accessibility nor to simulate potential improvements. The case study example described here provides a brief insight into how such tools can offer benefits in this area. However, the simulation shown is for one individual and yet most inclusivity issues concern the needs of populations, public transport must be designed to meet the needs of the majority of users and not reflect individual user needs.

4. Exploring the Representativeness of the HADRIAN Database

From its inception the sampling strategy of the HADRIAN database attempted to capture data from participants with an even distribution across each of the measures recorded. For example the database has participants with an age in every decile between the 10's (18yrs) to the 80's (89yrs), in every decile for percentile stature for both males (1st–99th) and females (1st–98th) etc. However, it was always understood that even with careful sampling the 102 individuals would never be representative of a whole population. It is therefore important to discuss the value of any results gained from the exploration of accessibility issues with members of the HADRIAN virtual user group in the context of their ability to inform decisions that affect whole populations.

In the previous section a single individual is used in an assessment. With a single participant, insights into usability can still be obtained. However, drawing broader conclusions regarding the needs of a design aimed at the broadest range of users is not straightforward. The insights gained cannot necessarily be used to support a design intervention without further understanding of the implications of the intervention on other users. If the case study in the previous section were repeated with the whole HADRIAN user group the results would be much broader in scope. More insights would be generated and there is a greater likelihood that conflicting requirements would be highlighted and subsequently support an opportunity to evaluate any necessary trade-offs if an intervention were to be made. Validation work with the database does support this claim with many of the insights generated by the use of HADRIAN reflecting those observed in real-world evaluations (Marshall et al., 2013; Summerskill et al., 2009). Yet the issue of representativeness is still a potential concern. As a counterpoint to these concerns, real world testing of physical products tends to utilise relatively modest numbers of people. For example research has shown that the majority of issues can be identified with as few as four or five participants (McClelland, 1995). As such a user group of 102 might be considered to be of a good size to explore the majority of requirements. Indeed it is not uncommon for designers to use so-called personas to aid in the development of products and services (Saffer, 2007). These personas are research based archetypal users, employed by a design team to maintain focus on user needs. Typically between one and seven personas would be employed on a project (Marshall et al., 2013). In research by Goodman-Deane, Langdon, and Clarkson (2010) personas are highlighted as one of a number of methods that are engaging for designers suiting their informal and flexible ways of working. Whilst the HADRIAN database and its virtual user group are not personas in the traditional sense, they do offer similar characteristics particularly in the ability to foster engagement with end users (Högberg, Lundström, Hanson, & Wårell, 2009).

5. Disability Follow Up Survey of Great Britain

To explore these issues further, recent work on the HADRIAN database has investigated the ability to inform practitioners on the representativeness of the individuals in the HADRIAN user group. The approach taken has been to compare the capabilities of the individuals in the database to the data in the Office of National Statistics' (ONS) Disability Follow-up Survey (DFS) conducted in 1996/1997. This survey aimed to collect information about the prevalence of disability in Great Britain and the characteristics of those who were disabled (Grundy, Ahlburg, Ali, Breeze, & Sloggett, 1999).

The DFS survey was established to understand and

measure the ability to perform certain tasks that were divided into ability categories. Individuals were selected on the basis of certain criteria, for example, the receipt of benefits and an age greater than 16 years. To measure the level of disability, approximately three hundred questions were asked of 7300 participants, covering a variety of ability categories. A total of ten categories are defined including: Locomotion; Reaching and Stretching; Dexterity; Seeing; Hearing; Personal Care; Continence; Communication; Behaviour and Intellectual functioning. The questions largely concerned a self-assessment requiring participants to identify their ability to perform tasks, and the relative ability in that task, associated with each category, such as:

- Cannot walk at all
- Can only walk up and down a flight of stairs if goes sideways or one step at a time

or

- Cannot see well enough to recognise a friend across a room
- Cannot see well enough to recognise a friend across a road

The resulting responses were then evaluated by an expert panel so that an overall consensus on a disability scale might be achieved (Martin & Elliot, 1992). These scales were arranged in such a manner that the higher the value of severity score, the greater the severity of a particular disability. For example, a person with a reaching and stretching severity score of 9.5 (RS1-Reach and stretch level 1) has a more severe disability as compared with a person with a 5.5 (RS6) severity score. In this way, the data were used to measure the level of disability and estimate disability prevalence in the overall UK population at that time.

6. The Disability Follow Up Survey Severity Scales

One of the significant characteristics of the DFS is the view taken of disability and its categorisation focusing on practical abilities rather than medical definition. Thus the severity of a disability is defined as the extent to which an individual's performance of activities is limited by impairments (Martin, Meltzer, & Elliot, 1988). After developing scales for each category, there was a need to assess the overall impact of these impairments on an individual's ability/disability. The overall severity scale was constructed according to the formula:

Worst (score in any category) + 0.4 (second worst) + 0.3 (third worst)

The above formula was applied to everyone in the survey to calculate an overall severity score for each person. Finally, these overall severity scores were grouped into the ten severity categories; their levels and ranges are shown in the table 1.

During the data collection for the HADRIAN database, relevant scales from the DFS were used for the assessment of level and severity of disability from all 102 participants. Because of this similarity in severity scales used in the HADRIAN database and the DFS, it might be said that the individuals presented in the database, are similar in some specific ability categories with the population represented by the ONS data.

The common severity scales used for different areas of disability in the disability survey and the HADRIAN database; are presented in tables 2 to 5. Only four of the ten categories were used due to practical constraints in data collection and the focus being primarily on physical rather than cognitive abilities.

Similar scales were developed for the other categories by the DFS however discussion here is limited to those which HADRIAN and the disability survey have in common.

Table 1. Levels of disability severity in accordance with overall severity scores Sources: Grundy et al. (1999) and Martin et al. (1988).

Severity category	Overall severity score
10 (most severe)	19 or higher
9	17–18.95
8	15–16.95
7	13–14.95
6	11–12.95
5	9–10.95
4	7–8.95
3	5–6.95
2	3–4.95
1 (least severe)	0.5–2.95

6.1. Locomotion

Table 2. Different levels of locomotion ability and respective severity scores. Sources: Grundy et al. (1999) and Martin et al. (1988).

Level	Question	Severity Score
L1	Cannot walk at all	**11.5**
L2	Can only walk a few steps without stopping or severe discomfort/cannot walk up and down one step	**9.5**
L3	Has fallen 12 or more times in the last year	**7.5**
L4	Always needs to hold on to something to keep balance	**7.0**
L5	Cannot walk up and down a flight of 12 stairs	**6.5**
L6	Cannot walk 50 yards without stopping or severe discomfort	**5.5**
L7	Cannot bend down far enough to touch knees and straighten up again	**4.5**
L8	Cannot bend down and pick something up from the floor and straighten up again	**4.0**
L9	Cannot walk 200 yards without stopping or severe discomfort/Can only walk up and down a flight of 12 stairs if holds on and takes a rest/Often needs to hold on to something to keep balance/Has fallen 3 or more times in the last year	**3.0**
L10	Can only walk up and down a flight of 12 stairs if holds on (doesn't need a rest)	**2.5**
L11	Cannot bend down to sweep up something from the floor and straighten up again	**2.0**
L12	Can only walk up and down a flight of stairs if goes sideways or one step at a time	**1.5**
L13	Cannot walk 400 yards without stopping or severe discomfort	**0.5**

6.2. Reaching and Stretching

Table 3. Different levels of reaching and stretching ability, and respective severity scores. Sources: Grundy et al. (1999) and Martin et al. (1988).

Level	Question	Severity Score
RS1	Cannot hold out either arm in front to shake hands	**9.5**
RS2	Cannot put either arms up to head to put a hat on	**9.0**
RS3	Cannot put either hand behind back to put jacket on or tuck shirt in	**8.0**
RS4	Cannot raise either arm above head to reach for something	**7.0**
RS5	Has difficulty holding either arm in front to shake hands with someone	**6.5**
RS6	Has difficulty putting either arm up to head to put a hat on	**5.5**
RS7	Has difficulty putting either hand behind back to put jacket on or tuck shirt in	**4.5**
RS8	Has difficulty raising either arm above head to reach for something	**3.5**
RS9	Cannot hold one arm out in front or up to head (but can with other arm)	**2.5**
RS10	Cannot put one arm behind back to put on jacket or tuck shirt in (but can with other arm)/Has difficulty putting one arm behind back to put jacket on or tuck shirt in, or putting one arm out in front or up to head (but no difficulty with other arm)	**1.0**

6.3. Dexterity

Table 4. Different levels of dexterity and respective severity scores. Sources: Grundy et al. (1999) and Martin et al. (1988).

Level	Question	Severity Score
D1	Cannot pick up and hold a mug of coffee with either hand	**10.5**
D2	Cannot turn a tap or control knobs on a cooker with either hand	**9.5**
D3	Cannot pick up and carry a pint of milk or squeeze the water from a sponge with either hand	**8.0**
D4	Cannot pick up a small object such as safety pin with either hand	**7.0**
D5	Has difficulty picking up and pouring from a full kettle or serving food from a pan using a spoon or ladle	**6.5**
D6	Has difficulty unscrewing the lid of a coffee jar or using a pen or pencil	**5.5**
D7	Cannot pick up and carry a 5lb bag of potatoes with either hand	**4.0**
D8	Has difficulty wringing out light washing or using a pair of scissors	**3.0**
D9	Can pick up and hold a mug of tea or coffee with one hand but not with the other	**2.0**
D10	Can turn a tap or control knob with one hand but not with the other/Can squeeze the water from a sponge with one hand but not the other	**1.5**
D11	Can pick up a small object such as a safety pin with one hand but not with the other/Can pick up and carry a pint of milk with one hand but not the other/Has difficulty tying a bow in laces or strings	**0.5**

6.4. Personal Care

Table 5. Different levels of personal care ability and respective severity scores. Sources: Grundy et al. (1999) and Martin et al. (1988).

Level	Question	Severity Score
PC1	Cannot feed self without help/Cannot go to and use the toilet without help	**11.0**
PC2	Cannot get into and out of bed without help/Cannot get into and out of chair without help	**9.5**
PC3	Cannot wash hands and face without help/Cannot dress and undress without help	**7.0**
PC4	Cannot wash all over without help	**4.5**
PC5	Has difficulty feeding self/Has difficulty getting to and using the toilet	**2.5**
PC6	Has difficulty getting in and out of bed/Has difficulty getting in and out of a chair	**1.0**

7. Population Estimation for the DFS

The DFS aimed to produce national estimates about the number of people with different levels of severity of disability in Great Britain. The sample of 7300 people was statistically treated to estimate the number of people in the country with a similar level of disability. In this way, the proportions of the UK adult population (+16 years) with the listed levels of disabilities were estimated. The results of this survey were first published in 'Disability in Great Britain' by the Department of Social Security in their research report number 94 (Grundy et al., 1999; Martin et al., 1988).

Figure 14 provides the percentage of the UK adult population (16+ years of age) in each disability severity level for two different disability categories. For example, in both of these categories level 9 (L9 and R9) are the most common. The locomotion ability level associated with L9 (Table 2) is exhibited by just over 3 percent of the overall UK population. Similarly, reach and stretch level R9 (Table 3) occurs in just under 1 percent of the UK adult population.

From these percentages, it is possible to estimate the total number of persons in the UK population with a given ability level. By multiplying the percentage associated with a level (e.g. L9, approx. 3.1%) with the total adult population (45.6M at the time of the survey), the total number is estimated at about 1.41M persons in the UK adult population with this level of locomotion ability. In the same way, estimations against different areas of disability and levels of disability can be easily made.

8. HADRIAN Database Correlation with DFS

As described earlier HADRIAN has a database of 102 individuals which represents a variety of people on the basis of their abilities, shapes, sizes and behaviours. The database also contains a disability severity score for each individual in line with the DFS. This provides a means to provide an indication of how prevalent the ability level of a single individual in the HADRIAN database is within the UK population. Or alternatively, and more usefully in the context of design, if an individual in the HADRIAN database is excluded during the evaluation of a design, it is possible to provide a broad indication of the proportion of the UK population that would be similarly excluded.

Being able or unable to do some task under a specific capability category, describes an individual's ability to comfortably interact with products, services or environments. The DFS disability data were intended for the purpose of indicating the capability of individuals to perform certain tasks. Some of the questions also inquire about specific product, service and environment interactions. A number of the same questions were also put to the HADRIAN participants so that self-reported abilities, together with, their recorded task behaviours, coping strategies and comfortable postures could be coded into the digital human modelling system. In this manner the difficulties identified through the use of the HADRIAN virtual user group are in some way able to provide a broader view of issues likely to be faced by the population.

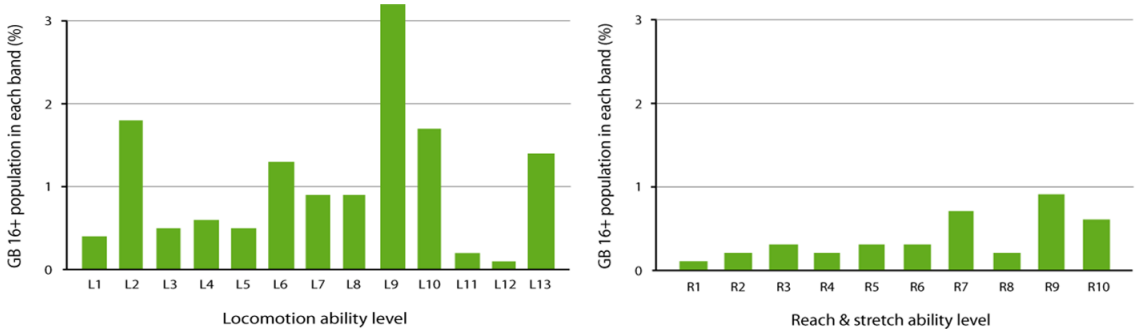

Figure 14. Disability prevalence data from the DFS for locomotion (L1 to L13 are the questions listed in table 2) and reach & stretch (R1 to R10 are the questions listed in table 3). From the Inclusive design toolkit: user capabilities. Source: Clarkson, Coleman, Hosking, and Waller (2015).

As an example Table 6 and Table 7 show the locomotion and reaching and stretching ability levels of the HADRIAN participants, their prevalence within the database and the estimation of their prevalence in the UK population through the DFS. The final column also provides an indication of the number of the population who may be excluded if a participant with a given severity score in the database were excluded.

The data shown in the tables above provide an example of how the capabilities of the individuals in the HADRIAN user group could be used as indicators of the capabilities of the population. They also provide an example of how simulation tools more broadly could be used to support population level decisions and policies. Table 6 shows that there are 102 individuals in the database of which 63 have no impairment to their locomotion that registers on the DFS scales. As we know that the HADRIAN database has used the same method for severity level assessment as used in the DFS, it can be said that there are 63 individuals in this database whose locomotion ability is representative of about 39.5 million of the UK adult population. Exploring further there are 6 individuals in the database with a locomotion severity score 6.5 (L5). It can be estimated that there are about 226,000 people in the population with a similar level of locomotion capability. In terms of application, these correlations allow analyses performed with individuals from the HADRIAN database to be place in a broader context. As an example, a task may require a user to climb a flight of 20 steps to access a

Table 6. HADRIAN severity scores and DFS-based population estimation for locomotion.

Locomotion severity score (L)	Number of persons in the HADRIAN database	Population estimation from the DFS (Thousands)	Population estimation from the DFS (%)	Cumulative population estimation from the DFS (Thousands)	Cumulative population estimation from the DFS (%)
No disability	63	39,455	86.5%	45,600	100.0%
L13 (0.5)	0	626	1.4%	6,145	13.5%
L12 (1.5)	0	41	0.1%	5,518	12.1%
L11 (2.0)	0	110	0.2%	5,477	12.0%
L10 (2.5)	6	784	1.7%	5,367	11.8%
L9 (3.0)	11	1,438	3.2%	4,583	10.1%
L8 (4.0)	0	414	0.9%	3,145	6.9%
L7 (4.5)	1	398	0.9%	2,730	6.0%
L6 (5.5)	1	598	1.3%	2,332	5.1%
L5 (6.5)	6	226	0.5%	1,735	3.8%
L4 (7.0)	5	256	0.6%	1,508	3.3%
L3 (7.5)	3	221	0.5%	1,253	2.7%
L2 (9.5)	1	833	1.8%	1,031	2.2%
L1 (11.5)	5	198	0.4%	198	0.4%
Total	**102**	**45600**			

Table 7. HADRIAN severity scores and DFS-based population estimation for reach and stretch.

Reach and Stretch severity score (L)	Number of persons in the HADRIAN database	Population estimation from the DFS (Thousands)	Population estimation from the DFS (%)	Cumulative population estimation from the DFS (Thousands)	Cumulative population estimation from the DFS (%)
No disability	81	43,859	96.2%	45,600	100.0%
RS10 (1.0)	5	279	0.6%	1,741	3.8%
RS9 (2.5)	15	390	0.9%	1,462	3.2%
RS8 (3.5)	0	113	0.3%	1,072	2.4%
RS7 (4.5)	1	306	0.7%	959	2.1%
RS6 (5.5)	0	159	0.4%	653	1.4%
RS5 (6.5)	0	130	0.3%	494	1.1%
RS4 (7.0)	0	90	0.2%	364	0.8%
RS3 (8.0)	0	159	0.4%	274	0.6%
RS2 (9.0)	0	69	0.2%	116	0.3%
RS1 (9.5)	0	47	0.1%	47	0.1%
Total	**102**	**45600**			

train station platform. This platform has no lift or ramp and thus the steps are the only means of access. A locomotion severity score of 6.5 (L5) is defined as "cannot walk up and down a flight of 12 stairs" and thus individuals categorised as L5 would not be able to complete the task and would be excluded from catching trains at the station. From the population estimations, it would also be possible to conclude that up to 226,000 adults in the UK would also be excluded. However, it is also possible to assume that, if those categorised as L5 are excluded, anyone with a greater level of disability e.g. L1-L4 would also be excluded. The right hand column in Table 6 and Table 7 is estimated by cumulatively summing the numbers of the population in the current level of severity with all levels of greater severity. Thus for the train station example, a flight of 20 steps actually has the potential to exclude 1.7M adults in the UK based on locomotion alone.

Returning to the bus simulations described earlier. The perception may be that there are some modest issues with traversing a bus for older passengers. If we place the results in context and evaluate the impact with more of the HADRIAN sample a clearer result can be obtained that may support the need for an intervention. For example if the assessment was repeated with participant 92, an 83 year old female, who has a reaching and stretching severity score of 2.5 (RS9), defined as "cannot hold one arm out in front or up to head (but can with other arm)" it is likely that this individual could not complete the task. As shown earlier, it is likely that two hands would be required to provide an older passenger with the ability to brace themselves against movement of the vehicle. The implication on P92 not being able to complete the task is that up to 1.5M people in the UK adult population would also be unable to complete the task. Thus, the conclusion might be drawn that the UK has buses in general service that are potentially dangerous for more than a million people within the current adult population if standing whilst the bus is moving. This conclusion is not particularly unexpected as it is well understood that passengers and particularly those who are older should not stand on a moving bus. Equally from discussion with bus operators and drivers, training suggests that drivers should not move off until older passengers are seated. However, these situations do occur and the accident data shows that older people continue to be injured and killed in these situations. Simulations such as those shown above, together with the ability to extrapolate the results to provide an indication of the magnitude of an issue at a population level, provide a means to obtain objective data to inform whether an intervention should be made.

9. Discussion

The potential of simulation tools such as HADRIAN that combine rich and applicable data on people together with the ability to assess existing or future designs provide an opportunity to evaluate accessibility in a proactive manner. This simulation capability can then be used to further explore issues that may be identified through a range of other sources from focus groups through to accident data. This understanding can focus on the detail such as causation, or can take a broader look at the potential impact of the issue through the potential to quantify the magnitude of the problem. As discussed, identifying a number of individuals who have a problem with a given design or environment is useful, however being able to gain in insight into the broader representation of these problems within the population has the potential to support decision making on possible interventions or design decisions in a much clearer manner.

However, this approach is not without its complexities. The correlation of individuals in the HADRIAN database with population estimations has to be considered with care. In the first instance the DFS survey was of 7300 people from which they have statistically extrapolated the representativeness to the whole UK adult population. So in many ways the concept is extrapolating one individual's capabilities to a proportion of 7300 people to a proportion of the UK population. This includes many assumptions and this requires the totals to be taken in an advisory context. Furthermore the DFS survey is now nearly 20 years old. The data within it are likely to be less representative of the population than they were particularly with an ageing population. It can be seen that in the 20 years since the survey was conducted the proportion of the UK population that is 65 years and over has increased from 15.8% to 17.7%. In addition the population itself has increased from 45.6M adults to 52.25M (Office for National Statistics, 2015). The implications of these changes is unknown and it may be possible to assume that an increasing older population would increase the prevalence of disability and increase the numbers in each of the DFS categories, making current estimations conservative. However our ageing population is also due to people living longer, thus our ageing population may be more able, making current estimations pessimistic.

The DFS survey itself is also somewhat problematic for this kind of application. As discussed by Waller, Langdon and Clarkson (2010) the DFS survey was never intended to support this kind of analysis and has its own limitations in sampling, interpretation of the responses and in the questions/categories it defines. For example the categories mix broad abilities. As described earlier, L5 is defined as "cannot walk up and down a flight of 12 stairs" whereas L7 is defined at "cannot bend down far enough to touch knees and straighten up again". The categories assume that someone at level L5 is more disabled than someone at L7, however being unable to walk up 12 stairs does not necessarily mean you cannot bend down to touch your

knees. Whilst the categories have a broader scope than might be considered ideal, they can be largely described as univariate, dealing with one type of disability in each case. However, most tasks are multivariate. Requiring a combination of locomotion, reaching and stretching, dexterity etc. These combinations are not accounted for in this approach. If a HADRIAN participant has a combination of ability levels of which a number are relevant to a particular task, the exact reason they may be excluded may be difficult to filter out from the combined ability of that individual. For example, Participant 96 in the database is a wheelchair-using older woman, can only walk a few steps/cannot walk up or down one step (score 9.5 for Locomotion), cannot get in/out of bed without help (score 9.5 for Personal Care), has difficulty using a pen or pencil (score 5.5 for Dexterity), cannot hold one arm out in front or up to head (but can with other arm) (score 2.5 for Reaching and Stretching) may be excluded from a task for any combination of those factors. HADRIAN does provide some insight into a task failure and where this has a clear mapping to the DFS categories the population estimation may be clearly defined. Research such as that performed by Clarkson et al. (2015) has attempted to unpack some of the interrelated nature of these data in their inclusive design toolkit. However, further research is still required to address the limitations with the DFS data to make them ideally suited to this form of application. At present, for situations in which a task failure is attributed to an ability that crosses DFS categories the population estimation would be down to the practitioner using the system to decide the most relevant category to estimate the percentage of the population potentially affected.

10. Conclusions

In order to support practitioners in the development and implementation of socially inclusive policy and design changes, a software simulation tool called HADRIAN has been developed. HADRIAN works with a digital human modelling system called SAMMIE to allow virtual users to assess the accommodation of existing or planned designs. The use of the simulation tool, through a case study exploring the safety of standing passengers on UK buses, has highlighted the ability to identify accessibility issues for individuals within a virtual user group. Such an approach has the potential to provide an understanding for practitioners on the issues that might be faced by real people. Whilst only one virtual user has been shown in this paper, digital evaluations combined with automated analysis of virtual user-groups has the ability to evaluate the experiences of up to 102 virtual humans in the case of HADRIAN in a manner that is expedient, and avoids the ethical issues with real-world user trials. The experiences of the individuals are further explored through their correlation with the disability follow-up survey of Great Britain. Using the survey's findings, it is possible to make broad estimates of the potential population impact of an individual virtual user being excluded through poor design. The correlation process does have its own concerns as the original data were never intended to support his form of application and so the data must be treated with care. However, even with the acknowledged limitations, a further understanding of the potential representativeness of any simulation results would be beneficial. Together the approaches provide a possible means of exploring social inclusion and accessibility issues that consider individual user needs, whilst also providing a means to quantify the impact on the population of a policy or design change.

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Conflict of Interests

The authors declare no conflict of interests.

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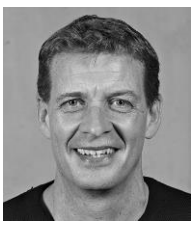

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Article

The Effect of Transport Accessibility on the Social Inclusion of Wheelchair Users: A Mixed Method Analysis

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Abstract
In recent years the accessibility of London buses has improved with the introduction of ramps and wheelchair priority areas. These advances are meant to remove physical barriers to entering the bus, but new conflicts have arisen particularly over the physical space aboard. We aimed to research the barriers faced by wheelchair users in public transport using a mixed methods approach to establish the breadth of issues faced by wheelchair users. To this end we quantified the push-force used alight a bus and a study to understand the coping mechanisms used by people to propel up a ramp. This quantitative approach found push forces which resulted in a load of 2 to 3 times body weight being transferred through people's shoulders, forces which can be directly linked to shoulder injury. This could disable the user further, preventing them from being able to push their wheelchair. Alongside the quantitative study, we conducted qualitative research comprising of a number of in-depth interviews with wheelchair users about the barriers they face in public transport. Our main claim, highlighted through this interdisciplinary collaboration, is that proposed 'solutions' to accessibility, such as ramps, often generate problems of their own. These barriers can affect the life of wheelchair users, impacting on their confidence and causing social isolation. These can be long-term in nature or immediate.

Keywords
accessibility; disability; interdisciplinarity; public transport; science and technology studies; Transport for London; wheelchair

Issue
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1. Introduction

> "If I were to ask you to describe transport accessibility for wheelchair users in London as it is today with three words, what are the three words you would choose?"
> "Well-intentioned. Inadequate. Uninspiring." (Peter)

With three adjectives, Peter painted a less than ideal image of London's public transport from his perspective. A 25-year-old lawyer who works and lives in Central London, he carefully chose where to live in the European capital to ensure an easier commute, requiring only a short underground journey on the famous Tube network. His is one of several stories and ways of talking about transport and its impact on people's lives, particu-

larly the influence that transport (in)accessibility might have on wheelchair users' social inclusion. In this article, we want to consider transport and inclusion with wheelchair users' accessibility to the network as the primary focus by using two, quite different, disciplinary approaches—sociology and engineering. The aim is to highlight how both approaches demonstrate, in different ways, how solutions proposed to improve accessibility may also generate future problems for wheelchair users.

In 2005, the main transport authority in London, Transport for London, introduced low-floor buses with boarding ramps for wheelchair users. These buses would eliminate some obvious physical obstacles (compared to the previous model of buses, the Routemaster, which had a step) and permit wheelchair users to board and alight buses, ensuring their inclusion to one mode of the public transport network. However, as we will discuss below, this implementation was not the end of accessibility problems as wheelchair users can also face other issues. Indeed, with wheelchair users being able to physically use the bus, other conflicts began to appear generated by these improvements.

This research was initially developed as a pilot study in 2013 as a collaboration between the UCL departments of Civil, Environmental and Geomatic Engineering and of Science and Technology Studies. The intention was to think about accessibility from both perspectives, quantitative and qualitative, with the aim of seeing whether these two ostensibly incommensurable disciplines could inform each other and provide new insights into transport accessibility for wheelchair users. The aim of this article is to explore the initial results of this interdisciplinary collaboration. To begin, we will briefly describe the policies and regulations which frame transport accessibility in the UK and, more specifically, London. We will then address the question of accessibility with a mixed methods approach, developed below in two separate sections: the first offers a quantitative analysis from an engineering and biomechanics perspective. The second section takes on a qualitative approach, based on the field of Science and Technology Studies. In the last section we ask what new insights were acquired through the collaboration of engineers and social scientists, and discuss the rigidity of the transport system in London as it affects wheelchair passengers.

2. Background

Public transport is incredibly important to disabled people in Great Britain. In a recent report analysing secondary data by Jolly, Priestley and Matthews (2006) it was found disabled people attach a greater importance to and almost half are totally reliant on public transport for each journey they take. The main reason for public transport reliance is a lack of access to a car. However, disabled people travel a third less than the general public (Miller, Gillinson, & Huber, 2006). When public transport is not accessible then mobility can not happen, which in turn can isolate people from the economic, political and social life of the community (Kenyon, Lyons, & Rafferty, 2002). There are 1.2 million wheelchair users in England (National Health Services Modernisation Agency, 2004). Wheelchair users have specific access needs as most find gaps and steps difficult to overcome, therefore a ramp is needed to overcome the naturally occurring gap between the footway and the bus. Specific to London, guidelines have been developed for accessible bus stop design, and accessible buses (Mayor of London, 2006). A key guideline in this document is the need for a wheelchair accessible space and an interface between the bus and footway which results in a ramp gradient of less that 12% (7 degrees). It is believed this gradient is a compromise between reducing the necessary push force needed to ascend or descend the ramp, and the requirements of the built environment.

Accessibility is a term which means different things to different audiences, generally due to the scale over which it is being measured. At a micro-level accessibility can be measured using the Capability Model (CM), which focuses on measuring the Provided Capabilities of the person when undertaking a task and comparing these to the Required Capabilities of the task (Holloway & Tyler, 2013). In this respect the CM looks to understand accessibility by understanding the interactions between the person and the environment. Holloway and Tyler explore the CM with regards to attendant wheelchair propulsion noting that when an assistive technology such as a wheelchair is used by someone this then enhances their provided capability set (for most tasks). In a similar manner the bus ramp can be assumed to reduce the required capabilities thereby increasing accessibility. The CM looks to address how people accomplish these tasks, these 'coping strategies' can range from simply avoiding an activity or adapting the movement required to complete the task. The engineering component in our research uses the Capability Model as its framework to discuss the difficulties wheelchair users have while boarding and alighting a bus. It uses peak and average tangential force when pushing up a standard bus ramp to quantify the provided capability. A model of how a person pushes is developed and the forces occurring at the shoulder are used as a secondary measure of provided capability, while the muscle activity patterns of pushing are used to describe the coping strategies.

On the other hand, accessibility can also be understood from a qualitative perspective as a potential factor for inclusion. Here, we need to listen to people's own experiences of the public transport system to grasp the barriers they face. In our research, the social sciences approach based its framework on the field of Science and Technology Studies, which has built up a substantial body of literature that analyses scientific processes and technological innovation not as 'things in themselves' but as institutions comprised of both things

and people. As such, any new or changing technology must be considered alongside the variety of users, producers, maintainers, regulators and other groups which come into being or change with the technology itself (Bijker, 1997; MacKenzie & Wajcman, 1985).

The public transport system lends itself aptly to an STS analysis, particularly given the work of Actor-Network Theory (ANT) scholars, some of whom have already worked on transport networks (Galis & Lee, 2014; Latour, 1996). In ANT, a system such as the transport network is perceived as being composed of more than just 'things'. It has its buses, trains, tracks, gears, engines, roads, but it also embraces a much wider variety of actors, from the drivers and staff to the passengers, but also includes diverse groups such as regulators, engineers, mechanics, and others. Moreover, the size of London's public transport system, the placement of its stations, bus stops, the employment of thousands of staff members and the way it transfers millions of passengers, we can see it as a large sociotechnical system with the ultimate goal of carrying its users across the city (Hughes, 1987). A key advantage of viewing the transport system in this way is that it foregrounds the fact that different actors will view the system differently, for instance, a 'perfectly reasonable regulatory standard' from the perspective of managers may be a 'pointless impediment' from the perspective of wheelchair users. Moreover, some of these perspectives may be particularly prominent and visible, whilst others are rendered invisible and marginal (Star, 1991).

STS has also developed some literature which works with disability and disabled people (Blume, 2009; Blume & Hiddinga, 2010; Winance, 2006), but much of this work is concerned primarily with the development of prostheses and how it interacts with the disabled person (and vice-versa) or with definitions of (dis)ability. Our work, however, will be primarily directed towards thinking about the shaping of the public transport network in London, an example of a sociotechnical system, in which a constellation of human and non-human actors come together to permit passengers to reach their destinations. Additionally, underlying this system there is a history of choices that have been made pertaining to its design and elaboration—choices that impact the users in a variety of ways, both overtly and covertly (Winner, 1980, Woolgar 1991). This observation highlights that the system could be different. Different choices could (and can) be made (Bowker & Star, 2000; Lampland & Star, 2009; Star, 1991). Our interviews with wheelchair users sought to re-insert their voices and experiences as active participants within this socio-technical system.

3. Methods

During the pilot study, we recruited a number of wheelchair user volunteers to come to the Pedestrian Accessibility Movement Environment Laboratory (PAMELA) where they would engage in two activities. The first consisted of asking participants to board and alight a bus with the gradient set to 7 degrees. The experiments were recorded using the CCTV cameras on-board the bus and these were analysed to determine the components of the task which caused difficulty. In particular, time to complete tasks, number of pushes and number of attempts were recorded. Having participated in the engineering component of our research, the participants were invited back into the reception of the PAMELA facility. They were then engaged in in-depth, semi-structured interviews covering themes around their experience of the London public transport system. These interviews were recorded, transcribed, and then coded using data analysis software according to recurring themes using standard qualitative methods (Silverman 2006; Weber, 1990). Interviewees' names have been anonymised, using pseudonyms of their choice. Unlike quantitative survey techniques, qualitative research does not seek a statistically representative sample but instead seeks to explore, in depth, people's experiences and the meanings they attach to those experiences (Berg, 2001; Seale, 2004).

As our sample sizes for the pilot study were initially small (four participants), the data we are using here has been supplemented for both branches. For the engineering component, we ran an additional study in the PAMELA facility with seven male participants with a history of spinal cord injury. We had initially aimed to have an equal gender split but we struggled to recruit people for the study and failed to recruit any females unfortunately. Each participant used a manual wheelchair as their primary form of mobility. Participants were asked to propel a manual wheelchair on a stretch of level paving, up a 6.5% incline and up a 12% incline. On the qualitative side, a series of 18 semi-structured interviews with wheelchair users in London were undertaken in the summer of 2015. This additional data brings the total number of interviews with wheelchair users in this paper to 22, covering a wide variety of impairments, age, gender, and employment status.

4. The Engineering/Biomechanics Approach

4.1. Pilot Study

As the numbers were so few in the pilot study, the aim was to understand how people completed the task as opposed to quantifying exactly how difficult it was. The follow-on study which just took a single component of the task—the ramp push—was then conducted to understand exactly how hard the task is. In this instance, wheelchair users were asked to board and alight a bus three times, each time in a way which was easiest for them. For all participants, video was recorded using the standard CCTV cameras on-board a bus (see Figure 1).

The video data was analysed using video observation software and the GPS clock displayed on the top left corner of each recording. A proxy for provided capability of task time was used to understand how difficult the task of boarding and alighting was for the wheelchair user. Task time was calculated for each trial from this analysis and a description of how each person boards and alights a bus was developed. In addition the coping mechanisms used by people were observed.

There was no difference in alighting time with each person consistently exiting the bus in 4 seconds. However, differences in technique and ability meant that there was a clear difference in boarding time, which is shown in Figure 2. In particular participant MM needed to use the handrails to pull herself onto the bus and CH failed on two attempts to board the bus on the first time on two of the runs. With regards to coping strategies people adapted their pushing style in different manners. For example in Figure 1 it can be clearly seen that CH leant forward to maximize the pushing time. However, others used the yellow grab handles or shorter faster pushes to complete the task.

It was apparent by these coping strategies that people were struggling to manage the task. It was decided, following this pilot, to complete a more controlled assessment to compare the amount of force used (provided) to board a bus (a short, steep ramp) with a longer, less steep ramp and also flat footway pushing to understand the potential accessibility barrier posed by a bus ramp. This was conducted in the detailed biomechanical study.

4.2. Detailed Biomechanical Study

The detailed biomechanical study is fully described in Holloway et al. (2015). However, the methods are summarised here to aid the reader. Seven male participants with a history of a Spinal Cord Injury attended PAMELA facility. Each participant used a manual wheelchair as their primary form of mobility. Participants were asked to propel a manual wheelchair on a stretch of level paving, up a 6.5% incline and up a 12% incline, which was chosen to replicate the incline found on a London Bus access ramp. During the propulsion tasks, forces applied to the wheelchair push rim to estimate the provided capabilities of the user. In addition upper limb joint movement and shoulder joint muscle activity were recorded and used as inputs to a computer model of the upper limb, to estimate forces experienced at the shoulder joint. Shoulder joint forces have been shown to be correlated to shoulder pain and injury, therefore we think it is essential to understand the forces produced in undertaking the accessibility tasks both in terms of quantifying provided capabilities and also understanding the effect of coping strategies. It should be noted that all participants were free of shoulder pain at the time of this study and had not had a recent shoulder injury or pain.

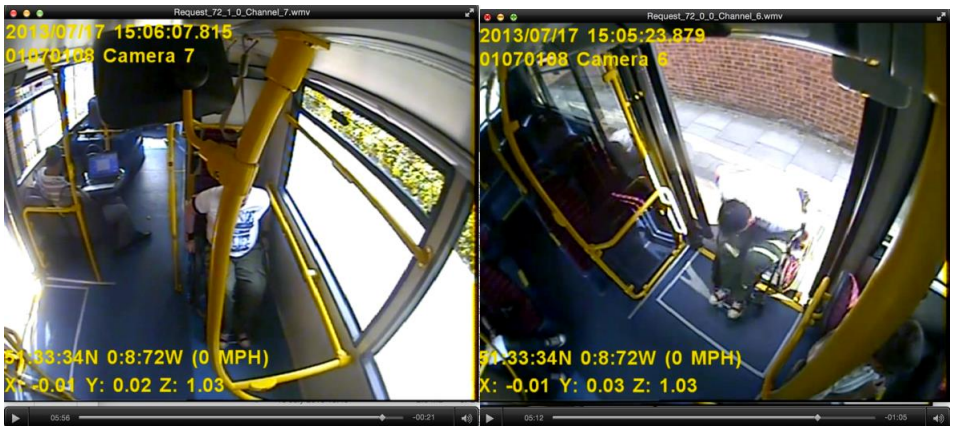

Figure 1. Showing a screen grab of each of the video playback angles used for task time analysis.

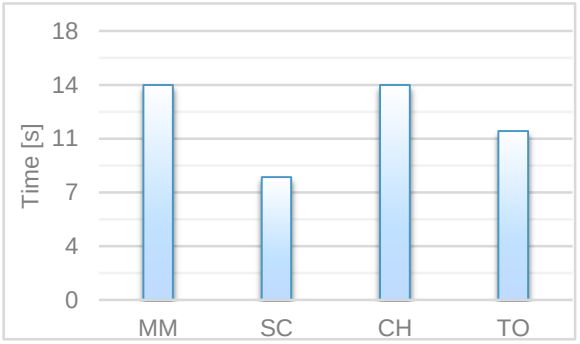

Figure 2. Boarding time (averaged over 3 runs) for each person.

4.2.1. Results of Detailed Biomechanical Study

Provided Capabilities: The total propulsion forces applied to the wheelchair push rim were significantly affected by the tasks. Climbing the 6.5% incline people used significantly greater force than level propulsion (106.90N vs. 50.36N), and climbing the 12% incline people used a significantly greater force than climbing the 6.5% incline (139.63N vs. 106.90N). These forces translated into significant increases in shoulder joint forces experienced during the incline propulsion tasks. During level propulsion, peak shoulder joint forces were under one body weight. During the 6.5% incline, peak shoulder forces were over two times body weight and during the 12% incline task, peak shoulder forces were over three times body weight.

Coping strategies: How each individual managed to generate the push force varied and this is reflected in the different muscle activity. Generally there were significant increases in peak muscle activity levels during the incline tasks compared to level propulsion. During level propulsion, peak muscle activity levels around the shoulder joint were on average 26% of maximum. When climbing the 6.5% incline, peak muscle activity levels were on average 63% of maximum and when climbing the 12% incline, peak muscle activity levels were on average 77% of maximum. Interestingly it would appear that when going up a 6.5% slope the deltoid, which is the very large muscle at the top of arm reaches a maximum, and as the person attempts to go up a 12% slope they are forced to increase the amount of muscle activity in smaller muscles such as the infraspinatus.

5. The Social Science Approach

5.1. Findings

During the interviews, we spoke to wheelchair users about the barriers that they face and the impact that this has on their daily life. Through the 21 conversations, we attempted to understand the origins of problems these users might face and whether we could attempt a classification of these barriers. Through coding the interviews, we generated three heuristic categories of problems narrated by the interviewees as distinct moments and barriers: spatial, technical, and social. Here, we would like to reinforce that these classifications are actor's categories. For example, while accounting their experiences, our interviewees would narrate the barriers as distinct moments, e.g. "One day, I had a problem because of the ramp. Another day, I had a problem because of the lack of space."

5.1.1. Technological Barriers

> "I've been to so many bus depots because the ramps were broken and I can't get off. You end up going to a depot." (Adam)
>
> "I accept that it's improved and improvements that have been made have been amazing in some respects, but on the other hand, it's still as if…. It's still as stressful if not more stressful because the wonder of technology is the wonder that it ever works." (Michael)

In order for the space on the bus to even become an issue as a passenger, a wheelchair user must first be able to board it at all. Transport for London prides itself in its fleet of low-floor buses, all of which have mechanical ramps to be deployed for a wheelchair user to be able to board and alight. This change in the rolling stock of London buses in 2005 was a true turning point for accessibility throughout the city. It is, of course, dependent on this technological artefact functioning as intended: a broken ramp, which might break either before or after the wheelchair has boarded the bus, can mean a passenger having to wait hours or take a long detour. What emerged in our interviews is a sense of the wide variety of ways things could go wrong on buses and throughout the transport system.

Wheelchair users are dependent on boarding ramps when it comes to the London Overground and Underground train stations that are accessible from street-level to the platforms. Here, however, it is not just an issue of the ramp working. These are low-tech versions of the fitted, mechanical ramps on buses and are dependent on others deploying them correctly:

> "The chap with the ramps did arrive and he went to put the ramp for me get off with the doors open. The driver of the train either hadn't seen him or didn't want to see him because they were running behind schedule, or whatever, so the doors shut with the ramps in a half position, me inside, and actually clunked the chap on the platform so he fell over." (Basil)

It becomes particularly interesting to think about the ramp as a potentially problematic factor in accessibility for wheelchair users when we think back to the research done by engineers. Despite none of our interviewees having mentioned developing joint pain as a result of ramp inclination, this is still a problem which engineers have pointed out. In addition, some wheelchair users have mentioned the steepness of ramps as a problematic factor in accessibility as it makes their boarding of the bus more difficult, and their alighting more dangerous.

There is a variety of technological 'bits and bobs' which also frustrate and hinder wheelchair users beyond the practicality of the ramps, both manual and electric. For instance, inside the buses, a special button by the wheelchair priority area is supposed to be used to alert the driver that they would like to get off at the

next stop. This allows the drivers to get ready to deploy the ramp, and makes a sharp siren noise to get their attention. The siren noise is also activated continuously while the ramps are being put out and coming back in, perhaps to alert other passengers and passers-by on the street of what is happening. Interviewees such as Alex and Sophie have expressed some discomfort at this because it calls attention to them, and even expressed the experience as akin to public humiliation:

> "[Imitates alarm noise] And everyone looks, everyone stares, and I'm like, yeah, I'm just getting on the bus." (Alex)
> "So I don't like the fact that there's the siren that starts wailing at you, or at everybody, when you're about to get on or about to get off the bus. It's all a bit of a big faff, but you get used to it. I mean, public humiliation seems to be…you've got to be able to deal with it if you're disabled anyway, because people will look at you, people will…etc." (Sophie)

Despite such barriers not affecting the physical acts of boarding and disembarking, they impact on wheelchair users' wellbeing, their impressions of the public transport system and, in the above quote, compound Sophie's existing sense of being stigmatised. These negative experiences play into their personal perceptions but also on their desire to use the network and overcome potentially being confined to their home and to engage in activities beyond their local community.

5.1.2. Spatial Barriers

> "You're in a chair and you can't move and you can't get out of the space so they tend to close up around you." (C.S.)
> "You'll hear this time and time again, there's generally only one wheelchair space, but it's also the space that can be used for toddlers, buggies, suitcases, and things like this." (Basil)
> "And also sometimes you know, they have rails that are probably in the way of the user to manoeuvre within the space." (Um Hayaa)

Space is an inevitable part of the background whenever people speak in general about transport: moving around the city; going from Northeast to Southwest; or the mileage from one stop to another (Vertesi, 2008). For wheelchair users, another kind of space was present in our interviews: personal or manoeuvrable space. In the above quotes, the 'space' referred to is the 'wheelchair priority area', a demarcated location on the bus which is specifically designated for these passengers' use. It is prescribed as "the only place wheelchair users can travel safely" (Transport for London, 2014, p. 70) and these passengers are required to place themselves facing opposite to the direction of travel.

Despite the title of 'wheelchair priority space', interviewees reported that it is often a key source of anxiety before travelling. The issues around it are many, from the size of their own wheelchairs and difficulty manoeuvring in or out of the space, to the sadness of not being able to travel with a friend who is also a wheelchair user, or even the much publicised debate around buggy and pushchair users or luggage sharing the space (Bellisario, 2012; Moss, 2013). The direction of travel can also provide a degree of frustration and discomfort. In these cases, the users described how they subvert the wheelchair space by travelling in a way that suits them best:

> "For me, I prefer to go face-in and hold on to the rails, I find that fine. The reverse side, I sometimes get that sick feeling." (M.)
> "I suffer sometimes with travel sickness and so I find it easier sometimes to sit the opposite way to how you're supposed to sit in the wheelchair space." (Michael)

Despite this subversion of the space, this can also be the source of anxiety, as both interviewees laughed nervously and mentioned they probably should not be saying that. They expressed that some bus drivers understand, but that it is often a risk in terms of their, and other passengers', safety. Interestingly, here we find another example of a potential solution to wheelchair users' travelling needs which is also proving to be more complicated than initially intended. Like the ramp, the wheelchair priority area was meant to facilitate accessibility but is also a source of anxiety.

5.1.3. Social barriers

> "Obviously, you've heard about the problems with wheelchairs vs. buggies on that space. That's not the only problem that you'll actually find. You'll find that you've got people standing in the space who don't necessarily want to move, or you've got people who've got luggage in the space who don't want to move, or you've got older people who've got their shopping trolley in the space. That's always very problematic." (Marie)
> "It is like a battle of wheels, buggy versus wheelchair. It should never, never be that way. It should never be that way." (Faith)

The category of social barriers—by which we specifically mean barriers created by other people—was particularly evident when interviewees discussed what has perhaps been the most prominent debate in the UK media around transport accessibility, the "wheelchair vs. buggies" priority debate. In 2012, Doug Paulley sued FirstGroup in Yorkshire after having been denied access to a bus because the space was occupied by a

mother with a pushchair (Press Association, 2014). Three years and one overruling later, the case has escalated and will be heard by the Supreme Court in the UK. It was previously established that the wheelchair area should be used on a first-come, first-served basis but for the wheelchair users we interviewed this can sound outrageous when they are only given one space to ride on the bus.

> "A buggy can fold, they have that option." (M.)
> "And when I see things like that, my reaction is, it's not about who's more important, it's about who has a choice; so I do not have a choice about my use of the wheelchair whereas a baby can be got out of its buggy." (Diana)

After research done in 2012, Transport for London launched a campaign that November to address the issue, with campaign posters on buses and at bus stops in bold black and red letters asking, "Buggy users, please make way for wheelchair users". Interviewees' perceptions on the impact of that campaign were mixed, but conflicts with bus drivers were also mentioned as a source of anxiety. In some cases, they reported, drivers are unclear on the rules of whether a wheelchair user and a buggy are allowed to share the space, or in some cases drivers simply do not stop the bus at all for a wheelchair user to board it.

> "I've had buses drive past me without even stopping, you know, and I've been sent to the end of the route occasionally because they've forgotten I'm actually on the bus." (Michael)

Yet these conflicts with buggy users and drivers are not the only social barriers for wheelchair users. A large number of interviewees expressed concern at social attitudes towards disabled people in London. Negative reactions towards them take a variety of forms such as awkward "nosy questions", invading their personal space by pushing their wheelchair without asking, or even outright verbal and physical abuse. Participants described these social issues as a mix of a lack of public awareness around disability and, according to some interviewees, a media push towards depicting disabled people as "scroungers". To some, this stigmatisation is being done with the government's support:

> "I think we've only got the rights that we fought for and it takes constant ambition to add onto these fights because in the interest of saving money our government has, I believe, quite deliberately and callously waged a media campaign depicting us as a drain on the state and an unacceptable one at that." (Leda)

Although our focus in this article is on barriers, it is important to add that these negative views were also matched by comments from the interviewees that there was a willingness to help. Moreover, in three interviews the wheelchair users explicitly stated that they had no issues with buggies at all.

5.1.4. Isolation

These three different sources of barriers to using the public transport system create a sense of anxiety and frustration in the wheelchair users we interviewed, but perhaps more problematic is the social consequence of this fear. For instance, when asked what happens when a trip goes wrong and they are faced with a barrier, Marie described how all you can do is complain to the transport authority and, in response, receive a generic email. She explained that this "puts you off" travelling:

> "It isolates you even more because your world is getting smaller, and smaller, and smaller, all the time…." (Marie)

A functioning, accessible, transport system, particularly in a city as large and crowded as London, is the difference between being able to get around, and isolation. Options to public transport would include taxis or personal cars, which are described as "luxury" items but also, in some cases, as the only viable option.

> "If I use an adapted vehicle, it's much better, much easier, than being pressured to wait in the cold at the bus stop hoping that the first bus will accommodate my needs." (Um Hayaa)

Um Hayaa had to resort to private transport to pick up her daughter from a variety of after school activities, otherwise she would have had to take three different buses, each trip fraught with the anxiety of broken ramps, impatient drivers, and not enough space. However, she had to make an investment choice to purchase a vehicle, one which not all wheelchair users are able to make. Sophie, who also makes use of a private vehicle, described how aware she is that it is a privilege not to worry about public transport. Beyond the costs of a private car, wheelchair users often have to worry about the costs related to their mobility aid itself. She explains:

> "Disability is a luxury that not many people can afford, and that's the problem. People don't realise how expensive everything gets. Either how isolated life is if you don't have the money and/or the equipment, which, equipment means money. And that's why people are so scared of disability." (Sophie)

The general narrative around the public transport net-

work in London for wheelchair users that emerged in our interviews centres on anxiety, pre-planning, battles, and effort. The consequence of these impediments, it is suggested, is greater isolation for these groups. In the words of one of our interviewees:

> "I'm sure you know, getting out and about changes people's lives, and it makes things…. Being social makes you much more alive, much healthier, and public transport is really good for that if you've got that option[.]" (Alan)

6. Discussion

6.1. Well-Meaning Solutions

When Transport for London writes about accessibility in its network, many figures are cited, from its bus fleet being 98% low floor access (the few exceptions being some older Routemaster models still used on Heritage routes) to a quarter of the Tube stations and half of the Overground stations having step-free access. All of these figures are to be welcomed. The image of this network is quite positive, and wheelchair users do seem to benefit extraordinarily. But this should not allow us to ignore that the reality of the network does not always match these numbers, and wheelchair users still face the variety of barriers described above.

In addition to the barriers wheelchair users themselves describe as facing, the engineering section of our research has found that with each push the make, they further wear their shoulder and eventually, nearly all will have upper limb injuries, some so severe they will be unable to independently push themselves. A number of factors effect the development of injuries and the associated pain. These include: the cyclical nature of the wheelchair push cycle (Kotajarvi et al., 2004; Mercer et al., 2006), the low gross mechanical efficiency of wheelchair pushing—only 10% of effort goes directly into making a person move forwards (De Groot, Veeger, Hollander, & van der Woude, 2002) and challenging surfaces (Holloway et al., 2012). To give an indication of the scale of the problem, the incidence of shoulder pain is reported to range from 42% (Dalyan, Cardenas, & Gerard, 1999) to 66% (Fullerton, Borckardt, & Alfano, 2003), with the most commonly reported injury damage to the rotator cuff muscles (Akbar et al., 2010).

It was found that upper limb demand and injury risk were significantly greater during incline wheelchair propulsion in comparison to level propulsion, which means that ramps at a greater incline for boarding and alighting buses and trains can further add to the risk. As the gradient of the incline increased, upper limb demand and injury risk increased. During level propulsion, on average, muscles around the shoulder were working at 27% of their maximum and joint forces were less than one body weight. During the 12% incline task, on average, muscles around the shoulder were working at 77% of their maximum, and joint forces were above three times body weight. The results demonstrate that a common daily task such as accessing a bus places a high demand on the upper limbs of a manual wheelchair user. Push force is an important factor in assessing the accessibility of transport for wheelchair users as it has been shown to be directly proportional to forces which occur at the shoulder. The shoulder is the most commonly injured joint for wheelchair users with injury rates ranging from 42% (Dalyan, Cardenas, & Gerard, 1999) to 66% (Fullerton et al, 2003). Shoulder pain can be so severe that it leaves the person without an independent form of mobility. It has been noted previously that the method of assessment of accessibility can affect the resulting guidance, and that even when guidance is followed it can be challenging to wheelchair users (Holloway & Tyler, 2013). Guidance such as *Manual for Streets 2* (Department for Transport, 2007) used by the UK to help produce accessible pedestrian infrastructure are not always produced based on empirical evidence, and are often developed via case studies or rule of thumb practice which. In a society where sensing technology is becoming ubiquitous, there is an opportunity to both collect more diverse and also dynamic datasets and to use these to assess infrastructure policy changes. Projects such as Wheelmap (www.wheelmap.org) and Accessible Routes form Crowd-sourced Cloud Services (www.arccs.org) are beginning to develop web and mobile tools to enable more dynamic modelling of accessibility. The challenge will be to understand how such crowd-sourced data can be used effectively to inform and evaluate policy, and indeed to see if it can be shared across traditional policy sectors e.g. health (rehabilitation) and transport (accessibility).

This data from the engineering component of our research is enlightening when paired with the narratives put forward by the wheelchair users themselves. As pointed out in section 5.2.1., though our interviewees did not specifically indicate developing an injury as a particular hinderance in their use of the public transport system, ramps did figure prominently as a potential barrier. Yet it seems ironic that the enabler of their access to public transport can also be a problematic factor. The same thing can be seen with the other aspects of 'accessibility': the alarms which signal ramp deployment are seen as unwanted attention, the wheelchair priority areas become contested spaces with pushchairs and luggage, etc. What our interdisciplinary collaboration has helped highlight is this paradox where well-meaning solutions do not simply solve the problems with accessibility. The engineering approach has shown this through ramp inclination when even where guidance is followed, injuries can still occur, while the sociological perspective has teased this

out from wheelchair users' description of the barriers they face. We would like to make it clear that we are not criticising the improvements that have been made as such, but rather that they should be taken as a lesson where, rather than thinking in terms of solutions as an end-point we should speak of ongoing conversations and of adjustments to the network. However, this becomes difficult if the public transport system is seen as a stabilised network.

6.2. Standardisation and Rigidity

It would come as no surprise to STS scholars that, despite the heuristic classification of the different barriers made by our interviewees into social, spatial, and technical origins, the problem is not always so clear-cut. Indeed, most STS scholars make the point that these classifications are rarely, if ever, obvious (Bowker & Star, 2000). In other words, despite the problem seeming to be due to a technical issue, it can also be related to spatial and social dimensions. Broken or faulty ramps are a good example of this blurring of categories. This technology was developed with sensors which withdraw if an obstacle is detected. If the ramp does not deploy appropriately when an obstacle is detected, is the barrier for the wheelchair user spatial or technological? The ramp does not work (technical) but is this because of spatial features such as the presence of street furniture, or the design of the curbs (either too low or too high)? Similarly, the debate around the wheelchair priority area can lend itself to a similar question: is the problem social (negotiating priority with other passengers on the bus) or is it spatial (the space is not big enough)?

The difficulty in drawing these lines is testament to how tightly knitted these different aspects of the network are, which brings us back to the notion of sociotechnical systems referred to in the background section above. In a system where there are numerous types of agents, human and non-human, physical and non-tangible (such as legislation), intense collaboration between all of them is imperative to make it a cohesive whole. Yet this very cohesiveness is dependent on another process, that of standardisation and consolidation. Hughes describes consolidation as the moment in the life of a sociotechnical system in which there are few competing systems (Hughes, 1987). Transport in London has definitely reached such a period in its development as it is controlled by a single higher authority, Transport for London. Historically, much work goes into reaching this moment of consolidation, mainly by passing through the development of standards, which function as a unifying language, to ensure that all different actors and agents of the system are communicating and compatible (Bowker & Star, 2000; Lampland & Star, 2009; Scott, 1998; Timmermans & Berg, 1997). Generally, this has been a successful process for most users of the London transport system, so why are experiences so irregular for wheelchair users?

Given the age of various means of transport in London, we can say that the process of standardisation and stabilisation have been ongoing for at least a century. The London Underground celebrated its 150-year anniversary in 2013. These processes happened throughout a period where the perception of disability and impairment were different. Disability Studies scholars argue that through the Victorian era and up until the 1960s, there was a medical model of disability which individualised impairments and placed the burden of care on the disabled person and/or their family. This model normalised the absence of disabled people from social settings, giving the idea that it was a person's impairment which hindered their inclusion into society. In the 1960s, the social model of disability made its first appearances with a series of disabled rights activist groups arguing that disability has its origins in social notions (Blume & Hiddinga, 2010; Davis, 1999; Linton, 1998; Shakespeare, 2006). The Union of the Physically Impaired Against Segregation defined disability as "the disadvantage or restriction of activity caused by a contemporary social organisation which takes no or little account of people who have physical impairments and thus excludes them from participation in the mainstream of social activities" (Union of the Physically Impaired Against Segregation, 1976).

It is only in the past two decades that accessibility has been added to the transport agenda in the UK, with the backing of legislation such as the Disability Discrimination Act of 1995, now superseded by the Equality Act 2010. Much of the negative experiences related by wheelchair users are arguably due to an initial lack of inscription of their needs into the transport network, which up until the past decades did not consider them as potential passengers, as well as a slow shift of social perceptions and assumptions about disabled people in general (Beckett & Campbell, 2015; Shakespeare & Watson, 1997). As Star argues: "A stabilised network is only stable for some, and that is for those who are members of the community of practice who form/use/maintain it" (Star, 1991, p. 42). For the moment, wheelchair users are still somewhat 'non-standard 'agents within this sociotechnical system and do not (yet) experience a stabilised network.

We argue that, perhaps precisely because wheelchair users are non-standard agents, they experience the transport system through its fragments rather than its entirety. For this reason, the narratives given by interviewees often point to different and diverse factors (space, people, technology) rather than the system as a whole (as ANT scholars tend to do). The use of standards as necessary to regulate and stabilise the system is what is now locking out these users from experiencing it as such. This is reminiscent of what Scott (1998) described in *Seeing Like a State*, where the establishment

of norms and regulations from a top-down approach does not necessarily translate in a positive and productive manner for those on the ground, such as the development of accessibility regulation still straining the bodies of wheelchair users and causing harm, as is shown by our engineering section. This feeds back to what was discussed in section 6.1. on prescribing solutions as an end-all, when for the many actors who interact with these proposals they may generate problems in and of themselves.

We would also like to briefly point out that it is important to remember that wheelchair users are not 'passive'. While these barriers strain their journey through the system, they also develop their own tactics for dealing with these issues. Our interviewees have provided some examples, such as M. in a quote above mentioning that she gets into the space facing forwards and holding onto the rails. Other examples from out interviews include wheelchair users carrying toolkits to fix ramps, 'bunny-hopping' off a bus or train, using their wheelchairs on escalators, or even organising activists group to campaign for improved accessibility. This is a rich area of research that merits further exploration in the future as it can provide some insight and suggestions for improvement in transport policy.

7. Conclusion

In this article we intended to think about accessibility through an interdisciplinary lens, using both an engineering and a sociological approach, and consider the new insights this collaboration might bring. Transport is an essential service to the population which ensures people's inclusion in society as it provides the link between the private (the home) and the public (the museum, coffee shop, Parliament, etc.) spheres. In the case of our participants, we can see that issues around the accessibility of public transport can lead to anxiety and social isolation, but also to physical injury. The collaboration between disciplines helped to highlight that what can be framed as a solution to barriers in accessibility can also generate problems in itself, such as ramps becoming broken or straining wheelchair users' bodies and causing harm. This is often due to the 'add-on' nature of some of these fixes onto a system that has already been mostly stabilised in the past century. Despite STS and ANT theories telling us that these systems are more complicated, our interviewees described the issues they face as physical, spatial, or social which we suggest is due to their experiences being fragmented.

For this reason, policy-making in transport, including the establishment of legislation, regulations and best-practice guides, should be developed in as plural a manner as possible where, rather than speaking in terms of 'solutions', ongoing conversations about improvements are held. The physical and spatial environment needs to be understood and people's abilities can be measured to provide better guidance. This should also be supplemented by the understanding that transport is an extremely large network which encompasses not only things, technologies and policies, but also a wide variety of people and social interactions. A plural approach to investigating the limits and weak points of public transport networks, including engineering, biomechanics, sociology, city planning, among others, can permit a wider range of solutions to be proposed.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Perceived Accessibility of Public Transport as a Potential Indicator of Social Inclusion

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Abstract
Perceived accessibility has been acknowledged as an important aspect of transport policy since the 70s. Nevertheless, very few empirical studies have been conducted in this field. When aiming to improve social inclusion, by making sustainable transport modes accessible to all, it is important to understand the factors driving perceived accessibility. Unlike conventional accessibility measures, perceived accessibility focuses on the perceived possibilities and ease of engaging in preferred activities using different transport modes. We define perceived accessibility in terms of how easy it is to live a satisfactory life with the help of the transport system, which is not necessarily the same thing as the objective standard of the system. According to previous research, perceived accessibility varies with the subjectively-rated quality of the mode of transport. Thus, improvements in quality (e.g. trip planning, comfort, or safety) increase the perceived accessibility and make life easier to live using the chosen mode of transport. This study (n=750) focuses on the perceived accessibility of public transport, captured using the *Perceived Accessibility Scale* PAC (Lättman, Olsson, & Friman, 2015). More specifically, this study aims to determine how level of quality affects the perceived accessibility in public transport. A Conditional Process Model shows that, in addition to quality, feeling safe and frequency of travel are important predictors of perceived accessibility. Furthermore, elderly and those in their thirties report a lower level of perceived accessibility to their day-to-day activities using public transport. The basic premise of this study is that subjective experiences may be as important as objective indicators when planning and designing for socially inclusive transport systems.

Keywords
perceived accessibility; public transport; social exclusion; social inclusion; subjective well-being; transport planning

Issue
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1. Introduction

Facing a future with ageing populations and an urging need for a sustainable development in transportation (Banister, 2008; United Nations, 2015), it now seems more important than ever to gather forces towards an inclusive sustainable transportation system that can offer high accessibility for all, including the disabled, those with physical or social impairments, or those who are not so young and able anymore.

It has been established that accessibility is positively connected to several travel outcomes, such as well-being (Parkhurst & Meek, 2014) and transport-related social inclusion (Farrington, 2007; Stanley, Stanley, Vella-Brodrick, & Currie, 2010) and that insufficient accessibility may cause social exclusion (Hui & Habib, 2014; Kenyon, 2011), proposing that accessibility is a key issue for research development on social inclusion and

sustainable transport planning. Up until now however, measuring accessibility has been limited to objective measures such as travel time or distance, not capturing the perceived accessibility of individuals or certain groups of people, limiting the usefulness of the link between accessibility and social inclusion since the measured accessibility may not capture the reality (Curl, Nelson, & Anable, 2011). This gap in measuring accessibility has been pointed out by researchers for years, urging for the inclusion of subjective accessibility (Budd & Mumford, 2006; Curl et al., 2011; Farrington, 2007; Handy & Niemeier, 1997; Stanley & Vella-Brodrick, 2009; van Wee & Geurs, 2011), but up until now not much has been done. In 2015, we developed a quantifiable measurement for perceived accessibility in public transport, the Perceived Accessibility Scale (Lättman et al., 2015). Perceived accessibility is based on individual assessments of accessibility, rather than on objective estimates, and in the current study, the work is continued by further exploring perceived accessibility in relation to transport quality, safety, travel frequency, and age, looking for significant determinants.

1.1. Accessibility

A popular and well-used definition of accessibility is "the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s)." founded by Geurs and Ritsema van Eck (2001). As the definition implies, accessibility has conventionally been closely linked to the ability to move (e.g., mobility), and more specifically defined and operationalized through objective measurements such as travel time, distance to train station, or distance and travel time to a selection of destinations. This is risky, not only because of the lack of individual perspectives, but also as targeting increased mobility for certain groups of individuals in a society, may inadvertently decrease the mobility for other groups whose mobility-preferences we are not aware of (e.g. by moving bus-stops, changing time-tables) and they may experience social exclusion (Kenyon & Lyons, 2003). However, the focus in transport planning has of late shifted from mobility to accessibility (Halden, 2011; Preston & Rajé, 2007; Qviström, 2015) widening the scope of focus, but still not including individual or group perspectives. Individual characteristics are known to influence a person's level of access to transport modes in terms of needs, opportunities and abilities that set temporal-spatial constraints (e.g. age and physical condition) (Geurs & Van Wee, 2004). Budd and Mumford (2006) found several flaws in the common generalization that high (area) accessibility equals high individual accessibility; meaning that objective generalizations do not take into consideration awareness of opportunities, ability to use, personal relevance or interest.

Accessibility to important activities is influential for subjective wellbeing (De Vos, Schwanen, Van Acker, & Witlox, 2013; Olsson, Gärling, Ettema, Friman, & Fujii, 2013; Parkhurst & Meek, 2014). Not having full access to different travel modes may thus exclude people from various activities and lower their subjective wellbeing. Many researchers are aware of this link; however, looking past proposed solutions to reduce travel hardships with the aim of increasing accessibility in a cost-effective manner (Martens, 2012), or using objective determinants as the basis for accessibility evaluations (Bekiaris & Gaitanidou, 2012; Kryvobokov & Bouzouina, 2014; Lucas, 2012; van Wee & Geurs, 2011), we argue that, in order to improve social inclusion and wellbeing, we need to understand what drives perceived accessibility and use this knowledge to make it easier for people to be a part of society. Thus, perceived accessibility to social activities and friends cannot be evaluated using conventional accessibility measures, since these choices and routes are highly individual.

We define perceived accessibility in terms of *how easy it is to live a satisfactory life using the transport system* which includes accessibility while using the transport system per se, ease of getting to the transport system, and the perceived possibilities and ease to live the life one wants with help of the transport system. We argue that, what needs to be evaluated in order to improve accessibility is whether or not the travelers themselves (or potential travelers) perceive the transport system as accessible, and something they are able to benefit from, and also to explore what determines the perceived accessibility.

1.2. Social Inclusion and Accessibility

Preston and Rajé (2007), influenced by Sen (2000) established a conceptualization describing social exclusion as caused by an absence of access to social opportunities, rather than a lack of opportunities per se. In line with this work The Social Exclusion Unit (2004) has worked from the perspective that the main solution for transport-based social exclusion is accessibility planning. More specifically, they state that aiming for an increased accessibility to services and key locations by the transport services is essential in preventing social exclusion. Following this, work by Kenyon and Lyons (2003) and Currie and Stanley (2008) link social exclusion to a lack of access to social opportunities in the UK and Australia, respectively. Kenyon (2011, p. 764) more recently claims that "a lack of access to opportunities/social networks necessary for inclusion in the society can cause social exclusion". Research by Farrington and Farrington (2005), and Farrington (2007) conclude that greater accessibility is linked to greater social in-

clusion and social dimensions of sustainability. They also claim that by targeting accessibility we force transport planners in different areas to interact toward a common policy goal (Farrington & Farrington, 2005). More recently it has been established that people who experience the transport system as accessible also experience less social exclusion, and a key factor determining experienced accessibility is frequency of services (Hui & Habib, 2014). Another study has found positive links between public transport usage and social inclusion, "possibly suggesting that public transport is assisting people to be included" (Stanley et al., 2010, p. 283).

1.3. Quality

Since previous research has revealed relations between (some) public transport quality attributes and accessibility (Redman, Friman, Gärling, & Hartig, 2013) there is reason to believe that additional quality attributes also are important to accessibility. A large number of attributes have been proposed in attempting to define public transport quality, but most commonly used quality attributes in determining conventional accessibility are travel time (including waiting time and punctuality), distance and departures (Bates, Polak, Jones, & Cook, 2001; Friman, 2010; Hensher, Stopher, & Bullock, 2003). A recent literature review (Redman et al., 2013) revealed that reliability is a key quality attribute of public transport service, with frequency, fare prices, and speed also being important. Other studies have shown the importance of safety/security (de Oña, de Oña, Eboli, & Mazzulla, 2013; Friman & Gärling, 2001), the information given to travelers (de Oña et al., 2013), the system (with supply and reliability items) including comfort/design (dell'Olio, Ibeas, Cecín, & dell'Olio, 2011), and staff behavior (Friman & Fellesson, 2009) on transport quality.

More recently, researchers have begun to include safety aspects in their theories on individual accessibility, e.g. holistic safety-chains from origin to destination (Bekiaris & Gaitanidou, 2012) and women's fears while in the public transport environment (Loukaitou-Sideris, 2009). Safety refers to the emotional evaluations (feelings) of the individual (Redman et al., 2013), whereas most quality dimensions depend on cognitive evaluations.

It is generally held that we are able to affect up to 40 % of our own wellbeing, by participating in daily activities (Lyubomirsky, Sheldon, & Schkade, 2005). Unfortunately, not all of us have the ability to affect our own travel or our daily participation in activities due to insufficient accessibility, and this may lead to a form of seclusion that causes social exclusion. According to Currie and Stanley (2008) the mere risk of being socially excluded has a directly negative effect on subjective well-being. Social inclusion is dependent on the ability to use the transport system for social activities, as much as for getting to work. It is thus important to capture these aspects when measuring transport accessibility. Previous studies encompassing perceived accessibility have not been equipped with measures to quantify the results. The perceived accessibility scale (Lättman et al., 2015) was developed with the aim of capturing how easy it is to live a satisfactory life with the help of the chosen, or designated, travel mode. Without reliable measures of perceived accessibility, it is argued that evaluating and following up goals and visions regarding accessibility, from a user perspective, will be difficult, thus creating a broad and generalizable measure of perceived accessibility was needed in order to investigate or compare accessibility between different transport modes, between different groups of people, in different areas, for different purposes, or in different transport systems.

1.4. Aim and Hypotheses

In this study, we argue that the quality level of public transport creates prerequisites for possibilities and ease of engaging in preferred activities, and that the above-mentioned aspects—quality, safety, frequency of use, and age—affect perceived accessibility in public transport. By looking at transport service quality level in relation to perceived accessibility our hope is to reach an understanding of the driving factors of perceived accessibility. More specifically; we test the impact of perceived level of quality of the chosen transport mode, frequency of use, age and safety on perceived accessibility. We also propose that safety mediates (explains) some of the effect quality has on perceived accessibility, and that the effect of quality on perceived accessibility is moderated by (dependent on) frequency of use.

Hypothesis 1: Perceived level of quality has a direct positive effect on perceived accessibility
Hypothesis 2a: (Feelings of) safety has a direct positive effect on perceived accessibility
Hypothesis 2b: The effect of quality on perceived accessibility is positively mediated by safety

The above hypotheses 1 and 2a are strengthened by a study (Lotfi & Koohsari, 2009) suggesting that a low level of perceived accessibility is due to people feeling unsafe and experiencing low quality in terms of comfort. We also believe that the effect of quality on perceived accessibility is positively mediated by the individual's feelings and perceptions of safety (2b). In other words we think that part of the relationship between perceived quality and perceived accessibility can be explained by safety.

It is furthermore hypothesized that frequency of use, as in how frequently the individual travels using

the assessed transport mode, directly effects perceived accessibility (3a), but also moderates the effect of quality on perceived accessibility (3b). More specifically, it is suggested that more frequent travelers put more emphasis on aspects of quality, and the effect of quality on accessibility is higher for frequent travelers. This also implicitly indicates that the effect of quality on accessibility will be smaller in groups of less frequent travelers. Finally, we investigate whether age affects perceived accessibility proposing that age has a negative relationship with perceived accessibility, meaning that the older one gets, the lower the perceived accessibility, in line with previous research on age and accessibility (Sundling, Berglund, Nilsson, Emardson, & Pendrill, 2014).

Hypothesis 3a: Frequency of use has a direct positive effect on perceived accessibility
Hypothesis 3b: The effect of quality on perceived accessibility is moderated by (conditional on) frequency of use
Hypothesis 4: Age has a direct negative effect on perceived accessibility

In summary, this study will increase our knowledge of different aspects associated with perceived accessibility in public transport. Next section provides a description of the method and data used for analysis. The results of a conditional process model, applied in order to examine the proposed relations, will be discussed. Finally, we will draw some conclusions and discuss some avenues for future research.

2. Method

2.1. Participants

The data was collected in the City of Karlstad, a middle sized town in Sweden (90.000 inhabitants) on three occasions; June 2013, November 2013, and May 2014. Each data collection went on for three subsequent days, between 8.00 am and 5.00 pm approximately. The 750 participants were asked to complete a questionnaire while waiting for the bus, coming from the bus or sitting on the bus. People located in the town bus-transfer areas or on the bus at the time of the collection were asked to participate. The questionnaire was distributed on a clipboard and took approximately five minutes to complete. The participants were offered a lottery ticket with a chance of winning a 30 day bus pass. As this was the first approach to studying links between perceived quality occurring at different stages of travel (before, during), and perceived accessibility this initial data collection involved only bus-travelers. The participants were aged between 16 and 87, M = 27.60, SD = 13.47 (61 % women and 39 % men) the majority were on their way to or from work, school or social activities (visiting friends or family, shopping, sports etc.).

2.2. Survey and Instruments

The survey consisted of three sections. Part one included the quality attributes capturing the quality dimensions, part two included the perceived accessibility items, and part three included background data. The background data consisted of questions about frequency of travel by public transport (less than once a month, once a month, once a week, or daily), gender, and age.

2.2.1. The Perceived Accessibility Scale

The Perceived Accessibility Scale (PAC) is an aggregate measure of perceived accessibility (Lättman et al., 2015), developed for use in transportation. It is easy to use and distribute; due to its compactness and interpretable outcome, making it useful not only within research, but also as a tool on the policy and planning levels. The PAC consists of four items that measure the ease of travel ("It's easy to do [daily] activities with public transport"), the ability to live the life one wants ("If public transport was my only mode of travel, I'd be able to continue living the way I want"), and accessibility to activities ("It's possible to do the activities I prefer with public transport" and "Access to my preferred activities is satisfying with public transport"). These items capture the overall level of perceived accessibility on self-assessment scales, from 1–7 (1 = I disagree 7 = I completely agree) which are then indexed into an overall accessibility score, based on previous psychometric findings (Lättman et al., 2015). Cronbach's Alpha for this sample revealed a satisfying reliability of α = .88 (N=747).

2.2.2. Quality Dimensions

A set of items was devised to measure the perceived quality level of the public transport services (see Table 1). The items were intended to tap into different, but complementary, aspects of quality. For each item, the respondents checked a seven-point scale ranging from "very dissatisfied" (1) to "very satisfied" (7). They were asked to rate these items regarding trips with the local bus company (Karlstadbuss) in general, not just the ongoing trip. Given the relations between quality aspects, and when they occur during travel, we divided the items into four quality dimensions labeled; reliability/functionality, information, courtesy/simplicity (on board), and comfort. These sub-dimensions were established psychometrically sound by a confirmatory second-order factor analysis (χ^2= 149.69, df = 128, p = .092, NFI = .977, CFI = .996, RMSEA = .015) with quality as the main construct.

2.2.3. Safety

Safety represents the emotional evaluation the individual makes regarding aspects of safety connected to travel. Safety was measured using two reversed items, asking the participants to grade their level of security (I feel secure) on a 1–7 Likert-scale, and asking them to grade their usual level of distress or peace of mind (when traveling by public transport) on a continuum from 1–7 (I usually feel distressed–I usually feel calm). The correlation between the items was r = .31. We averaged the items to form a safety variable.

2.3. Conditional Process Modeling

In order to investigate the relation between overall quality level and perceived accessibility, with other predictor variables (age, frequency of use, and safety) that would also serve as a mediator (safety) and moderator (frequency of use) of the effect of quality, a conditional process model (Hayes, 2013) was deemed appropriate for the analyses. Conditional process modeling is used when the purpose is to estimate direct (X to Y) and indirect (intermediate through a mediator X-M-Y) pathways, and how the effect of one (or more) of these depend (is conditional) on another variable, the moderator (X-Y depends on W). For a more thorough description see Hayes (2013).

3. Results

As the aim of this study was to examine the relationships between level of quality and perceived accessibility, a quality index was initially created from the four quality dimensions described in section 2.2.2. A conditional process analysis (Hayes, 2013) was then run to determine the relations between quality index, frequency of travel, safety, age, and perceived accessibility, with safety as a proposed mediator of quality, and frequency as a proposed moderator of quality. As a final step, a cluster analysis was performed which looked more closely at the relationship between age and perceived accessibility. Table 2 provides descriptive statistics of all the included variables, while the results of the subsequent analyses follow below.

3.1. Quality-Index

In order to run a combined mediation and moderation analysis (see 2.3), a quality index had to be created from the four quality dimensions. A Principal Axis Factoring analysis (Warner, 2008) was used to determine whether the four quality dimensions described in section 2.2.2 are unidimensional (Byrne, 2010; Gorsuch, 1997). This analysis extracted one factor with an eigenvalue of 2.85, explaining 71.3 % of the variance in the factor. The Kaiser-Meyer-Olkin measure revealed a multiple KMO of .82, with all individual item KMO values above .80, putting the sampling adequacy well above the threshold of .5 (Field, 2013). The factor score coefficients were used to create the quality index in order to get a weighted relevance for the total score. A reliability analysis of the quality index revealed a satisfying Cronbach's alpha (α = .76), with no significant changes for item deletion. The factor loadings, factor score weights, and weighted relevance are presented in Table 3.

Table 1. Items measuring four dimensions of quality.

Reliability/Functionality	Information	Courtesy/Simplicity(on board)	Comfort
Travel time	Mobile app	Announcements	Air quality
(no. of) Departures	Info on homepage	Staff attitude/behavior	Cleanliness
Distance (to bus stop)	Info at bus-stop	Info on board	Lighting
Trip coordination		Boarding and exiting	Noise level
Payment options			(overall) Comfort
Punctuality			Seating

Table 2. Sample statistics, correlations, means (M) and standard deviation (SD) for each variable in the study.

Variable	1	2	3	4	5	6	7	M	SD
1. Age	---	---	---	---	---	---	---	27.60	13.47
2. Frequency	-.22*	---	---	---	---	---	---	2.61	0.68
3. Reliability/Functionality	.14*	-.04	---	---	---	---	---	26.52	5.26
4. Comfort	.17*	.04	.64*	---	---	---	---	26.83	5.99
5. Information	.05*	.00	.62*	.53*	---	---	---	12.30	2.77
6. Courtesy/ Simplicity (on board)	.21*	-.02	.66*	.67*	.59*	---	---	17.12	3.45
7. Safety	.03	.05	.56*	.61*	.46*	.54*	---	8.76	1.48
8. Perceived accessibility	-.07	.17*	.55*	.46*	.47*	.46*	.49*	5.12	1.34

Note: * p < .05.

3.2. Conditional Process Model

In order to examine the proposed relations, a conditional process model was used (described in 2.3). The analysis included proposed mediation of quality on perceived accessibility through safety and proposed moderation through frequency of use, using PROCESS model 5 (Hayes, 2013). The model proved significant (R^2= .377; $F^{(5,636)}$ = 79.93 p < .001) and showed that quality, age, and trip frequency predict perceived accessibility (PAC) (.050, -.012, and .273 respectively). The effect of quality on perceived accessibility is positively mediated by safety (the safer an individual feels—the higher their PAC score) (see Figure 1).

However, contrary to our hypothesis, the impact of quality on perceived accessibility is not moderated by frequency, suggesting that the importance of quality in predicting perceived accessibility is not conditional on frequency of use.

3.3. Cluster Analysis

The conditional process model confirmed age as a negative predictor of perceived accessibility; however, a plot of the result indicated a curvilinear relationship. A K-means cluster analysis was performed aimed at identifying potential subgroups in the data, looking at age and level of PAC. The clusters were calculated using an iterative process, searching for representative means in the data and assigning cases to the nearest mean.

Table 3. Factor loadings, factor score weights, and weighted relevance for the four quality dimensions* (N = 750).

Quality dimensions	Factor loadings	Factor score weights	Weighted relevance in %	α if item deleted
Reliability/Functionality	.825	.337	32 %	.61
Courtesy/Simplicity	.827	.337	32 %	.70
Comfort	.778	.242	21 %	.66
Information	.714	.180	15 %	.77

Note: * Factor loadings = The extent to which the item measurements are related to the latent construct. Factor score weights = How much each dimension affects the factor score.

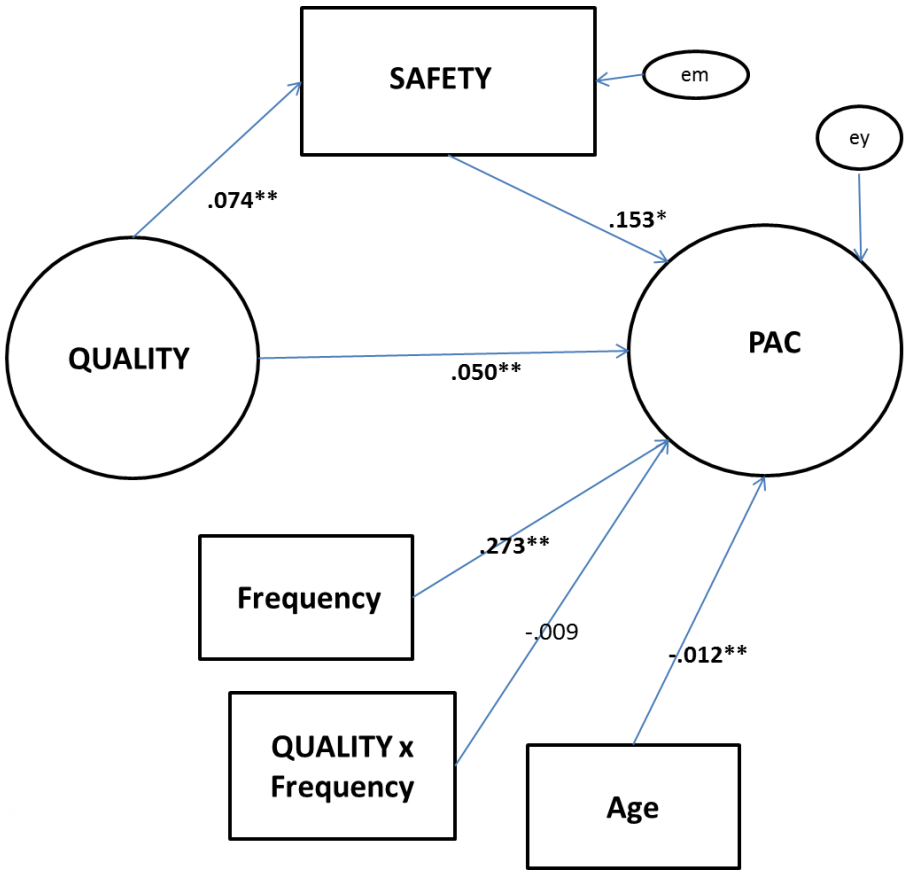

Figure 1. Conditional Process model of the effect of Quality, Safety, Frequency and Age on Perceived accessibility (PAC). (N=642). Note: *p <.005 **p <.001 (ey and em represent measurement error in the y (dependent) and m (mediating) variables, respectively).

Table 4. Classification of bus travelers by mean age and level of PAC (mean).

	Cluster 1 (n=473, 72%)	Cluster 2 (n=85, 13%)	Cluster 3 (n=73, 11%)	Cluster 4 (n=22, 3.5%)	ANOVA F	*p*
Age	21	34	52	68	2358.93	<.001
Perceived accessibility	5.21	4.77	5.09	4.82	2.95	.023

This process is repeated until only small differences occur when transferring cases between clusters, indicating a good fit. Several K-means analyses were run, in order to determine the preferred number of clusters, resulting in a model of 4 clusters, as displayed in Table 4. Individuals around the age of 34, and elderly (around 68), reported significantly lower levels of perceived accessibility than people in their twenties and fifties. No gender differences were observed when comparing the clusters.

4. Discussion

As hypothesized, our findings indicate that quality is important for perceived accessibility. Overall quality positively predicted perceived accessibility, which suggests that an increase in perceived quality will lead the users to perceive the transport mode as being more accessible, in turn making it easier for them to live the life they want, creating prerequisites for social inclusion. However, the results also show that some quality dimensions seem to contribute more than others. Specifically two quality dimensions appeared to be more important. Distance to bus stops, the availability of transport at convenient times, and flexibility and ease when buying tickets combine to make the first highly ranked dimension (Reliability/functionality) with staff attitudes and behavior, ease of getting on and off vehicles, announcements on board, and information available during travel being included in the second dimension (Courtesy/simplicity). These dimensions together make up for 64% of the weighted importance in the overall quality variable, and considering the close link between accessibility and social inclusion (Kenyon, 2011), these findings have implications for which service quality aspects that may be more important for building an inclusive sustainable transport system.

As expected, feeling safe is also important for perceived accessibility. Our findings show that perceived quality positively affects our feelings of safety, the higher the perceived quality the higher perceived safety, and that safety explains some of the effect perceived quality has on perceived accessibility. Safety also has a direct effect on perceived accessibility, not affected by perceived quality. These results imply that safety is an important predictor of perceived accessibility, both in its own right, but also as an intermediate mechanism for other accessibility determinants, such as quality dimension. This finding reminds us that it may be important not to confuse feelings of safety with other, cognitive evaluations, of the quality of the transport mode. The outcomes are in line with studies of perceived satisfaction which determine that an experience contains both emotional and cognitive evaluations (Friman, Fujii, Ettema, Gärling, & Olsson, 2013) and also a study by Lotfi and Koohsari (2009) successfully separating safety from quality and linking these to perceived accessibility.

The proposed conditional relationship was not supported in the analysis, suggesting that the importance of quality when predicting perceived accessibility is not conditional on frequency of travel. This may be good news, since an increase in quality would affect the levels of perceived accessibility for all passengers, not only those who travel frequently. However, frequency of use itself influences perceived accessibility, indicating that more frequent users perceive the chosen transport mode as more accessible than those who travel less often.

Our results further indicate that age is important for perceived accessibility. In line with previous research on accessibility and social exclusion, we had hypothesized that elderly would experience lower levels of perceived accessibility, However, two groups turned out to experience a lower level of accessibility, elderly and people in their thirties. Relying on our definition of perceived accessibility this outcome can be explained by different quantities, and types of, activities. A Swedish study shows that the elderly (aged 58–94) experience difficulties with long distances to bus stops, stairs and level-differences at interchanges, timetables that are not synchronized, and departure times that are not suitable for their daily activities (Berg & Levin, 2011). The other age group experiencing a low level of perceived accessibility belongs to a phase in life which is closely linked to parenting. Parenthood means a totally different activity pattern for most people, characterized by taking children to school and leisure activities. This group experiences the lowest level of perceived accessibility, an unexpected and important finding considering the ongoing development towards sustainable transport.

Another inference we draw is that the instrument for determining perceived accessibility, and how easy it is to live one's life with the help of public transport, also has the ability to differentiate between various groups in society. Conversely, the preconditions, as in the objective accessibility, are the same for all the participants in our study.

4.1. Conclusions

The main point emerging from our analyses is that perceived quality of the transport mode is an important driver of perceived accessibility along with safety, frequency of use, and age. Knowledge of the drivers of perceived accessibility will be useful when planning for the inclusive and sustainable transport system we will be dependent on in the near future.

Another conclusion is that the instrument for determining perceived accessibility also has the ability to differentiate between groups. This point out its usefulness compared to objective measurements of accessibility, where no consideration is given to individual differences within, for instance, a certain neighborhood. This also strengthens the given need of a complementary, subjective measure of accessibility not only for accessibility research per se, but it may also be useful for discovering groups of people in risk of social exclusion. For instance, our results suggest that it is not only the elderly that report lower levels of perceived accessibility, but rather, people in their thirties seem to be the group experiencing the lowest perceived accessibility in public transport, indicating that if public transport was the only alternative for this group they could be a target for social exclusion.

Our findings of the mediating role of safety in the relationship between perceived quality and perceived accessibility strengthens the role of emotional evaluations as intermediate mechanisms between input and outcome (as a part of an experience). In future studies on perceived accessibility, the emotional aspects ought to be highlighted in order for researchers to determine how important they are in this area.

4.2. Policy Implications

Usable and comparable methods are sought in order to boost policy progress. The quantifiable operationalization of perceived accessibility paves the way for social inclusion policy integration on multiple levels since it will not discriminate against certain groups if we use it for a representative or random sample of the population. The leap toward actually using knowledge of social research in transport planning becomes shorter when our ability to evaluate accessibility improves. We argue that, by means of listening to those who use the system, perceived accessibility can help us improve social inclusion and subjective well-being. However, we need to examine accessibility further in order to explain what drives it and how it differentiates between groups. Also, we need to compare the results of perceived accessibility with accessibility as measured by objective measures, to search for discrepancies and areas where accessibility needs improvements in order to minimize perceived social exclusion. There are a number of variables that were not measured in this study, but still have the potential to be important drivers of perceived accessibility, and thus indirectly also of social inclusion. Previous research mentions, for instance, costs (fares), socioeconomic status, and area of residence.

The findings of the present and other studies (Lotfi & Koohsari, 2009), e.g. that quality and feelings of safety have measurable effects on perceived accessibility, should be a reminder that subjective experiences may be as important as objective indicators when planning and designing socially inclusive transport systems. For many people, being able to live the life they want, e.g. experiencing ease of doing daily activities and having access to preferred activities, may be equally important for social inclusion. This insight is particularly significant to convey to the policy makers who are responsible for providing an attractive and accessible transport system.

4.3. Future Research

This research has investigated the role of perceived quality of a certain transport mode (bus) in the experience of actual travelers, on perceived accessibility. It is reasonable to assume that greater understanding will be reached when we can investigate perceived accessibility from the experience of non-travelers, and within other sustainable travel modes, or combinations of travel modes. An interesting approach would be comparative studies on perceived accessibility between different areas with different level of objective accessibility, between different groups of people or between cultures. Especially interesting is the unexpected findings that people in their thirties experience lower accessibility than other groups of users, even the elderly. Another approach with implications for social inclusion would be to compare our measure of perceived accessibility to (other) measures of social inclusion or social exclusion.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Framing Social Inclusion as a Benchmark for Cycling-Inclusive Transport Policy in Kisumu, Kenya

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Abstract
Cycling in many cities of the Global South faces unending exclusion from street spaces despite the on-going transport policy reforms. This exclusion worsens the marginalisation of the poor majority who use this mode. In this paper, we formulate social inclusion as a policy tool for reconciling transport policy to the cycling needs of Kisumu, Kenya. We draw from social quality theory and Lefebvre's right to the city concept to assemble the ideals of social inclusion. These ideals form the benchmark for a qualitative content analysis of the policy pronouncements contained in the Kenya Vision 2030 and the Integrated National Transport Policy to ascertain the opportunities presented by these policies for cycling inclusion. Findings from interviews held with transport professionals in government and private practice support this content analysis. Results show that while the Kenya Vision 2030 focuses on economic growth, the Government has prioritised the implementation of its projects, thus diminishing the fragile opportunity for cycling inclusion presented by the transport policy. To consolidate this opportunity, we propose different policy recommendations to improve the terms for cyclists to claim and produce street spaces.

Keywords
cycling; Kisumu; social exclusion; transport-led exclusion; transport planning

Issue
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1. Introduction

Providing street-spaces that support utility cycling remains an elusive target of transport policy in many Sub-Saharan African cities. In Kisumu, Kenya in particular, this challenge seems to be compounded by mixed commitment to cycling that is generated by the parallel pursuit of economic growth and transport policy reform agenda. While cycling combines the advantages of speed and affordability for its users, the concurrent pursuit of these economic and transport policy agenda has not influenced street-space allocation in ways that support its use. Consequently, transport infrastructure and service expansion projects that aim to improve safety, connectivity and accessibility (GoK, 2009) have instead created street-spaces that exclude cycling. This exclusion worsens the social exclusion of the poor majority who rely on cycling to access opportunities and to generate income by offering bicycle taxi services (Mutiso, 2010; UN-HABITAT, 2004).

Finding a way of addressing this transport exclusion is the central concern of this paper. The paper specifically explores the extent to which social inclusion can be packaged to form a policy frame for reconciling transport planning in Kisumu to the city's neglected cycling needs. Social inclusion is understood to be 'the process of improving *not only* the terms for individuals and groups that are disadvantaged on the basis of their

identity to take part in society, *but also...the process of improving their* ability, dignity, and opportunity *available for them to do so'* (World Bank, 2013, pp. 3-4, emphasis added). Guided by this conception, the paper pursues two objectives: i) to assemble a literature-based frame for analysing social inclusion in transport, and ii) to find out the extent to which Kenya's economic development blueprint is consistent with its transport policy and the implications of this extent of consistency for cycling-inclusive transport planning in Kisumu.

The paper draws on the inclusionary principles espoused by social quality theory (Maesen & Walker, 2002) and Lefebvre's right to the city concept (Lefebvre, 1996) to assemble the key tenets that guide its analysis of Kenya's economic development blueprint (i.e. Kenya Vision 2030) and transport policy for the opportunities they hold for cycling inclusion in Kisumu. We discuss these policies in section 4.

The remainder of this paper is organised in six sections. The next section presents a theoretical basis for employing social inclusion in the current paper. Section 3 contextualises transport exclusion in Sub-Saharan African cities while section 4 puts Kisumu, the study city into perspective. The methodology is presented in section 5. Section 6 builds a theoretical analysis that generates the themes against which the provisions of the extant policies that shape transport planning in Kisumu are analysed in section 7. The implications of policy results for the inclusion of cycling are also presented in section 7. The conclusions and policy proposals are given in Section 8.

2. Theoretical Framework

2.1. Social Quality Theory

Social quality theory emerged in Europe in response to the withdrawal with which policymaking tackled the social dimension of development. Its central argument is that traditional economic analysis, with its neoliberal inclination, is insufficient to explain the changing nature of daily circumstances such as production, employment and distribution systems (Walker & Maesen, 2003). The theory decries the inability of economic growth on its own to solve social challenges such as limited access to social services and rising poverty (Walker & Maesen, 2003). Focusing on economic growth as the sole indicator of development is argued to conceal the totality of development, by subordinating the social and cultural dimensions of people's needs and preferences (Maesen & Walker, 2002; Walker & Maesen, 2003).

The theory holds that because the individual is the core unit of the society, meaningful development therefore ought to be that which creates conditions that enable individuals to effectively be part of the society. Development policies should hence produce conditions that enhance individual wellbeing and potentials while at the same time creating room for them to participate in the social and economic life of their societies (Beck, Maesen, & Walker, 1997; Maesen & Walker, 2012). This argument is used as a basis for analysing the extent to which policies enhance the ability to cycle in Kisumu.

While the initial development of the theory aimed to redress weak social welfare and industrial relations in Europe, its scope has now widened beyond this narrow theme and geographical concern. Within Europe, the theory has been tested in various policy areas including urban development (Maesen & Walker, 2002). Other applications outside Europe have also emerged, with the most well-documented ones being in East Asia (e.g. Lin, Ward, & Maesen, 2009). In this paper, we explore the use of the theory in transport planning.

Social quality theory offers a theoretical and methodological tool for measuring human wellbeing that goes beyond the conventional quality of life measures such as social indicators (e.g. Baud, Sridharan, & Pfeffer, 2008) and human needs and basic needs (e.g. Doyal & Gough, 1991). While these individualised indicators offer a robust approach to assessing quality of life at the individual level, they are less useful when community and other social relations are the focus of analysis (Siltaniemi & Kauppinen, 2005). Moreover, the conventional quality of life paradigm presupposes the existence of certain social structures and relationships, thus precluding a critical analysis of how social structures and relationships relate with exclusion and wellbeing (Siltaniemi & Kauppinen, 2005; Ward, Meyer, Verity, Gill, & Luong, 2011). In contrast, social quality theory takes the premise that the individual is part of the larger society. Thus individual wellbeing is the product of the tension between individual development preferences and societal development needs on the one hand and the tension between community development aspirations and the development aspirations defined by groups, institutions or formal organisations on the other (Maesen & Walker, 2002). The challenge therefore is to temper these tensions such that the individual is enabled to actualise. Section 7 examines the extent to which government policies have coincided with cycling needs and the opportunities this avails for enabling cycling.

Four hypotheses that are fundamental for enabling individuals to participate in their societies are proposed by social quality theory. These include socio-economic security, social inclusion, shared norms, and autonomy (Walker & Maesen, 2003). The first two hypotheses are particularly relevant in the quest for inclusive street-spaces that this current paper is concerned with. The first hypothesis holds that people must have access to socio-economic security in order to protect them from poverty and other forms of deprivation. Accordingly, this paper investigates the extent to which transport planning has created inclusive streets that directly facilitate bicycle taxi operators to

earn their living while indirectly enabling poor households to free up portions of their incomes that are tied on transport expenditure. We show in section 4 that transport expenditure is a major source of financial burden for poor households. With regard to social inclusion, the theory holds that people must experience social inclusion or minimum levels of social exclusion from key social and economic institutions. In this regard, we explore the extent to which transport planning has created street-spaces that accommodate all modes irrespective of the socio-economic statuses of their users. This discussion is developed in sections 6 and 7.

This sub-section has shown that development effort is incomplete until excluded individuals are facilitated to participate in normal social activities. The next subsection pushes this idea further by arguing that inclusion is a right, rather than a privilege.

2.2. The Right to the City

The concept of the 'right to the city' was first formulated in 1968 by Henry Lefebvre as a call for a radical alternative to capitalism (Lefebvre, 1996). He criticised the continued disenfranchisement of urban residents by the political and economic agenda that were pursued under capitalism at the time (Lefebvre, 1996; Marcuse, 2009). Specifically Lefebvre argued that the preoccupation of capitalism with managing individual consumption impeded its ability to tackle larger social essentials, which were not necessarily material products (Lefebvre, 1996). The capitalist model was argued to be wrought with internal contradictions and crises, which produced injustice as a result of its failure to tackle non-materials concerns of the society (Marcuse, 2009; Soja, 2010). This injustice denied urban residents the right to appropriate and produce the city.

As a departure from capitalism which tackled what could arguably be termed as the symptoms of development challenges, Lefebvre focused on the root causes of these challenges to present a new perspective for understanding them. He took the radical stance that a meaningful solution could be found by addressing unjust structural relations that denied urban residents the right to appropriate and to produce urban spaces (Lefebvre, 1996). This stance presents a departure from welfare protection and market (de)regulation and other interventions, which focused on satisfying 'want' (Marcuse, 2009) rather than dismantling the underlying structures that generated injustice. Lefebvre's presentation of the right to the city as a cry and a demand demonstrates a resolve for meaningful change that not only enables urban residents to access resources but also empowers them to determine how resources are produced. In the words of Marcuse (2009), the right to the city therefore presents a 'demand' for resources that should be justly accessible to the excluded and a 'cry' by the alienated for the right to determine how these resources are produced.

On the basis of the foregoing understanding, the current paper explores the extent to which social inclusion can be packaged as a policy frame for advancing the right of cyclists to access street-spaces and to influence how street-spaces are produced through their active travel behaviour.

This section has presented a theoretical argument that identifies the participation of excluded individuals as not only a precondition for all-inclusive development but also a right that needs to be recognised and be upheld. In the next section, we take a look at transport exclusion and its possible research directions in Sub-Saharan African (SSA) cities.

3. Contextualising Transport Exclusion in Sub-Saharan African Cities

The last fifteen years have witnessed a renewed attention to social exclusion in transport research (e.g. Church, Frost, & Sullivan, 2000; Kenyon, Lyons, & Rafferty, 2002; Lucas, 2011; Scheiner, 2010). A common theme through this research is the conception of exclusion as suppressed travel due to disadvantaged socio-geographical locations of residential places (Church et al., 2000; Shergold & Parkhurst, 2012), limited access to the car and public transport (Kenyon et al., 2002; Shergold & Parkhurst, 2012), and socio-demographics such as gender, age and race (Engels & Liu, 2011; Shergold & Parkhurst, 2012). Transport exclusion is therefore arguably a form of social exclusion given that it occurs because of the social status of the excluded.

While the socio-economic and demographic indicators discussed above are useful in enabling a normative categorisation of exclusion, they nonetheless do not take account of different travel behaviour (Shergold & Parkhurst, 2012). This gap raises doubts about their capability to explain transport exclusion that arises because of the choices that travellers make. Specifically, the results of these indicators remain unclear on the differences in exclusion experienced across travel modes and travel routes, although these choices present unique conditions that can be argued to impact differently on exclusion.

In view of the foregoing revelation, we argue that focusing on the empirical travel behaviour and policy processes that produce spaces where travel choices are made would lend a richer understanding of exclusion. Within the context of Europe, Scheiner (2010), for instance, alludes to this position even though his study does not directly focus on social exclusion. Based on the notion that households choose residential locations that suit their travel behaviour, he employs empirical travel data to show a positive association between vertical social inequality and limited activity spaces that those in the lower social ranks can access. Such results are concealed when inclusion strategies focus on nor-

mative categorisation of exclusion based on socio-demographic and geographical indicators.

It is even more difficult for these indicators to fully account for transport exclusion in Sub-Saharan African cities unless they are adapted to do so. This is because of the unique circumstances that define exclusion in these cities. These circumstances include the predominance of non-motorised transport (Gwilliam, 2003; Salon & Aligula, 2012), persistent absolute poverty and consequent low car ownership levels (Lucas, 2011), and the tension between the rapid sprawl of residential locations and the predominant mono-functional urban land-use regime (UN-HABITAT, 2014). All these contrast to factors that cause exclusion in developed cities, where the current proxies of exclusion have been developed. The interplay of these circumstances creates a situation where as many as 80% of daily trips in SSA cities are made using non-motorised options (Diaz Olvera, Plat, & Pochet, 2013; Salon & Aligula, 2012). In addition, exclusion also takes a gender dimension. Cases have been reported where the most vulnerable women, children, the old, and physically disabled are constrained from making out-of-home trips due to poor road conditions (Diaz Olvera et al., 2013), unaffordability (Salon & Gulyani, 2010), and poor and unreliable public transport (UN-HABITAT, 2014). We therefore argue that richer results of exclusion could be obtained if the definition of transport exclusion in the context of these Sub-Saharan African cities incorporated these conditions.

The foregoing revelations present a need to extend the scope of transport exclusion to incorporate the conditions that cause exclusion in Sub-Saharan African cities. Policy efforts that aim to address transport exclusion in these cities must ideally address these factors. The next section now puts Kisumu into the context of this transport exclusion by presenting its transport situation and policy environment.

4. Putting Kisumu into Perspective

Kisumu city is the main commercial, administrative, and educational hub of Kisumu County. There are 46 other administrative counties across Kenya. The city has an estimated population of 400,000 inhabitants and a land mass of about 297km^2, making it the third largest city in Kenya after Nairobi and Mombasa (GoK, 2010a). The city is administered by Kisumu County Government that is also in charge of different dimensions of urban planning in the city.

Due to its function as the principal urban centre in the region, Kisumu has continued to attract a sustained inflow of population that comes in search of opportunities (Maoulidi, 2012). However, the production of the very opportunities that attracts this population to the city has hardly kept pace with its inflow, thus making unemployment, poverty, and poor access to services a daunting planning challenge for the city (Nodalis, 2014). Unemployment and poverty rates are estimated at 30% and 48% of the city's total workforce and households respectively (Nodalis, 2014). The bulk of this poor population resides in the slums and informal settlements of the city (Nodalis, 2014).

Although inadequate access to transport services is an important dimension of poverty (Kim & Dumitrescu, 2011), little research attention has gone into the transport disadvantage that faces the poor of Kisumu. Instead, efforts to tackle poverty in the city have focused on improving the delivery of socio-economic opportunities such as employment, housing, water, and education (e.g. Nodalis, 2014). Meanwhile, studies of cities of comparable socio-economic conditions reveal that the poor spend as much as 25% of their disposable incomes on meeting recurrent transport costs, partly due to lack of affordable alternatives (Kim & Dumitrescu, 2011; Odero, Sibanda, Njenga, Mbathi, & Opiyo, 2009). Furthermore, they make fewer trips yet they spend more time travelling and are the most predisposed to road-crashes when compared to their high income counterparts (de-Langen & Tembele, 2001; Kim & Dumitrescu, 2011). In Kisumu, these challenges are compounded by poor road conditions, which cut off most of the city's slum and peri-urban settlements from public transport service.[1]

Utility cycling among the poor of Kisumu is thus a pragmatic response to unemployment and inadequate access to faster and affordable alternatives to walking. Although the poor are the predominant bicycle users, other income groups also cycle, either privately or using bicycle taxis (Kola, Onyango, & Oindo, 2012). The modal share of cycling is estimated at 16% (Makajuma, 2006). It is thought that the recent emergence of motorcycle taxis has caused a general decrease in this modal share because its operators are mostly former bicycle taxi riders who have switched to operating motorcycles.[2] However, a new pattern characterised by a rise in the number of private cyclists has also emerged as some travellers who relied on bicycle taxis resort to using their own bicycles.[3] Generally, motorcycles are even more expensive than public transport which is equally expensive for a majority of the poor. Despite this undying significance of cycling in Kisumu, the city authority has failed to support cycling in terms of infrastructure and traffic rules. This failure occasions not only its exclusion from the streets but also the social exclusion of its riders, passengers and operators.

The recent formulation of the Kenya Vision 2030 (KV2030) and the Integrated National Transport Policy (INTP) presents an opportunity for interrogating government commitment to inclusive transport that ad-

[1] Field interview with County Chief Officer in charge of transport, 27.08.2015

[2] Field interview with practising NMT expert, 20.08.2015

[3] Field interview with practising NMT expert, 20.08.2015

dresses the foregoing disadvantage that faces cycling in Kisumu. Although these two documents are national government documents, the structure of government in Kenya (GoK, 2010b) provides that they are implemented at the local level. The influence of these documents in shaping the development of Kisumu is further emboldened by its selection as one of the priority cities under the KV2030 plan (GoK, 2007).

The Kenya Vision 2030 is an economic development blueprint that aims to turn Kenya into a middle-income country by the year 2030 (GoK, 2007). It was launched in 2008. The document envisages sustained economic growth, social justice and political accountability as the basis for realising its vision. It provides a long-range vision for these sectors and proposes to achieve their specific targets by implementing priority projects that it identifies within a successive five-year medium-term planning framework.

Relevant to the current paper is the recognition of the role of transport infrastructure in accelerating business and improving livelihoods. In this regard, the government seeks to develop and maintain a safe, integrated, and efficient transport network as its transport vision (GoK, 2007). In order to realise this vision, the document prioritises the development of Bus Rapid Transport and the light railway system in Nairobi and later in other priority cities such as Kisumu (GoK, 2007). The document also targets to develop an Integrated National Transport Master Plan to guide infrastructure development across all Kenyan cities, including Kisumu. Curiously though, the KV2030 does not acknowledge the INTP, which was prepared two years before KV2030 was initiated and only launched in 2009 after undergoing some amendments to align it to the KV2030. This raises curiosity about the consistency between the two documents and the implications of this consistency for inclusive transport. This issue is explored further in section 7.

5. Methodology

The study begins by a theoretical analysis to enable it build a framework for employing social inclusion in problematizing transport disadvantage in the context of Sub-Saharan African cities. This is followed by a qualitative content analysis of the KV2030 and the INTP to identify the extent to which the thematic concerns generated from the theoretical analysis are tackled by the extant policies. Where possible, the study makes reference to the transport proposals of Kisumu Integrated Strategic Urban Development Plan (ISUD)[4] to demonstrate the situation in Kisumu. This content analysis is sparingly supported by results of field observations and qualitative analysis of interviews held with relevant government officials and transport experts.

[4] The ISUD is the strategic plan that guides the development of the city for the period 2013 to 2030.

5.1. Data

The main data used in the analysis is the content of KV2030, INTP and ISUD documents. Copies of these documents were obtained from Kisumu County Government. To supplement this data, the study held semi-structured interviews with the chief officer in charge of transport at Kisumu County Government and one Non-Motorised Transport expert. These respondents were purposively selected because of the rich information they possessed on the subject matter of our investigation because of their official responsibilities and experience in transport in general and cycling in particular (Singh, 2006). The interviews were held in August 2015, with the main theme being the opportunities and challenges that faced cycling and its users under the present planning framework in Kisumu and the on-going policy reforms. An interview schedule that was tailored along the emerging issues enumerated in section 6 was prepared to guide these interviews.

Field observations were made on an on-going basis to get a grasp of the challenges that faced cycling on the streets and to cross-check the findings from the interviews.

5.2. Analysis

The theoretical analysis presented in section 6 generated 5 main themes that formed the categories that were used in the subsequent analyses in section 7. These themes centred on problematizing transport disadvantage in general, contextualising exclusion, visibility of exclusion, conception of spaces of exclusion, and response to the ideals of inclusion. The content analysis is organised according to these themes that enabled us to formulate our preconceptions and pre-knowledge (Mayring, 2014) of what inclusive policies and processes should entail. The content of KV2030 and INTP documents were then analysed to find out the extent to which they tackled these thematic concerns and the opportunity they availed for cycling inclusion. According to Mayring (2014), a content analysis is not a standardised instrument; it should rather be flexible enough to suit the material in question and issues at hand. The content-related arguments take preference over procedural arguments because validity is regarded more highly than reliability (Mayring, 2014). Table 1 (Miles & Huberman, 1994) presents a summary of how the three policy documents have tackled the thematic concerns raised.

6. Linking Social Inclusion to Transport Discourse

6.1. Problematizing Transport Exclusion through Social Inclusion

Social inclusion is increasingly presented to be a basic condition for achieving sustainable urban transport

(Khayesi, Monheim, & Nebe, 2010; Lucas, 2012; World Bank, 2013). Although it is conceptually differentiated from social exclusion (Labonte, 2004), it arguably offers a basis for problematizing the plight of individuals and groups that are excluded by transport systems (Church et al., 2000; Lucas & Musso, 2014). This opportunity is presented by its conception as both a means to ending social exclusion and concurrently an end to be pursued in its own right. The central aim of social inclusion is to strengthen the participation of excluded individuals and groups in social processes by improving their ability and dignity as well as the opportunities available for them to participate (World Bank, 2013).

The foregoing conception projects social inclusion as the central target of efforts that aim to achieve the tenets of the social quality theory and the right to the city. In fact, the very emergence of the concept of social inclusion is itself a response to the challenges of social exclusion and by extension the restrictions that this exclusion places on the right to the city (Allman, 2013; Harvey, 2012; Labonte, 2004). Specifically, its growing use is motivated by the need to reduce the relative disadvantages that face individuals or groups because of their weaker social statuses, that limit their ability to participate in normal social activities (Sen, 2000). These disadvantages have been argued to limit their enjoyment of the right to the city (Harvey, 2003, 2012).

Despite the potential of social inclusion in problematizing transport disadvantage, it has received little research attention, particularly in medium-sized Sub-Saharan Africa cities (Lucas, 2011). It seems that transport exclusion itself is still not very clearly understood in these cities. In this paper, we therefore operationalise normal social activities to refer to participation in mobility and accessibility by all modes of transport. We use this understanding to interrogate how Kenya's development blueprint and transport policy problematize the transport challenge in general and the extent to which this problematization accommodates cyclists.

6.2. The Context of Exclusion Matters

The fundamentals of social quality theory and the right to the city concept seem to converge at the view that social inclusion forms the common denominator that is necessary to support participation in social processes. This is especially so if one considers that social inclusion outlines the terms and nature of this participation that underpin the achievement of the tenets of the theory and the concept. In the case of social quality theory, social inclusion is directly identified as a precondition that enables individuals to be part of the society (Maesen & Walker, 2012). Similarly, the right to the city concept also argues for social inclusion, not only in appropriating existing resources but also in determining how these resources are produced (Marcuse, 2009).

But facilitating social inclusion requires an unambiguous understanding of who the excluded are and the factors that exclude them. Existing literature on social exclusion has thus far narrowly limited the scope of disadvantage that defines exclusion and the excluded individuals and groups to the contexts of the challenges that face countries from where this literature emanates. These include mainly countries of Europe, Asia and to some extent Australia and the USA. Consequently, income status, race, gender, sexual orientation, ethnicity, religion, physical disability status, and caste dominate as the basis for defining exclusion (e.g. Øyen, 1997; Sen, 2000; World Bank, 2013). These forms of exclusion are typical in the context of these countries and are by no means exhaustive, more so with regard to the transport disadvantage in SSA cities. A more realistic investigation of exclusion in SSA cities must hence begin by recognising this context-specificity of the phenomenon (Silver, 2007).

The foregoing unruly nature of social exclusion demands that the phenomenon is conceptualised to reflect its context-specific drivers and forms in SSA cities if it is to be useful in understanding transport disadvantage in these cities. At the same time, while some of the dimensions of exclusion used in existing literature resonate with exclusion in the context of SSA cities, they must be adapted to reflect the unique circumstances in these cities. For instance, although cyclists in many SSA cities are predominantly the poor (Pochet & Cusset, 1999; UN-HABITAT, 2004), indirectly addressing their transport disadvantage through tackling poverty is not likely to yield their inclusion. This is because their exclusion has more to do with street-spaces, which hardly cater for cycling and less to do with their poverty status. Poverty in this case only adds to their invisibility during street-space allocation but does not in itself trigger their exclusion from the streets. Indeed, research shows that not all cyclists are necessarily poor (Bechstein, 2010; Nkurunziza, Zuidgeest, & van Maarseveen, 2012; Salon & Aligula, 2012). This example demonstrates the ease of blurring the real drivers of exclusion when its conception gives undue prominence to the socio-economic statuses of the excluded. Useful insights into different dimensions of transport exclusion could be obtained by shifting attention to the planning processes, products and outcomes that occasion exclusion (Cameron, 2006; Schwanen et al., 2015).

This paper therefore attempts a direct conception of the exclusion of cyclists for what it is—exclusion from the streets. We employ this conception to focus the problematization of the transport disadvantage discussed in the previous section to cycling concerns in Kenya in particular. We interrogate the extent to which current policies enable the disadvantage that faces cyclists to be identified as well as the extent to which these policies facilitate cyclists to participate in mobility and to influence street-space allocation through their active travel behaviour.

6.3. Unrelenting Exclusion amid 'Progress' in Transport

Within transport research, the use of social inclusion has been inspired by transport-related marginalisation that persists despite the progress witnessed in transport service and infrastructure development (Jones & Lucas, 2012; Kenyon et al., 2002). This progress is evidenced by road expansion, improvements in public transport, and a concurrent rapid growth in motorisation (Gwilliam, 2003; Watson, 2014; WHO, 2015). While these developments are desirable to the extent that they enable goods, services and people to reach destinations, their benefits are evidently skewed against non-motorised modes such as cycling because the planning strategies that generate them are not sensitive to the needs of non-motorised modes (Gwilliam, 2003; Watson, 2014; WHO, 2015). These auto-oriented strategies not only make it hard and unsafe for non-motorised modes to access cities (Gwilliam, 2003; Watson, 2014; WHO, 2015); they also lead to increased number of accidents that disproportionately affect non-motorised modes (WHO, 2015). These disadvantages ultimately lead to reduced accessibility to opportunities such as jobs, education and health services for those who cannot afford motorised modes (Diaz Olvera, Didier, Pochet, & Maidadi, 2012; Salon & Gulyani, 2010). The appropriateness and effectiveness of these auto-oriented transport planning strategies to generate positive social impacts for low income groups remains doubtful (Grieco, Ndulo, Bryceson, Porter, & McCray, 2009; Lucas, 2011; McCray, 2004; Watson, 2014).

The result of this mismatch between progress in transport conditions on the one hand and its outcomes for non-motorised modes on the other draws particular attention to cycling in medium-sized Sub-Saharan African cities. While cycling commands a significant modal share in most of these cities (Bradbury & Howe, 2002; Quarshie, 2004; UN-HABITAT, 2010), the modernist planning regime that is prevalent throughout the region oddly stifles its use by failing to recognise it and to cater for its infrastructure needs alongside those of motorised modes (Asingo & Mitullah, 2007; Steyn, 2012; Watson, 2014). This failures exposes cycling to unsafe competition with motorised modes over street-spaces that are designed to facilitate motorised transport (Kim & Dumitrescu, 2011; Odero et al., 2009; UN-HABITAT, 2004). It is unsurprising therefore that cyclists accounted for about 9.1% of the fatalities reported in Kenya between 1994–2008, making it the third most dangerous mode after driving and walking (Ministry of Transport, 2009, cited in Odero et al., 2009). In Kisumu specifically, cycling further faces active government ban (Alal, 2014) although it remains one of the most popular travel modes in the city (Makajuma, 2006). These disadvantages meted on cycling intensify the exclusion of the poor majority who use the mode for commuting, intra-urban connection and as a tool for income generation by operating it as bicycle taxis (Bradbury & Howe, 2002; UN-HABITAT, 2004).

Transport exclusion however restricts not only the physical access to opportunities; it also directly stifles efforts to bridge social inequality gap in many SSA cities. It is estimated that as many as 50% of the inhabitants of some of the cities live below the poverty line and can afford neither private cars nor public transport (UN-HABITAT, 2014). In the case of Kisumu, the failure to provide for cycling not only generates the physical exclusion of its users; it also excludes bicycle taxi operators from their source of livelihood. As mentioned earlier, this failure also strains household budgets by locking large proportions of their incomes to transport expenditure.

This current paper therefore questions the extent to which the extant policies make this exclusion visible and the opportunities that such visibility offers for cycling inclusion.

6.4. In Search of Inclusion in Excluded Spaces and Processes

Urban streets have historically been the object of the struggle for the right to the city for modes other than the car (e.g. Attoh, 2012; Furness, 2010; Murthy, 2011). This struggle is shaped by transport exclusion that results from growing motorisation that is reinforced by state planners' conception of street-spaces as corridors of motorised traffic rather than spaces of multi-modal use (Banister, 2002; Murthy, 2011). The neoliberal agenda (Harvey, 2012) and the modernist approach to transport planning (Hobson, 1999; Watson, 2009, 2014) are at the centre in propagating this exclusion. On the one hand, this neoliberal agenda is responsible for commodifying urban spaces (Harvey, 1982, 2012), thus reducing street-space allocation to an exercise of maximising economic value rather than the use value of street-spaces. On the other hand, the modernist planning agenda devalues non-motorised modes by prioritising automobiles in its pursuit for 'modernity' (Furness, 2010). The resulting exclusion of non-motorised modes takes many forms. Key among these are outright stigmatisation of the modes (Furness, 2010; Salon & Aligula, 2012) and a blatant failure to allocate street-spaces that support their use (Furness, 2010).

Cycling inclusion remains a difficult target under this modernist planning regime. This is because its ensuing negative social representation (Khayesi et al., 2010; Pochet & Cusset, 1999) prohibits transport planning in its current form from allocating street-spaces that can facilitate its use. At the same time, cycling stands no chance for inclusion in commodified spaces because it generates no economic return that is readily quantifiable using the current transport evaluation tools such as the Cost-Benefit Analysis (Jones, Moura, & Domingos, 2013). It is therefore relevant to explore

the extent to which policy efforts that aim to include cycling can centre their ideals on the active travel behaviour of cyclists in terms of their mode choices, route choices and the attendant challenges. Moreover, it is also relevant to explore the extent to which such policies can consolidate the right of cyclists to produce street-spaces as they already do, albeit without state recognition. In this connection, the current paper questions how spaces of exclusion are produced by the policies and explores the challenges and opportunities availed by these policies for cycling inclusion.

6.5. Ideals of Inclusion

Addressing the limitations imposed on cycling by the planning agenda discussed in the previous section requires clarity on the ideals that social inclusion strives for. It has been suggested that social inclusion must strive to achieve and safeguard ability, dignity and opportunity as its basic ideals (World Bank, 2013). Ability in its broader sense is recognised as an innate quality (Fodor, 1975) that must nonetheless be socially mediated (Prinz, 2005). In this context, we present the existing cycling culture in Kisumu as an innate quality that requires deliberate planning support in order to enable it play an effective role in enabling mobility and income generation or saving. Dignity on the other hand concerns respect and recognition with which cyclists are treated in policy and practice. Low dignity attached to cycling by state planners renders the mode invisible in official statistics and consequently unattended to both in terms of policy and of infrastructure provision (Khayesi et al., 2010). Lastly, inclusionary efforts must also aim to enhance the opportunities for cycling by reducing the physical barriers to cycling. These barriers are occasioned by a lack of supportive infrastructure and traffic conditions (Alando, Brussel, Zuidgeest, & Durgi, 2013). In this paper, we explore the difficulties that cyclists are exposed to by the failure to provide infrastructure and traffic conditions that support cycling. These ideals form a basis for assessing the policies for the opportunities that they avail for cycling inclusion.

This section has attempted to interweave the connection between social inclusion and transport disadvantage in an effort to construct a frame for assessing the extent to which KV2030 and the INTP are inclusive. The next section now dialogues the two policies to find the extent of their convergence on inclusion and the implications of this extent for cycling inclusion.

7. Dialoguing the Kenya Vision 2030 and the Integrated National Transport Policy: Implications on Inclusion

This section carries out a qualitative content analysis of the policy pronouncements contained in the KV2030 and INTP to find out the opportunities they hold for cycling inclusion in Kisumu. The content analysis is guided by the categories identified in section 6. Accordingly, the policy documents were analysed to find out how the messages they contained had tackled the thematic concerns that were raised in that section (Mayring, 2014).

Table 1 summarises the findings. Where possible, the study makes reference to ISUD plan to demonstrate its points.

Table 1. The extent to which policy and practice have tackled key thematic concerns of inclusion.

Concern	KV2030	INTP
Problematizing transport disadvantage	• Hindrance to mobility and economic participation • Modernist • Overall road crashes and pollution • Traffic congestion • High cost of transport	• Hindrance to accessibility • Inadequate transport integration • No vision for transport sector • Poor quality transport services
Contextualising transport exclusion	• Regional disparity in road network coverage	• Inappropriate modal split • Transport unaffordability • Planning biased against NMT • Lack of infrastructure provision for NMT
Visibility of exclusion	• No mention of NMT even in delegated form • Only recognises regions of the country that are excluded from roads for motorised transport	• Explicit acknowledgement of bias against NMT modes in general
Production of spaces of exclusion	• Capital infrastructure projects	• Integrated transport
Response to the ideals of inclusion	• Focused on priority projects (capital projects) • Road is synonymous with space for cars • Benchmarking with international 'best practices' • Pursuit of aesthetics in infrastructure design	• Need for integrated transport including NMTs recognised

7.1. Problematizing Transport Disadvantage

The two policy documents agree on the existence of transport disadvantage that impedes different mode users from full participation in transport activities. However, there is a divergence in the manner in which this disadvantage is problematized by the two documents.

First, the KV2030 perceives this disadvantage in terms of the hindrance it places on mobility, participation in national economy and the international competitiveness of the country. Thus transport disadvantage is problematized in terms of the need to improve transport infrastructure in order to *'facilitate firms and citizens in their wealth-creation efforts'* (p. 17). Attendant to this is the need to reduce traffic congestion, high cost of transport, road crashes and pollution, all of which are focused on improving the conditions for motorised modes. At the same time, there is a visible pressure to develop transport infrastructure facilities that are among other things '*aesthetically appealing*' in order to '*to provide cost-effective world-class infrastructure facilities and services in support of the Vision'* (p. 17). This confirms the pressure of modernisation (Steyn, 2012; Watson, 2009, 2014) that limits transport strategies from being realistic to the practical challenges that face SSA cities. While it is expected of a national policy document like KV2030 to develop targets like these, *inadequate room allowed for policies other than KV2030 to influence development at the local level*[5] raises doubts about the ease of recognising the challenge that faces cycling under this arrangement.

On the other hand, the INTP demonstrates an integrated outlook in the way it problematizes transport disadvantage. Specifically, it identifies poor quality transport services, lack of a vision for the transport sector, which particularly disadvantages non-motorised modes (p. 46), and inadequate transport integration. The policy acknowledges that these challenges impede accessibility for non-motorised modes like cyclists just like they do for motorised modes. A clear opportunity to problematize the challenge facing cycling is therefore availed by this policy. However, this problematization is not likely to lead to the prioritisation of cycling issues in Kenya in general and Kisumu in particular unless KV2030 is reoriented to give room for other policies to influence development priorities at the local level. This can be achieved through the five-year-medium-term-planning framework that is provided for under KV2030 (GoK, 2007). Steyn (2012) has shown the need to reconcile such conflicting forces in order to allow the inclusion of the excluded urban citizens.

7.2. Contextualising Transport Exclusion

The theoretical analysis presented in section 6 demonstrates that exclusion means different things in different contexts and that there is a need to understand this exclusion in transport terms in order to tackle it. There is a mix of social concerns that are raised by the two policies and which can form a basis for cycling inclusion. However, these concerns are scattered and sometimes not even directly related to transport.

The most prominent transport exclusion concern that emerges from KV2030 is presented in terms of regional disparities in road network coverage. Accordingly, the policy seeks to *'implement infrastructure projects that will stimulate demand in hitherto neglected areas targeting increased connectivity and reduced transport and other infrastructure costs'* (p. 19). This prioritisation of transport strategies at the regional scale does not however elicit the inclusion cycling because of practicality of using the mode over such long distances. The strategy is thus in every practical sense for motorised transport. It is instructive that the neglected regions mentioned in the policy document are the Arid and Semi-Arid areas of the country and not the neglected slum areas of it cities, most of which equally need a deliberate transport strategy. Salon and Gulyani (2010) for instance demonstrate that most of the urban poor who can hardly afford the cost of transport reside in these settlements.

The social pillar of the KV2030 presents an opportunity through which the inclusion of disadvantaged modes could be contextualised in secondary cities like Kisumu. Specifically, the pillar seeks to implement policies *'that minimise the differences in income opportunities and access to social services'* (p. 196). This target identifies urban slums and pockets of extreme poverty as some of the areas that need this attention. The policy intention fits the situation in Kisumu where cycling is not only a mode for accessing destinations, but also a tool for income generation. However, the policy does not recognise the central part played by transport in income generation and enabling access. The opportunity presented by the policy for the inclusion of cycling is thus lost since the policy prioritises improved education, health, water and sanitation, among other human resource investments as its strategies (p. 198). Moreover, although transport is a major component of household expenditure (Kim & Dumitrescu, 2011), the policy does not address this connection in its bid to '*create a socially just and equitable society without extreme poverty*' (p. 199).

The INTP on the other hand contextualises the transport disadvantage that faces cycling in a more direct way that can elicit attention to this disadvantage. It identifies inappropriate modal split, transport unaffordability, bias against non-motorised modes by planners and lack of infrastructure provision for non-motorised modes. While these disadvantages resonate with the cycling situation in Kisumu, '*they are not likely to be addressed as long as they remain separated from*

[5] Field interview with Practising NMT expert, 20.08.2015

the priorities of the KV2030'[6]. According to the experts, lack of priority to cycling by KV2030 has been a hindrance to acknowledging the need to cater for cycling in terms of infrastructure and traffic rules. It should be pointed out that KV2030 projects have taken precedence over most other projects when it comes to government funding and support. A possible strategy to deal with this lack of harmony between KV2030 and the cycling priorities would be to acknowledge the social aspect of transport in the social pillar of KV2030. This would ingrain exclusion issues in the transport sector to the social pillar so that they get prioritised in government plans.

7.3. Visibility of Exclusion

This analysis sought to understand the extent to which the two policies made the exclusion of cyclists visible and the opportunities that such visibility offered for cycling inclusion. Differences were found between the two policies.

To begin with, KV2030 does not refer to non-motorised modes, neither in terms of acknowledging their problems nor in laying out strategies to deal with the challenges they face. This lack of mention makes the mode completely invisible from any intervention that is initiated by the KV2030. The only closest mention of exclusion relates to excluded regions and slum settlements. However, as already discussed before, the latter areas are not mentioned for transport interventions. The implication of this invisibility of cycling concerns in KV2030 is that the mode will continue to face exclusion for as long as the current arrangement that prioritises KV2030 projects remains.

In contrast, the INTP demonstrates a clear articulation of cycling concerns. These have already been discussed earlier. However, it is notable that the policy explicitly acknowledges the bias against non-motorised modes in general. The policy acknowledges that public transport in urban areas remains unaffordable to many members of working households despite the country's elaborate road network (p. 45). The policy also acknowledges that transport development in Kenya in general has focused its attention on roads for motorised transport, yet these are only accessible to a small minority since the majority remain poor. What is interesting is that despite this knowledge of this phenomenon that is arguably a case of social exclusion, non-motorised modes in general are not recognised in law to qualify them for government funding and other forms of support (GoK, 2009). This lack of recognition perpetuates lack of safety for cycling as it has to use road-spaces that are designed for motorised transport.

The articulation of the challenge that faces non-motorised modes described above brings out the social component of transport disadvantage. This is particularly so with regard to how it impacts on the transport cost for the poor, excludes them from the street-spaces, and makes it unsafe for the poor to use the streets. Packaging the solution to this challenge as a social inclusion agenda would arguably afford non-motorised modes in general and cycling in particular the visibility they require for the government to facilitate their use. It should be pointed out that the social pillar of KV2030 already tackles such social concerns although it is not explicitly linked to transport disadvantage. This makes this form of transport disadvantage invisible. The social concerns raised by INTP should hence be packaged as social inclusion concerns and be linked with the social pillar of KV2030 in order to afford them the necessary government attention. Doing this can lead to the prioritisation of cycling in Kisumu, which is hardly recognised or even catered for in spite of its active use by the poor majority.

7.4. Production of Spaces of Exclusion

Differences in the conception of the transport disadvantage presented in the previous sections elicit different infrastructure and traffic interventions. While the INTP advocates for integrated transport that includes streets that cater for cycling, KV2030 on the other hand focuses on capital infrastructure projects in its effort to address the transport disadvantage that it identifies. As mentioned already though, the targets of the KV2030 are priorised in determining not only the planning but also the execution of transport infrastructure projects. This leads to the production of spaces that exclude cycling. According to the planning authorities, '*accommodating pedal cycling [on the road] remains a challenge due to limited funds, lack of policy priority, and the emergence of motorcycles [which attracts more political attention] even though we understand its role in enabling the poor the move'.*[7]

Kisumu is currently implementing key transport infrastructure projects that are intended to improve its linkage with the neighbouring cities of Kakamega, Busia, and other cities along the Kisumu-Nairobi transport corridor. These projects are implemented within the framework of the flagship projects of KV2030 and are *largely driven by the pursuit of economic goals rather than social ones*[8]. It is notable that while the roads affected by these projects double as urban roads within the city boundaries, no clear provision has been made to accommodate cycling on their urban segments. This, despite the significance of cy-

[6] Field interview with Practising NMT expert, 20.08.2015 & County Chief Officer in charge of transport, 27.08.2015

[7] Field interview with County Chief Officer in charge of transport, 27.08.2015.

[8] Field interview with County Chief Officer in charge of transport, 27.08.2015.

cling in terms of employment for bicycle taxi operators and as an alternative mode of transport, particularly among the low-income earners of the city (Oballa, Mwaura, & Stellmach, 2012). Instead, the car-oriented street design has now cut off access, thereby preventing cyclists from turning at some important junctions in the city.[9] This makes it riskier to cycle on these roads and casts doubts on whether the projects have cyclists in mind in their quest to increase safety, connectivity and accessibility.

The foregoing production of street-spaces that exclude cyclists is not improved by the ISUD either. Instead the plan seems to borrow heavily from KV2030 and therefore a continuation of its desire for capital infrastructure projects. Cycling concerns do not receive any attention beyond the recognition of the role of cycling in enabling accessibility and the need to provide for it in terms of infrastructure and traffic conditions (Nodalis, 2014, p. 36). This is curious because the plan should offer concrete strategies on how to include the mode in order to enable it play the roles that the plan acknowledges. Instead, the plan only duplicates the capital projects proposed for Nairobi under the KV2030 without much regard to the unique cycling culture of Kisumu.

While it would have been expected that this ISUD plan would contextualise the KV2030 and tackle the unique local level planning challenges and opportunities, it fails to do so. The plan does not offer any concrete proposals on how to progressively include cycling within the street spaces of Kisumu but instead evadingly recommends that the present modal mix should be organised by providing dedicated lanes and stops and waiting areas (p. 36). In view of this insecure treatment of cycling concerns, we argue in this paper that presenting these concerns as challenges of social exclusion could generate the urgency needed to integrate the concerns into future infrastructure developments projects. This integration can occasion the production of more inclusive street-spaces. Doing this would pre-empt the difficulty of doing so once this opportunity is lost.

Responding to the infrastructure and traffic needs of the bicycle is also complicated by the use of the term 'non-motorised' modes to refer to cycling and walking, and indeed sometimes even more modes. Whereas the KV2030 fails to recognise the role of non-motorised transport, its introduction by the INTP requires enhanced clarity in order to allow its operationalisation. In Kisumu, the use of the term '*boda boda*' by planners to refer to both pedal bicycles and commercial motorcycles diminishes the possibility of producing street-spaces that include cyclists even further. This lack of clarity about the exact meaning of 'non-motorised modes' and '*boda boda*' in the context of Kisumu has engendered ambiguity with regard to the few non-motorised lanes that have been provided on the Kisumu-Busia and Kisumu-Nairobi roads under the on-going roads projects. It remains unclear who the intended users of these spaces are. These lanes have been claimed by bicyclists, pedestrians, hawkers, and motorcyclists,[10] thereby making all of them vulnerable to accidents just like they would have been if the lanes did not exist. There is therefore a need to operationalise these terminologies in order to clear the current ambiguities that emerge from their use. Moreover, it also emerges that the production of streets that include cycling cannot be tackled in isolation of these other modes and activities that claim the same spaces as the bicycle. Addressing these concerns is however beyond the scope of the current paper.

7.5. Response to the Ideals of Inclusion

The theoretical analysis revealed the need to mediate cycling in order to address its concerns. Whereas KV2030 responds to the projected growth in travel demand through capital infrastructure projects, the recognition of modes other than motorised by the INTP presents an opportunity for mediating cyclists to meet their travel demand using the bicycles. However, practicalizing this recognition remains a challenge due to the current influence of the KV2030, which focuses on stimulating economic growth rather than social inclusion. Because of this inclination, the KV2030 looks at inclusion indirectly as a means to enabling participation in the economy, rather than directly as an end in itself. Moreover, the kind of participation it envisages is by motorised modes, rather than non-motorised ones like cycling. Again, the focus of KV2030 on benchmarking its transport infrastructure standards with international best practices and developing infrastructure that is aesthetically appealing in design (p. 38) are clearly informed by the need to facilitate motorisation rather than cycling and other forms of non-motorised modes. It therefore remains doubtful if the current arrangement where the provisions of the KV2030 are prioritised can mediate cycling in Kisumu and other Kenyan cities.

The foregoing challenge is worsened by the ISUD, which proposes the expansion of existing roads and the creation of more roads to create room for the projected growth in motorised transport in Kisumu. It appears that the accessibility concerns of cyclists will continue to remain secondary unless transport planning is reoriented to enable cycling. *'[So far] cycling lanes are only considered in areas where road corridors [reserves] can accommodate it…often what remains after motorised transport has been catered for'*[11]. This attitude not only diminishes the importance of cycling; it also generates incoherent cycling network that does not encourage

[9] Field observation.

[10] Field observation.

[11] Field interview with Practising NMT expert, 20.08.2015.

cycling. There is clearly a need to demystify the inferior social construction of cycling that occasions this diminished attention to it, and to design the roads to allow safe multiple-modal use.[12]

The ISUD plan evidently renders the growth of the city car-dependent, as can be seen in the proposals to decentralise the city to outlying areas in the outskirts of the current city centre (Nodalis, 2014). The proposed relocation of public transport termini to these new nodes will certainly lead to growth in the use of private cars as these nodes are far from the city centre where most daily services such as government, banking, and social services are located. All these proposals come at a time when the city has not exhausted the space it has close to the city centre. It is curious that no provision has been made to accommodate the infrastructure and traffic needs that will arise due to the use of the bicycle to connect these nodes. These proposed changes in land-use structure, in addition to the natural triggers of travel demand, will necessitate the use of different modes by travellers of different socio-economic groups. There will hence be a need to revise the priorities of the KV2030 through the five-year medium-term-plans in order to accommodate emerging issues that the preparation of the KV2030 never foresaw[13].

8. Conclusion and Policy Recommendations

This paper has attempted to develop social inclusion as a frame for cycling-inclusive transport planning in Kisumu. Basing its arguments on social quality theory and the right to the city concept, the study developed key criteria upon which it assessed the Kenya Vision 2030 and the Integrated National Transport Plan for the extent to which their pronouncements were inclusive of cycling and its street-space needs. The aim was to identify the gaps that the policies presented as well as the opportunities that they availed for making social inclusion an imperative of transport policy. The paper shows that both the Kenya Vision 2030 and the Integrated National Transport Policy hold some potential for fronting the need for cycling-inclusive streets through social inclusion. While the Kenya Vision 2030 holds the power to influence action at the local city level, it is nonetheless weak when it comes to directly advocating for inclusive transport. On the other hand, the Integrated National Transport Policy identifies challenges that can be packaged as social inclusion concerns. However, its policy pronouncements are less prioritised in comparison to those of the Kenya Vision 2030. This diminished priority makes the INTP less influential in shaping pro-cycling interventions in Kisumu. These dissenting strengths of the two policy documents are not likely to generate the inclusion of cyclists unless they are harmonised. The current paper seizes the opportunity presented by the social nature of exclusion that faces cycling to present social inclusion as a frame for reconciling these contrasting strengths and to articulate the need for cycling-inclusive transport planning. Facilitating cyclists through their social inclusion is argued in this paper as a way of not only enabling them to participate in the mobility in ways that they can afford but also a way of recognising that they have a right to access the city by bicycles.

This study makes a number of key policy recommendations that it hopes can elicit better inclusion of cyclists through a more proactive policy formulation and implementation.

To begin with, there is a need to harmonise the two policies in order to build on their synergies. In this regard, it is relevant to directly identify transport disadvantage as a social concern and to make it one of the priority concerns of the social pillar of Kenya Vision 2030. This would accord it equal priority with the other targets of the Kenya Vision 2030. There will be need for such harmonised policies to emphasise inclusion as a goal in itself rather than a means to participation in the economy. This is because the opportunity for cycling inclusion would be lost if inclusion is presented merely as a means to participating in economic pursuits. These recommendations are relevant at policy formulation level and would call upon the national government to implement.

It is also relevant that the harmonisation of these two policies recognises that the use of bicycles on street-spaces is a right that ought to be protected by the state. These street-spaces however have multiple claims. Policies that seek to include cycling must as such link with land-use and other transport strategies to ensure that efforts to include cycling are not derailed by such multiple claims. This study also recommends that the use of social inclusion in advancing the cycling-inclusive policies should consider the context-specific factors that exclude cyclists, such as the conditions of the street-spaces and the processes of allocating these street-spaces. These factors should be used hand in hand with the socio-geographic indicators that have been used traditionally to study social exclusion. These set of recommendations would call upon both the national government as well as Kisumu County Government to implement given that they concern both policy formulation and implementation. This paper also recognises the role of local cyclists, bicycle taxi operators, and bicycle advocates in ensuring that recommendations relating to the right to access the city is recognised and upheld by the city authority.

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[12] Field interview with Practising NMT expert, 20.08.2015.
[13] Field interview with Practising NMT expert, 20.08.2015.

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Conflicts of Interests

The authors declare no conflict of interests.

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Article

Transport and Access to Inclusive Education in Mashonaland West Province, Zimbabwe

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Abstract
Lack of accessible transportation is considered a major barrier to education for children with disabilities—children already far less likely to attend school. While millions of children face challenges with getting to school, including long distances, poor roads, lack of transport and safety issues, these can be compounded for children with disabilities. Yet there is little data from low and middle-income countries on the nature and extent of this exclusion, or on attempted solutions. This paper explores some practical options for improving transport as part of providing inclusive education for children with disabilities in low income countries, as well applying concepts of transport-related social exclusion in such contexts. The paper reviews a project designed to improve sustainable transportation to school for children with disabilities in four districts in Mashonaland West Province, Zimbabwe. The most common solution was three wheel motorbikes (tricycles) with trailers. Whilst not been unproblematic, teachers, parents and the wider communities overwhelmingly agree that they have supported children with disabilities to attend school. Obviously tricycles are not the only component needed for an inclusive education system, but they are a start. The paper also highlights some crucial gaps in current approaches, key among which is the fact the most government departments work in silos. Whilst inclusive education is strongly supported by the Zimbabwean Government, there is a lack of joined up thinking between transport and education ministries. Without stronger collaboration across ministries children with disabilities will continue to experience avoidable barriers and transport-related social exclusion.

Keywords
accessibility; children with disabilities; inclusive education; participation; social exclusion; tricycles; transport solutions; Zimbabwe

Issue
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1. Introduction: Reconceptualising What Access Means in the Zimbabwe Context

To date there have been limited studies published on the impact of transport-related social exclusion on children with disabilities, nor specifically on how the lack of affordable, accessible transport may affect their access to education. This paper is an attempt to redress this gap, and will describe some of the impacts of integrating transport solutions into an inclusive education project, as well as community understanding of the challenges and opportunities that such an undertaking represents.

At a basic level, access to and from education is a fundamental right of a child, and when they are unable to exercise this right, they can be socially excluded from society both immediately and in the future. However, how we measure the ability of people to get to and from school is a more complex problem. At a mac-

ro-level, since the publication of the seminal report from the Social Exclusion Unit in the UK (Social Exclusion Unit, 2003), there has been a shift in focus on what social exclusion means in different contexts and for different groups. It is now well-established that social exclusion is a multi-faceted, relational problem – that is exclusion is comparable to the social norms of a community or society; and one which changes over time; (Lucas, 2012). Causal factors of social exclusion associated to transport can be seen at three levels: the level of the individual, the community/local area and the country/global level (Lucas, 2012).

There is an accepted link between physical inaccessibility and transport-related social exclusion (e.g. Bannister & Hall, 1981), as well as multiple policies to enable accessibility for persons with disabilities. However, the majority of these have been in higher income countries; moreover, merely having a policy in place has not automatically improved transport-related social exclusion (Lucas, 2012). Accessibility is critical to a person's basic human rights and is enshrined in Article 9 of the UN Convention on the Rights of Persons with Disabilities (UN, 2007). Under Article 9, a state must give equal access to public buildings and transportation to people with disabilities; something which is achieved via a number of different modes in higher income countries, ranging from adaptations such as low-floor buses to taxi cards which allow a person to travel free of charge for a specified number of journeys. However, in lower income countries such adaptations and policies are in many instances cost-prohibitive and therefore new methods must be found to help ensure people with disabilities obtain equal access. One such method which has been applied in other domains is that of participatory design (Stevens et al., 2014). This approach allows citizens to have a voice in both the design of solutions as well as in the collection of data.

Given the wide ranging exclusion of persons with disabilities in lower income countries (e.g. Groce, Kett, Lang, & Trani, 2012), in this paper we explore if transport-related exclusion theories can be usefully applied as a framework to better understand the mechanisms of transport-related social exclusion of adults and children with disabilities? Or, put differently, can the debates be moved beyond the policy level to suggest ways to reduce transport-related social exclusion in lower income countries, and is a participatory approach useful to initiate discussion around an accessible transport system for children in Zimbabwe? This article explores practical community-led options for improving transport as part of a programme providing inclusive education for children with disabilities in a low income country context. Such an approach chimes with a more rights-based approach to disability inclusion, and focuses less on what is and is not available, and more on what the consequences of this are in terms of access to opportunities, including education and employment (Lucas, 2012, p. 106).

This research, undertaken by the Leonard Cheshire Disability and Inclusive Development Centre at UCL in collaboration with the Leonard Cheshire Disability Zimbabwe Trust, set out to understand three main issues related to transportation for children with disabilities to and from school:

1. The extent to which teachers, parents and caregivers understand transport (or lack of transport) to be a barrier to education for children with disabilities;
2. The 'solutions' communities propose to overcome the barriers;
3. Whether the solutions proposed and piloted in this project appear to be sustainable and effective over time.

While of the components of the overall programme focused on ascertaining the effectiveness of the 'transport solutions', it should be stated from the outset that this was not an evaluation of the methods, but rather an attempt to better understand the transport-related barriers and exclusions that children with disabilities face, and what, if any, impact the community-led solutions had. We should also underscore the fact that we cannot make any direct inferences about the successes of the methods chosen in these communities for broader implementation—this was not a randomised trial, and there were numerous other counterfactuals and causal links. However, what the research can do is to allow us to highlight some specific findings regarding the links between access to school, transport, and children with disabilities in lower income countries —something missing from the literature to date; as well as understand how communities adapt policies and practices to make them work in the local context.

In order to do this, the paper will first outline the current debates in transport-related social exclusion and the extent to which these have been applied to low income country contexts. It will then move on to discuss the inclusive education project in more detail, specifically the research around accessible transport solutions. Finally, we present the findings of this research before closing with a discussion around the implications of these findings more broadly.

2. Transport-Related Exclusion

The majority of the studies on access to transportation to school and other facilities for persons with disabilities or other disadvantaged groups have been undertaken in middle and high income countries (see for example, Currie et al., 2010; Schwanen et al., 2015; Whitzman, James, & Poweseu, 2013). Within much of this work, researchers have suggested direct causal links between transport and social exclusion, particu-

larly through an expansion of empirical research (Schwanen et al., 2015, p. 1). To some extent this paper builds on this tradition and argues that this in itself has value in drawing attention to the impact of such causal links on the lives of adults and children with disabilities in low income countries.

Zimbabwe faces all of the commonly highlighted challenges in the literature, which can be summarized as follows:

i) Physical exclusion: whereby physical barriers, such as vehicle design, lack of disabled facilities or lack of timetable information, inhibit the accessibility of transport services;
ii) Geographical exclusion: where a person lives can prevent them from accessing transport services, such as in rural areas or on peripheral urban estates;
iii) Exclusion from facilities: the distance of key facilities such as schools, shops, healthcare or leisure services from where a person lives prevents their access;
iv) Economic exclusion: the high monetary costs of travel can prevent or limit access to facilities or employment and thus impact on incomes;
v) Time-based exclusion: other demands on time, such as combined work, household and child-care duties, reduces the time available for travel (often referred to as time-poverty in the literature);
vi) Fear-based exclusion: where fears for personal safety preclude the use of public spaces and/or transport services;
vii) Space exclusion: where security or space management prevent certain groups access to public spaces, e.g. gated communities or first class waiting rooms at stations.

(Adapted from Church et al., 2003, pp. 198-200).

Critics argue that while this approach is helpful in identifying the challenges, it fails to identify where barriers exist, in what priority these issues should be addressed, and how policy attention should be focused (Lucas, 2012). In order to address these gaps, other approaches have been suggested; for example, Grieco, 2006 (cited in Lucas, 2011) proposed adding the following to the list above:

(i) Place-based measures, including opportunities and services within the immediate area in which a person lives;
(ii) Social-category based measures, such as social stratification within a community to identify social need;
(iii) Person-based measures, such as the individual public transport user's profile of journey needs.

Whatever the measures used, they should be seen as dynamic, and existing against a backdrop of ever changing needs and mobility. Moreover, most of the work done identifies multifaceted challenges beyond the control of the transport sector alone and thus necessitate integration across two or more departments and ministries.

However, most development policy focus has not been on these challenges, but on large scale transport infrastructure projects as a social development tool, rather than on the travel needs of local communities, despite the fact that a focus on the travel needs of the local community may result in less expensive, more context-specific and—perhaps—more inclusive solutions (Lucas, 2012).

For example, the majority of studies undertaken in rural South Africa identify an almost complete absence of public transport services, resulting in an over-reliance on walking, which in turn gives rise to a range of inequalities particularly affecting women's participation in paid employment and formal economic opportunities. These inequalities may also result in low uptake of healthcare and educational opportunities (Lucas, 2011, p. 1321). In both urban and rural areas in many lower income countries—including South Africa, Kenya and Zimbabwe—often the biggest challenges are not the lack of transport per se—the ubiquitous Kombi or *Matatu* minivans, taxis and motorbikes cover extensive networks in many countries—but rather that these options may be unaffordable, unsafe, unreliable and unsuitable for the often long journeys that must be undertaken to access work, healthcare facilities and other key destinations. However, while there has been some work around transport exclusion and healthcare (see for example Banda-Chalwe, Nitz, & de Jonge, 2012; Van Rooy et al., 2012), to date none have focused specifically on access to education for children with disabilities.

Therefore despite a range of approaches to reduce transport-related social exclusion, as well as a growing body of academic literature critiquing such approaches, there are still people who are out of reach of most policies and practices, and it is to these people that developing participatory community-led approaches—and assessments—may offer a solution.

2.1. Transport Policy in Zimbabwe

Most Zimbabweans face many of the same challenges as transport structures in low income countries around the world, including South Africa: affordability, availability, (lack of) infrastructure, (lack of) policy and planning and regulation (see for example, Lucas, 2011; Walters, 2008), and an (over) reliance on low capacity vehicles (e.g. minibuses or Kombis, as they are known in Zimbabwe). It is also a hugely unsafe sector—according to national data, around 20% of disabilities in the country are related to road traffic incidents (Minis-

try of Health and Child Welfare, 2009).

Zimbabwe is attempting to respond to these challenges by changes in policy and practice. For example, the Government of Zimbabwe (GoZ) recently launched its National Transport Policy (Chideme, 2013) one aim of which was to reduce the dependency on low capacity vehicles (Kombis) by replacing commuter omnibuses with high-volume buses operated by a limited number of private players between 2014 and 2016. In part this was a political decision as Kombi drivers can be a considerable voting bloc, but there are other potential complications too, not least cost. Therefore while on the one hand, it is an opportunity to improve and /or introduce accessible transport options; on the other, it will most likely simply reduce the number of transport options available to many passengers (see also African Development Fund, 2013).

Such changes in policy have direct implications for persons with disabilities in general. For example, according to the National Transport Master Plan (African Development Fund, 2013), which is linked to the National Transport Policy and Medium Term Development (MTD) plan, and which has a specific focus on persons with disabilities, Rural District and Urban Councils and the District Development Fund will continue to be responsible for urban and rural roads respectively; while the MTD emphasises the role of communities in road maintenance. Though beyond talking about community programmes it does not elaborate on how this will be undertaken. Unfortunately however, the Transport Master Plan has no clearly stated comprehensive transport/social inclusion links.

Taken together, the policy environment in Zimbabwe may be tantalising close to an inclusive policy, but it is as yet unclear how it will be implemented; moreover, it is also unclear what alternative transport options will be provided. Furthermore, nowhere is the issue of access to transportation by children with disabilities specifically considered, despite the GoZ commitments elsewhere, including to the UN Convention on the Rights of Persons with Disabilities.

3. Inclusive Education, Transport and Community Based Solutions

Between April 2013 and December 2015, the Leonard Cheshire Disability Zimbabwe Trust implemented a UK Department of International Development (DFID)-funded project to promote inclusive education in Mashonaland West Province (MWP), Zimbabwe.[1] Based on local awareness of gaps in access, a component of the project focused on developing innovative, community-led transport solutions to enable children to access school in light of the general lack of attention to the accessible transportation needs noted above. To address some of these challenges, a pilot project was developed in conjunction with the inclusive education programme to facilitate access to school. Sustainable, accessible transport solutions were developed by the project team in collaboration with the communities themselves through a series of meetings and focus groups, taking into account the local context and limited project budget. From the outset, it was intended that whatever the solutions, they would be fully owned and maintained by the communities themselves. Based on the children's needs, the local terrain and weather—in particular heavy rains, and local availability, two main solutions were decided upon—scotch carts[2] pulled by donkeys, and trailers pulled by tricycles, both produced locally and at low cost. Communities agreed these would be cost-effective, easy to maintain, suitable for the poor road network and efficient in terms of the number of children that could be transported to school in a single journey. On average, the trailers can transport eight children at any one time. The overwhelming majority of communities opted to purchase tricycles with trailers, and over the course of the three-year project, 20 tricycles with trailers were purchased for 20 eligible schools in the four districts.[3]

The vehicles were provided through a project grant, with the drivers—often parents or teachers from the schools—selected and paid a small stipend by the School Development Committees (SDC). SDCs are elected bodies, composed of parents and other community members, who, along with teachers, have a managerial oversight role of the school. They also agree levies for fees and other additional resources. The SDCs can be powerful advocates or opponents of innovations such as the tricycle transportation scheme, depending on perspective.

With regards to sustainability, during the course of the project some parents and SDCs set up income generating projects such as keeping chickens or growing vegetable at the schools to raise funds to pay the drivers. One group even talked about developing a community-based transport co-operative, which would require funding through community projects, though this had not taken place at the time of writing.

4. Research Methodology

We employed several different approaches in order to address the following research questions:

1. The extent to which teachers, parents and

[1] Global Poverty Action Fund project 'Promoting the Provision of Inclusive Primary Education for Children with Disabilities in Mashonaland West Province, Zimbabwe'.

[2] Usually for agricultural use, these are designed to hold heavy loads and be pulled by an ox or donkey. They are also usually made locally in Zimbabwe.

[3] A total of 30 model schools were included in the project.

caregivers understand transport (or lack of transport) to be a barrier to education for children with disabilities;
2. The 'solutions' communities propose to overcome the barriers;
3. Whether the solutions proposed and piloted in this project appear to be sustainable and effective over time.

These approaches were a structured comparative survey in the four selected districts in MWP (Hurungwe, Kariba, Mhondoro Ngezi, and Sanyati), which aimed to gauge the knowledge, attitudes and practices (KAP) of head teachers, teachers and parents/caregivers about the education of children with disabilities. A pre-intervention survey was administered in the field by a trained survey team to a total of 441 head teachers, teachers and parents/caregivers in July 2013 (Deluca, Tramontano, & Kett, 2014a&2014b), and a post-intervention survey of 408 informants was undertaken in June 2015 in order to measure changes over the lifetime of the intervention. The survey is currently being analysed at time of writing (Deluca, Pinilla-Roncancio, & Kett, 2016, forthcoming).

The survey included questions around a range of barriers to education for children with disabilities. Whilst the majority of the barriers identified were at the school level, and included the school environment, teacher attitudes, inaccessible classrooms and toilets, etc., there were also a number of external factors which head teachers, teachers and parents/caregivers identified as barriers. Here transportation was a key concern.

In order to get an understanding of what the communities themselves thought, particularly teachers and parents, about issues around access to schools and sustainable community transport solutions we undertook a series of group discussions. In total eight workshops were undertaken (two in each intervention area). The first round of research was undertaken in May 2014, when four workshops were conducted (one in each of the project areas). The aim of these workshops was to bring together a range of stakeholders, including parents and children with disabilities, other community members, drivers (of taxis and buses where possible) to discuss current local transport options for adults and children with disabilities, as well as to try and discuss possible 'solutions' to transport challenges. A total of 55 persons participated in these groups.[4] At the initial workshop, participants were placed into groups based on where they lived to ensure that the discussion ranged around a broad set of perspectives from the same locations/routes etc. Each group was asked to draw one map to represent transport currently available, and the challenges that using these options do or may present for persons with disabilities in particular. They were then asked to draw a second map to suggest possible solutions—or what they would like to see as options. They then presented these annotated maps back to the group for discussion.

These were followed up almost a year later (April 2015), when we undertook a second round of workshops in the same communities. It was not always possible to identify the same participants as before due to challenges in location, changes in address etc. However, representatives of the same groups—parents (of children with disabilities), teachers, head teachers and drivers (of the tricycles) were again included in the workshops. The aim of these was to explore a series of questions around the transport 'solutions' provided in each of the four districts. Participants were asked to join their respective school groups and discuss a series of questions about the transport solutions implemented in their schools. These focused on effectiveness, organisation, usage, cost, maintenance, ownership and sustainability.

Below is a summary of the findings from the survey and workshops. The first section highlights the outcomes from the initial round or workshops discussing barriers, potential solutions and challenges—and it should be noted that at this point, communities and schools had not yet been given the transport grants. The second section discusses the results from workshops held after the transport solutions had been implemented.

5. Findings

Results from both the KAP survey highlight a number of transport-related barriers. For example, in the pre-intervention survey, head teachers, teachers and parents/caregivers overwhelmingly agreed with the statement that 'schools are a long distance from home'[5]: 87.9% of head teachers (N=66), 86.2% of teachers (N=180), and 67.0% of caregivers (N=179). Linked to the question of distance was a question about means of transport to school. Again, all three groups (head teachers, teachers and parents/caregivers)

[4] Broken down as follows: Sanyati: seven teachers (one per school); six parents (including parents of children with disabilities); two taxi drivers; and two persons with disabilities. Mhondoro-Ngezi: seven teachers (one per school, including one classroom assistant, six parents (including parents of children with disabilities); four taxi drivers; and two persons with disabilities. Kariba: Four school development committee (SDC) members; three parents of children with disabilities; one taxi driver and one person with disabilities. Hurungwe: three SDC members; two classroom assistants; five parents of children with disabilities; two taxi drivers and one person with disabilities.

[5] No distance was specified in the survey, in part to facilitate future discussions on what a 'long distance' means across communities.

overwhelmingly agreed that there was no means of transport to school: 81.9% of head teachers (N=66), 80.7% of teachers (N=181), 70.2% of caregivers (N=178) (Deluca et al., 2014a). However, it is important to note that some of the children with disabilities may not be attending their nearest school; rather they may be attending the nearest schools included in the IE project. Also, when questioned about distances, parents had varied opinions about the distances between homes and school, which apparently could be up to 3km each way. Of course, distance perception is highly subjective, and depends on what adults and children consider to be a long distance; as well as the context, degree of difficulty, and what transport methods are available and used, and by whom. Nevertheless, it also underscores how a relatively short distance may pose many challenges in school attendance for some children.

In practice, most children have to travel by foot to school, often over significant distances for them. Obviously this may be challenging for a number of reasons, including if the child has impairment which may interfere with their ability to walk a distance on their own, or if they are very young, or alone, all of which may make the child vulnerable. These children may either have to choose a difficult (and expensive) journey to school by the limited public transport options, or may have to be carried the distance by parents or siblings, or they frequently miss out on attending school regularly, if at all.

Where public transport is available, it is more often than not a motorbike taxi, which has better access in harder to reach (often rural) or remote areas, or kombis in towns and some more accessible rural areas. However, even when these options are available for children with disabilities, there were a number of factors preventing their use. At the top of the list of barriers, is the issue of costs, with 72.7% of head teachers (N=66), 70.0% of teachers (N=180), 76.0% of caregivers (N=179) somewhat or totally agreeing that indirect costs, with transportation being a key issue, for schooling are too high.

Compounding these reported barriers is the fact that MWP is a largely rural province, with many remote and hard to reach areas, many of which are surrounded by national parks. Therefore it is perhaps unsurprising that 65.7% of head teachers (N=64), and 73.9% of teachers (N=180), thought that natural environmental barriers (e.g. animals, rivers, floods, etc.) might be an additional set of barriers preventing children with disabilities from going to school. However, interestingly parents and caregivers were more split about these environmental concerns being a barrier (50.2% disagree and 49.8% agree; N=179), (Deluca et al, 2014a). Despite the divided opinion regarding environmental barriers, it is clear that parents and teachers both agree that distance, cost and lack of accessible transportation have an impact on the availably, accessibility and type of transport solutions that can be proposed for the area.

5.1. The Solutions

It was clear from the survey-based data that distance and (lack of) transport were a factor in exclusion from school for many children. So how did the communities themselves conceptualise these challenges, and what solutions did they propose?

At the initial workshop in 2014, groups from all four of the districts highlighted the rough terrain and lack of paved roads in the localities as challenging. Sandy road surfaces were highlighted as particularly difficult for pushing wheelchairs (if the child was fortunate to actually have one), or cycling—one father took his child to school on the back of his bike. Cycling in these conditions also made bikes liable to punctures and other breakdowns. The roads were also affected by the weather, especially rain. Another effect of the rain was an increase in traffic, so children may be even more delayed on their journey to school. Bad weather was cited as a key factor for many parents deciding to keep their child with a disability home from school on such days, though this is difficult to verify.

There was also some discussion amongst the parents about distances, available transport and context. In one district, participants highlighted that a major access challenge for persons with disabilities to public transport was not just inaccessible vehicles, but the willingness of drivers of kombis or taxis to stop and pick up children and adults with disabilities. One taxi driver explained that he had picked up passengers who use wheelchairs in his taxi (providing the wheelchair could be folded up to fit in boot). Another driver responded by saying they had their own set of challenges when it came to children and adults with disabilities alike. They explained that they have a minimum earning target per day (usually kombis are rented so the drivers need to pay the owner of the vehicle), so any delay can cost money. Therefore having a passenger who is slow to board, or needs to put something on the roof or in the boot of the vehicle, causes a delay and costs them money. This meant they were less likely to stop for them or to pick them up. Moreover, such practices are rarely challenged, particularly from a legal perspective (as discriminatory), so until such time as they are, they are like to continue. Nevertheless, drivers thought taxis might be more flexible and open to negotiation about transporting persons with disabilities, as they have less passengers than the kombis (though of course are more expensive). Everyone agreed that drivers needed to be more aware about persons with disabilities, yet they were rarely included in such discussions.

Workshop participants did discuss some possible solutions to the challenges raised. These ranged from

tangible inputs such as assistive devices and material goods and resources, including first aid kits for drivers for the (inevitable) accidents to less tangible, such as community awareness raising, and training for drivers. Others called for more accessible public transport—with wide doors, rails, preferential seating; as well as the possibility of free transport and improving the overall condition of the roads. This led to some debate about who was responsible for providing maintenance. As noted above, the GoZ current policy aims to push responsibility for road maintenance and other transport-related factors back onto local communities themselves, rather that the local authorities; in part as a cost saving measure.

There were also some specific issues raised in the four districts: participants from Sanyati raised the issue of road safety as there were no 'robots' (traffic lights) or designated crossing in their community so children were at risk from traffic accidents. But there were other risks identified as well. Parents said they may not accompany their children to or from school if they are busy (with income generating activities, for example), which leaves children unaccompanied and potentially vulnerable to other risks. This particular community is in a former gold mining area but now most of the miners are unemployed. They and their families have little means of income generation or social support, and some participants complained that many of the men spent their days in bars getting drunk, which caused some parents to be anxious that they could pose a risk to their children.

With regard to solutions, this group thought there should be 'less talk and more action'—including the (re)introduction of 'conventional' buses. Others thought that communities themselves could take more responsibility for road maintenance as well as provide input into locations for bus stops and zebra crossings.

In the Mhondoro-Ngezi District group, one visually impaired young man from the community outlined his challenges using public transport, which included trying to identify the correct stop, and having the correct change for the fares. Several members of the group stated that they had not considered some of these issues, and it had made them more aware about them.

Kariba is one of the least accessible districts the area in terms of transport and distance, so perhaps unsurprisingly, the lack of transport options, long distances to anywhere else and wild animals in the vicinity (it borders a national park) were key features of their group discussion. This group specifically mentioned the need for tricycles, as well as the need for pavements, in addition to fencing to keep wild animals at bay. They also mooted dormitories as a school level solution for children with disabilities.

Finally, Hurungwe District participants had an in-depth discussion over who should take responsibility for road maintenance in communities. They also brought up the issue of community-based transport co-operatives to support community transport solutions.

In the four post-intervention workshops held almost a year later using the same format, similar themes emerged. Significantly, participants agreed that the availability of transport had increased the likelihood of the children with disabilities attending school (Deluca et al., in press); as well as 'increasing their self-esteem and motivation'. Obviously the LCD inclusive education programme included a range of other factors, such as community sensitisation, school adaptations, and teacher training, so in and of itself just having transport may not be enough—especially if the numbers of children with disabilities attending school continues to increase. For example, some participants argued that depending on the number of journeys needed, time management may actually worsen, especially if the driver is also a teacher at the school. However, overwhelmingly the feedback was positive in that it had increased the likelihood of the children going to—and staying in—school. The extent to which transport alone can be singled out as a factor that ensures children with disabilities can access school is of course debatable; however, the transportation solutions provided did make a significant difference to the parents' daily lives. For example, one participant, highlighting the reduced challenges for parents, said that prior to the introduction of the tricycles some parents had been carrying their children to school on their backs. The availability of transport also freed them up to undertake other (income-generating) activities or household chores.

The majority of children who used the tricycle were children with disabilities; specifically, children included in the LCD IE programme. In most schools, it was the SDC who decided which children got to use the transport, and agreed it with the school administration. In the majority of cases, classroom assistants (another feature of the LCD IE programme in MWP) accompanied the drivers to pick up and drop off the children to and from school. As was common in most schools, the vehicle was also used for additional activities, for example, taking sick children to hospital or to sporting activities. All schools kept their tricycles parked at the school with the keys in safekeeping (usually kept by the school administration).

The new system of transportation therefore created new employment opportunities too. However, some of the drivers were parents of children with disabilities, who may or may not have had previous driving jobs, while others were already employees of the school (in roles such as teachers or caretakers). Very few drivers were given any formal training, either in driving or assisting children with disabilities—which is clearly a gap to be redressed—though some drivers did in practice assist the children to get in and out of the vehicles. There was some debate about what qualifications the drivers needed, including the extent to which

they needed to know about the children's specific requirements or child protection issues. Some of the drivers had met the children beforehand, and in most schools, the drivers were given a list of children who needed to use the transport, which also may include siblings of children with disabilities. In theory, drivers were voluntary, though in practice, almost all the schools included in the study paid the drivers a small salary (through the SDC). Participants were asked what they thought would be an ideal salary, which they mooted as between US$250–400 month, depending on location.

Some of the disadvantages of the tricycle highlighted were that they were rather weather dependent as they have no roof or cover. Some schools had made plans to put a tent or cover over the tricycle. A few parents and teachers were worried that the rain may cause the children to be taken home early or brought to school later (though apparently this scenario had not actually happened yet due to the timing of the interventions). Several participants mentioned the poor road conditions, but thought the tricycle could manage them well. Several other participants also raised the issue of safety—as there were no seat belts, first aid kits or fire extinguishers, and drivers were not always aware of safety needs—theirs or the children's. There was also the issue of the children's comfort, and the need to ensure that their health and safety was not compromised on the journey. Participants also wondered to what extend it was a good idea to have teachers as the drivers as on the one hand they may be delayed and be late for lessons, but on the other hand they were more likely to be familiar with the children.

Other challenges highlighted included the vehicle registration process, insurance costs and driver identification (e.g. for security purposed and to check qualifications). Some schools had painted a wheelchair logo (the universal disability sign) onto the trailer to avoid difficulties with the police. Wheelchairs were folded up and attached to the side of the trailer. One driver reported that the police had stopped him because he did not have reflective clothing.

Participants agreed the tricycles were economical to run, with fuel usage varying between 10 litres to 60 litres per week (fuel was around US$1.5 per litre at time of interview), depending on number of runs they had to do. Drivers at schools with higher numbers of children with disabilities, or at schools that operate a 'split shift', with lessons in the morning and afternoon (mainly in urban areas), often had to do additional school runs to accommodate all the children who needed to use the transport. In most cases, money for fuel was provided by the SDC, from income generating projects. Some children come from as far away as 15km from school in more remote areas—these were the children who had not been attending school prior to the project commencing. The tricycles also bought wider benefits; one driver had held a meeting with a village head about road maintenance and through community engagement they were able to ensure the roads were maintained to make them safer for the tricycles to travel on.

Overall the tricycles were seen as relatively economical, suitable for the environment, easily maintained (as parts can be bought locally); as well as having the additional benefit of improving the time management of parents, teachers and pupils. Not all schools chose the tricycle options, and it should also be noted that the total grant available was not enough to cover all the schools in the project,. One of the most remote schools in the area—140km away from the district headquarters—did not have a tricycle as the community thought purchasing fuel would be a problem. In others, there was no tricycle because the SDC chose an alternative option. For example, one school had opted to top up the grant and buy a car (a Toyota *Funcargo*), rather than a tricycle. Of course, this solution was not without challenges—especially fuel costs, and also raises issues about sustainability and environment. But this community thought it was more effective in rainy weather, and could take children right up to their homes, unlike a kombi van; yet another school in the district wanted to buy a kombi van, using income generating projects to raise fuel costs. Communities therefore had differing views on what they considered to be an 'accessible transport solution'.

In one school without any transport, children with disabilities had to rely on public transport, such as taxis or kombis. This meant they also relied on the driver (and/or classroom assistant) to assist them in and out of the vehicles, as well as tell them where they are going and when to get off. Some parents were worried that the children might end up far from their homes, putting them at risk. They were also worried that though they give the fares to the children, they might spend it on other things, such as sweets or snacks, leaving them with no money to get home. Of particular concern, in one district, as several children lived some distance from the school the SDC said they were considering building residential accommodation for children with disabilities, who, they posited, could be cared for by parents and teachers. However, while this may provide an immediate solution to the problem, it is likely to create far more problems in the long term, as well as perhaps indicate that some teachers (and parents) had not yet fully understood some of the fundamental premises of an inclusive education system—which would try to avoid separating children and families at all costs. It would also be additional work for the parents and teachers, without necessarily any additional resources. Interestingly, several of the other workshop attendees disputed this as a 'solution', saying that "if it is a transport problem, then there should be a transport solution".

6. Discussion and Conclusion

What does this information tell us about transport and social exclusion? Does the model piloted in this programme offer a way to support in the inclusion of children with disabilities in the education system? In Zimbabwe, children with disabilities face numerous challenges in accessing the education system. But the education—and transport—systems themselves face numerous challenges in Zimbabwe today, given the current state of the economy and public services (see for example Frye, 2013).

Certainly some of the responses to type of intervention piloted (the tricycle) clearly show that access is understood and experienced differently by groups even in the same context (Church & Marsden, 2003). The results outlined above demonstrate the challenges are multi-dimensional; relational and dynamic (Lucas, 2012). It was clear from some of the responses that communities were considering much broader issues than just transport for the children with disabilities—these ranged from additional life skills training for the children and training for drivers through to road safely and maintenance. Whether this is a result of the programme, or a general increase in awareness is unclear, but either way it is an achievement in itself.

Obviously transport—in this case tricycles—are not the only factor necessary for an inclusive education system, but they have highlighted some crucial gaps in the current approaches, as well as some crucial gaps in the literature around inclusive education. In this paper we have first discussed the impact of transport disadvantage on exclusion (Lucas, 2012)—in this case from the education system. The workshops highlighted the fact that this problem is indeed multi-dimensional: located both within the circumstances of the child who is affected, as well as the processes, institutions and structures in the wider society. Lack of transport may not be the only factor preventing children with disabilities from going to school, but it is a significant one, and may disadvantage those children in relation to the other children in the school.

Access issues range from time constraints for drivers (who receive pay per passenger), which in turn impact on their awareness and willingness to include persons with disabilities amongst their passengers. Conversely, community attitudes toward drivers were often of mistrust. However, as the participants in the workshops have highlighted, drivers were not unwilling to include adults and children with disabilities amongst their passengers, but wanted to ensure that their constraints were also understood. These challenges raise issues around public and private vehicle driver training (especially if they will transport large number of adults and children); as well as legislation. It is clear that there is a need to raise issues of discrimination in accessing transport to the relevant authorities to challenge current attitudes and practices. It is also important to remember that Zimbabwe did have a relatively good free public transport service for persons with disabilities (though this did not cover all areas) in the past, but due to the political and economic decline, this service is no longer available in most places (Chronicle, 2014).

The workshops also highlighted some of the challenges of coming up with sustainable appropriate, community-based solutions. In the case of the tricycles, it could be argued that these are an economical and effective 'solution'; but further inquiry is needed about what truly 'accessible' is in this context. Is it a solution that is affordable, reliable, regular and safe, or is it a more tailored solution, such as an adapted bus?

There are also broader challenges: the state of the roads, and who should take responsibility for their maintenance—current policy is pushing the onus back on communities themselves. While it seems from some of the respondents cited here that they clearly feel that they could take more responsibility for road maintenance, it also raises questions about the boundaries between civic duty and the role of the state. It may be possible to engage local councils in discussions about improving road conditions if these are linked to concrete examples such as the dangerous road conditions (e.g., pot holes, ruts) for the tricycles. As the tricycles are funded through the SDCs to support access to education, councils may be asked to contribute funds and resources alongside the communities to facilitate an effective compromise.

Then there is the issue of who supplies and maintains the tricycles or other accessible adaptations. This too may be more effective if seen to be a shared responsibility—e.g. with the schools providing transport. But this in turn raises questions of how sustainable funding for the tricycles will be, unless the schools and the communities see the benefits, and that the vehicles are not the sole responsibility of the parents and caregivers of children with disabilities. The evidence above suggests that parents, communities and schools have in some cases been able to come together to ensure that the transport solutions are sustainably and successfully achieved. The question of course, is whether they will be sustained beyond the life of the project.

All of these measures must be seen as dynamic, and against a backdrop of ever changing needs and mobility. As Lucas notes:

> "Transport and social exclusion can never survive as a solely transport-focused agenda. The accessibility planning (in its broadest sense) of public transport which is necessary to meet the travel needs of socially excluded people must be highly integrated with socially responsible land use, housing, health, education and welfare policies and programmes." (Lucas, 2012, p. 112)

It is clear that in Zimbabwe, there are programmes, policies and practices in place, but as yet there is very limited integration between them. Success in reducing transport-related exclusion of children with disabilities from school can therefore only truly be achieved through more coherent, joined up policy making—such as including representatives from the departments of transport, roads and planning in discussions about inclusive education, and education ministry representatives in discussions about urban planning, transportation and mobility; as well as engaging with schools, communities and parents themselves, to better understand their challenges, as well as some of their suggested solutions. In our discussions here, we have tried to demonstrate some of the opportunities there are to do this.

Hopefully what we have also shown here is that policymakers and practitioners working in lower income countries need to be aware that, despite legislation and policies in place, those most marginalised and social excluded are still likely to fall through the gaps, and only by listening to their voices and their suggestions can we begin to develop participatory, community-led solutions that offer a way to try and understand what the challenges are, and develop solutions to overcome—or at least try and avoid—transport-related social exclusion.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

The Quest for Gender-Sensitive and Inclusive Transport Policies in Growing Asian Cities

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Abstract
In cities all over the world, growing numbers of women are working or studying further away from home than ever before. This article presents policies by the World Bank and recommendations by the United Nations to improve conditions for women's mobility in cities. Although these stress different factors affecting women's experiences of traffic and transport, they all agree about the importance of enabling women's mobility. However, gender-sensitive policies have been largely unsuccessful. This article presents examples of conditions for women in New Delhi and other rapidly growing Asian cities that illustrate how gender norms operate. This study uses the perspectives of development research and gender studies to examine economic and political initiatives and the way women act and interact with transport in local contexts. It facilitates critical reflection upon existing transport policies and suggests 'how' women's needs may be effectively addressed. More in-depth knowledge about women's needs and the problems they face when travelling will be useful for designing of policies that address more than simply the harassments of women. More inclusive urban access would enhance conditions for women and enable them to make choices according to their needs. In this way, social science and policy will cross-pollinate one another.

Keywords
development banks; development research; gender; mobility; policy; public transport; sustainable transport; transport equality; United Nations; urban Asia

Issue
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1. Introduction

An increasing number of families are dependent on female breadwinners and greater numbers of women are now working further away from home than ever before in history. The conditions for women in cities around the world vary and the way they have to "juggle domestic responsibilities, marital relationships and paid work" is affected by various constraints (Tacoli & Satterthwaite, 2013, p. 6). In many cities women spend a large part of each day in public space, travelling on buses and trains or walking and bicycling on roads.

Modern transport facilities are seen as a prerequisite for cities to develop and prosper and for families to enjoy a reasonable quality of life. In recent years, alongside urban modernisation and gentrification processes, traffic and transport systems have undergone dramatic change in order to meet the mobility needs of people and goods. In most cities, large businesses and services have become better connected with the help of both public and private investment but the situation for low-income families or those who live in peripheral areas of cities have benefitted far less. From a gender perspective, it is also evident that traffic and transport policies and infrastructure have not responded equally to women's and men's mobility needs (Moser & Moser, 2005; SIDA, 2005). It is widely recognized that modern mobility is not inclusive and that many suffer

from problems with access to work, healthcare, leisure activities and social services (Lucas, 2004).

Urban growth puts great pressure on the infrastructure to accommodate greater numbers of people. Transport problems in the cities of emerging economies often seem overwhelming or even insurmountable (Thynell, 2003). National and local policies vary widely but in general they stress the role of transport in economic development and modernization, as illustrated by the policies in China and Vietnam (Thynell, Tran, & Schlyter, 2010). Urbanization is often associated with increasing opportunities for women and girls, but "most urban women experience profound disadvantages compared to men in their daily life" (Tacoli & Satterthwaite, 2013, p. 3). With its Western technical background, the transport sector tends to become gendered through various mechanisms relating to socio-economic conditions, traditional ways of life, religion, women's legal status, their position in the labour market and their role in decision making (Thynell, Tran, & Schlyter, 2010). Since few women are employed in the transport sector in the developing world, masculine norms tend to become invisible and taken for granted. According to the political scientist Kronsell "institutions that historically have or are dominated by male bodies reflect masculine norms which have normative power over its agenda" (Kronsell, 2005 in Kronsell, 2015, p. 7).

Urban journeys are not ends in themselves but are tools that women may use to improve their chances of participating in society and perhaps enhancing their quality of life.

This article focuses on the transport situation faced by women in rapidly growing Asian cities in which the number of motor vehicles is increasing. It explores this from the perspective of development and gender research. A gender analysis of women's travel behaviour, needs, priorities, opportunities and constraints and factors such as income, age, health and ethnicity all need to be understood in the local context in order to inform the design of appropriate transport policies (World Bank, 2010).

In 2015, the United Nations (UN) launched the Sustainable Development Goals (SDGs) and drew attention to the pressing need for inclusive mobility. Goal number 11 is called 'Make cities inclusive, safe, resilient and sustainable' and transportation is a key development issue described in target 11.2: "By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women and children, persons with disabilities and older person"' (United Nations Chronicle, 2015). However, although this points to the crucial role played by transport in fulfilling the SDGs, ministries of Transport and Environment and city administrators often find it difficult to translate international recommendations into effective policies.

Most agencies lack the requisite knowledge about local needs to address the gender aspects of mobility (World Bank, 2010), and they tend also to lack the capacity to guide governments in their efforts to establish 'transport equality'. Journeys are embedded in socio-spatial contexts and unsubstantiated beliefs about social inequality or gendered mobility are not helpful for designing effective policies. The current knowledge gap needs to be bridged and tools will have to be designed using information about how women act and interact with transport systems, the natural environment and the socio-economic and traditional context. This means that experiences gained from parts of the world that became motorized earlier, such as the US or Europe, are not necessarily applicable to developing Asian countries.

1.1. The Purpose and the Challenge of Women in Urban Mobility

The complex nature of mobility requires that we look beyond physical factors of traffic and transport and explore 'how' and 'why' the gender order influences women's mobility. The purpose of this study is to explore the conditions for women's mobility in growing Asian cities using three kinds of gender-sensitive perspective: research, the UN and the development banks. The study also aims to discuss how well-informed policy may facilitate women's mobility in rapidly changing and developing Asian cities.

The challenges associated with urbanization (climate change, growing inequality, rapidly changing cities) have introduced new understandings of the importance of urban development and traffic conditions in developing countries. Today's focus on sustainable development opens a window of opportunity for considering new ways of proceeding, and the notion of sustainable transport includes the issue of 'transport equality', which means considering road safety and security factors that are often of particular concern for women.

The gender mainstreaming of transport systems is at the core of several transport recommendations made by the UN and the development banks. Gender has become integrated into development research together with the notions of empowerment/disempowerment, strategic life choices, resource management and agency. Achieving transport equality involves ensuring that the perceptions, interests, needs and priorities of both women and men are given equal weight in planning and decision making (SIDA, 2005).

This article begins by introducing some earlier research and fundamental gender considerations that relate to mobility. These will be returned to in the concluding discussion. The World Bank and the UN have

developed various initiatives to address the problems observed in today's transport systems, which are seen to be permeated by masculine norms. The objective of the United Nations Panel on Climate Change is to meet the challenges of vulnerability, adaptation and mitigation (United Nations Intergovernmental Panel on Climate Change, 2014). Earlier gender-sensitive initiatives that targeted various aspects of women's roles in development (poverty reduction, social cohesion, sustainability) have also tended to share a concern with women's mobility and equal access in cities, albeit for varying reasons. However, this kind of initiative has thus so far failed to create equality of access to transport or enhanced women's urban mobility in Asia. The possibilities and obstacles for achieving more inclusive and female-friendly transport systems will also be discussed.

1.2. Earlier Research

Studies of women in developing countries emerged as a research field decades ago (Moser, 1989). The points of departure were several. *Firstly*, there was interest in the effects of freedom from colonialism and women's liberation. *Secondly*, researchers explored the social impact of the structural adjustments programmes that were implemented in emerging markets in the 1990's. *Thirdly*, there was interest in the second wave of feminism, as manifested in the UN women conferences (Nairobi, Beijing). *Fourthly*, researchers examined the discourse of civil society, participation and poverty reduction programmes and they critiqued development practices and rights. This is illustrated in the work of a number of scholars on topics such as poverty reduction programmes and development (Eyben, 2012), women's empowerment frameworks (Longwee, 1995), on the undoing of internationalized oppression (see Rowland, 1997) and on the ability to make choices (see Cornwall, 2004; Eyben, 2004; Kabeer, 2001).

Urban research dates back to authors such as Henri Lefebvre (1982) and David Harvey. In his book *Social Justice and the City*, Harvey (1978) claimed that the principle of justice has profound relevance for urban development and for the link between spatial form and social processes. He noted that transport plays a crucial role in this by removing barriers such as time and distance for equal access to opportunities.

The differences in men's and women's travel behaviour and attitudes were recognized long ago. A number of scholars in geography, sociology, feminist and urban studies have added to the growing body of findings and highlighted the cross-cultural features of gendered mobility. The notion of inclusive mobility refers to physical, social and culture aspects of travelling (Hanson, 1996, 2010). The values that guide attitudes and behaviour may therefore differ radically between continents. Mobility also refers to the ability to move between different activities sites, such as between home and school (Hanson, 1996, p. 4). The situation for women in relation to transport in rapidly motorizing and growing cities is still an emerging area of research but there is an extensive body of literature from developed countries that became motorized early on. However, mobility is a complex phenomenon and findings from the US, the Nordic countries or European countries are not necessarily transposable to Asia. Some alternative contributions to the literature have been made by authors such as for instance Adeel, Yeh and Zhang (2016), Grieco (2009), Grieco and Urry (2011), Peters (2001, 2011), Raje, Grieco, Hine and Preston (2004), Tiwari (2014), Turner (2012), Uteng (2011), and Wang and Qin (2015). The report from the conference 'Poverty and Mobility in the Context of Asia' refers to the work of organizations that are engaged in women´s mobility and various findings that engage in theories, practices and ethics that are becoming of growing concern to politicians in Asia (Bisan, 2010).

The following section presents some further background to the shifting needs of mobility.

1.3. Mobility Fundamentals: Gendered Patterns

The major reason that women travel is to get to work or a place of education (Tara, 2011). Their travel behaviour therefore relates to the location and forms of available employment—formal, informal, part-time, unskilled, self-employment (Hanson, 1996; Hanson & Pratt, 1995). Research has also shown that variables such as gender and employment status have a greater impact on the travel behaviour of individuals than does social class (Hanson, 1996). Work opportunities may be decisive for the number of journeys undertaken per week, the distance travelled, the means of transport chosen and the cost of travel. Other factors that influence women's mobility are responsibility for caring for children or elderly or infirm relatives (Camstra, 1996; Hanson, 1996).

Women often make more frequent but shorter journeys than men and often at off-peak hours. Notably, the gendered order is related to household practices, their position in the labour market and their access to vehicles (Law, 1999; Rosenbloom, 2004; SIKA, 2007). All these fundamentals are mainly from studies carried out in the US or Europe. Another study showed that women are more critical of car use then men are (Linden, 1994).

The Sustainable Development Goal 11 states "When compared to men, women move about cities at different times, for different reasons, in different ways, and have fewer financial resources; they are less able to afford many of the transportation options available to them" (United Nations Chronicle, 2015). In India, in general, women have lower incomes and suffer from spatial constraints and less mobility than men since costs of safe and secure transport are too high for

them (Tiwari, 2014). In Delhi, for example the relocation of squatter communities to the outer periphery of the city has been especially damaging to women's ability to earn a living. Female unemployment in these locations rose by 27% compared to 5% for men (Moser & Peake, 1987).

To save money, women may choose to walk instead of taking a bus and this means that poor women are more affected by distance. In general women depend more on public transport than men do. Women often try to work closer to home than men do, even at the expense of better work or higher incomes (Turner, 2012). Uteng (2011) states that dismal road conditions affect all users but there may be differences in what possibilities people have to handle the problems.

The next section presents some local features having an impact on women's options and behaviour.

2. Urban Journeys in Rapidly Growing Asian Cities

An ever-growing proportion of the world's population are living in cities. Another 2.5 billion people are projected to add to the world's urban population with nearly 90 percent of the increase concentrated in Asia and Africa. India alone is expected to double the number of city dwellers by 2050, with some 404 million more people living in its cities whereas the cities in China are likely to grow with 292 million (United Nations, Department of Economic and Social Affairs, 2014, p. 1). Although greater urbanization is desired by dominant global actors, housing, infrastructure and services are rarely planned to meet the increasing demands. Globally, some 828 million people are living in urban slums and the number keeps rising (United Nations, 2015). The Asian Development bank notes that "almost 25% of Asia's urban population is poor, and the rate is increasing, as there is a continuous influx of poor people into cities" (Asian Development Bank, 2014). In Cambodia, Bangladesh, the Philippines and Mongolia, some 40% of the population subsist below the poverty line.

Despite their historical, economic, sociological, political, and cultural disparities, cities such as Jakarta, Hanoi, Delhi, Mumbai, Metro Manila, Bangkok, Kuala Lumpur and Beijing all suffer from worsening traffic congestion and transport problems (Vasconcellos de Alcantara, 2001), air pollution and accidents (Wismans et al., 2015). Transport difficulties usually pose less of a problem for men while women frequently state that their needs are not being met (World Bank, 2010). Growing cities mean longer distances and more time spent on roads. Informal or newer parts in cities often suffer from lack of appropriate infrastructure and roads can be dangerous. Streets are often too narrow, badly maintained, have poor drainage and lack traffic management. In Shanghai, 7.4 percent of urban space is occupied by roads, in Seoul 20 percent, in Paris 25 percent, whereas, in Calcutta, Xian and Hanoi only 6 percent of space is occupied by roads (Thynell, Tran, & Schlyter, 2010).

It has been predicted that the demand for transport facilities is set to increase considerably but insufficient planning and weak law enforcement means that informal transport operators often tend to fill the gap and are likely to do so more in the future. Urban mobility will continue to be a major problem (Thynell & Wolmar, 2014) and more women are likely to be commuting in the future. Urban geography, the technical and natural environment, and social-cultural conditions also influence women's travel options and choices. In Dhaka, for instance, 75 percent of the people on the streets are men and amongst other things this, reflects the lack of safety and security for women (Kahn, 2009). Some common features of Asian cities are:

- Bicycles play a pivotal role along with other non-motorized vehicles (NMVs) and motorcycles.
- Non-motorized means of transport are seldom planned for or regulated and maintenance of footpaths, bus stops and streetlights is often lacking.
- A large proportion of women depend on public transport (formal and informal), which is often inefficient, uncomfortable, dirty, unreliable, poorly maintained and unsafe.
- Rates of traffic-generated air pollution and noise are soaring.
- There are high rates of traffic injuries and fatalities and pedestrians, passengers (all ages), drivers of NMVs and motorcyclists are particularly at risk (Wismans et al., 2015).

Access to a variety of destinations is important for women to be able to cope with the mixed demands upon them in providing for their families. Walking and cycling are both affordable and accessible ways for the vulnerable, including women and the poor, to move about cities. But 65 percent of the 1.2 million deaths that occur each year worldwide due to road accidents involve pedestrians and 35 percent of those deaths are children (Short & Pinet-Peralta, 2010). Unsafe roads and the price of travel are often strong deterrents for women to use transport. Globally, six out of ten of the world's poorest people are women (United Nations Development Programme, 2013) and this influence their choices in such a way as to make them less mobile than poor men. This means that jobs and social services are becoming more accessible to men only.

In some Muslim countries, men and women travel separately in taxis and on public transport. Some big cities offer women-only services, or 'pink solutions' and provide buses or metro cars exclusively for women and children. The separation of sexes in public transport was introduced on a private railway on Manhattan

some 100 years ago. It is now used during rush hours in mega-cities such as Mexico City, Cairo, Tehran, Dhaka and Tokyo. However, while 'pink solutions' may solve acute problems of harassment, humiliations, drug-dealers, purse-snatchers and so on, they also reinforce the gender order and "perpetuate divisions and differences between the sexes rather than comprehensively addressing the deep rooted gender biases inherent in current transport planning and policy making" (Peters, 2013, p. 35).

The following section looks more closely at women in public transport and in public space.

2.1. Public Transport and Public Space: Gendered Arenas

Public transport is a crucial element of sustainable transport and of efforts to reduce urban inequality. The social parameters of public transport policies may be summarized as the five A's: Affordability, Availability, Acceptability, Accessibility (Carruthers, Dick, & Faukar, 2005) and Appropriateness (Thynell, Punte, & Arora, 2009). Accessibility designates the number of opportunities available within a certain distance or travel time, and appropriateness is related to local meanings and cultural gender norms. A nearby bus stop might not be accessable because of insecure streets, heavy traffic, a lack of shelter from the sun or rain or lack of seating. Hence, accessibility is related to the overall transport environment and it begins with the public transport facilities themselves and how policy and planning respond to gender norms. Structural discrimination against women and children from low-income families means they are more exposed to risks when moving around the city. And "for a very large number of women in urban areas the constant threats, from verbal harassment to outright violence whenever they leave the home are an unwelcome reality" (Tacoli & Satterthwaite, 2013, p. 5).

Women's use of public space or public transport is often contested. A study from Delhi shows that 85 percent of women reported having faced harassment or violence in public space (Jagori & UN Women, 2011, p. 14). In 2012, the rape and murder of a woman on a bus in New Delhi brought the media's attention to the traditional treatment of women (Roychowdhury, 2013) in public transport. In New Delhi, 54 percent of women reported feeling unsafe when using public transport (Jagori & UN Women, 2011, p. 16). Another problem is that the frequency of bus services, route options and stop locations may not respond to women's needs. Since the average salary in New Delhi for a woman working in the informal sector is low (between 10–100 Euros according to unconfirmed information from National Survey Sample Organization and Indian Association for Women's Studies), the affordability of public transport is a major concern for women. For passengers without travel options—so-called captive riders—the fare price, safety, reliability and information about departure times are important (Carruthers et al., 2005). To avoid high commuting costs families sometimes try to stay in slum settlements in the city centre.

2.2. Other Problems on the Roads

The use of roads reflects broader economic and social trends and in Asian cities. It is common to find women working along the roadside selling, cooking, cleaning the streets or working on road construction. Their vulnerability is exacerbated by malnutrition and lack of healthcare. The absence of public lighting, poor infrastructure, lack of toilets or bus stops and car parks that lack guards all increase feelings of insecurity. There may also be little accommodation for the needs of pedestrians. Weak law enforcement may also make public space insecure, particularly for women. Other problems include:

- Long travelling distances and long hours spent on roads.
- A wide variety of modes of transport.
- Irregular bus and train services. Overcrowded vehicles, congestion, careless drivers, poorly constructed bus stops.
- No traffic priorities (lanes for buses, separation for NMVs or pedestrians).
- Unsynchronized routes and networks that are not adapted to fit the place of activities.
- Excessive levels of noise and pollution (Carruthers et al., 2005).

In Western cities that became motorized early on policy and planning has reduced many of the risks that women experience in rapidly growing cities or informal urban areas. In some cases, a shift towards sustainable transport has already begun. The following section presents some gender-sensitive approaches to these issues from researchers and international actors.

3. Discussion of Policy Framework

This section presents contributions from three international actors. The *first* is the research approach based on feminist epistemologies and development research. The *second* is that of international banks in the sector of traffic and transport systems and, the *third* is the UN recommendations and their potential influence on state policies and international organizations. These perspectives act and interact in asymmetric ways.

3.1. Perspectives in Development Research

At the Fourth UN World Conference on Women in Beijing in 1995, President Zemin stated: "Attaching great

importance to the development and advancement of women, we in China have made gender equality a basic state policy in promoting social development….We are resolutely against any form of discrimination against women" (Du & Kurz, 2003). This prompted the interest of researchers in the problems underpinning inequality and in how to strengthen the position of women relative to men. A number of initiatives were taken but they ignored the embeddedness of the problems in local socio-cultural relations. A framework emerged that included the visions, needs and interests of both women and men. Studies were undertaken of the problem of equal rights for women and girls—regardless of age or economic status were undertaken (Chant & Sweetman, 2012; Kabeer, 2005; Linden, 1994; Moser, 1989, 2006; Roberts & Soederberg, 2012). The commitment and co-operation of men were seen as critical for transforming gender relations: "Gender and development should also involve the inclusion of other social actors vital in supporting the empowerment of women—including, most importantly, men and boys" (Moser & Moser, 2005). Structural inequality was seen as a relational problem that must be addressed by all stakeholders: institutions, governments and society at large (Moser & Moser, 2005). Empowerment meant that "focus was not centred on women, but on the social, political and economic relations as well as the structures and processes that create, reinforce and sustain inequality on one hand, and, the result in different outcomes for both women and men on the other" (African Development Bank & African Development Fund, 2001). Feminist epistemology and development research use methods suitable for in-depth study of the social structures and the geographical, cultural and economic factors that shape modern transport conditions. Scientifically informed policies may make it possible to improve the position of women relative to men in public space and in the transport system. However, we are still very far from making use of these tools in rapidly growing and changing cities in Asia.

According to Western scholars of International Relations, the achievements at the Beijing conference were later marginalized and replaced in 2000 by the Millennium Development Goals. The shift in 'aid modalities' meant that gender issues became overshadowed by concerns with efficacy, management and corporate interests as governments changed policies (Eyben, 2004). Another explanation proffered for why interest in transport equality waned was that it became eclipsed by the post-9/11 security agenda and the War on Terror (Marchand, 2009).

The hypothesis here is that traffic and transport systems are shaped by male users and masculine norms. In only a few countries do women actively influence or work in the transport sector. The nature of modern mobility is beginning to become the topic of debate in some countries. However, in the huge Asian economies of China, India and Indonesia, embedded norms about transport in relation to growth and prosperity have not yet been called into question. Gender studies are not included in the university programmes of engineering or urban planning. Locally developed tools to measure a project's impact on gender inequality or the gathering of sex-disaggregated data remain unavailable at ministries and in planning departments.

The complex interplay between socio-economics and the physical and technical environment mean that quantitative and qualitative studies from different socio-economic contexts are needed to enhance our understanding of how inequality and gender are variably constituted. It has been found, for instance, that the choices men and women make about transport do not necessarily simply reflect economic status, access to cars or a particular feature of the transport system. "It is necessary to qualify this statement, while the transport behavior of women and men are chosen, the choices occur within a normative framework, where different transport uses relate to masculine and feminine identities and norms of mobility" (Kronsell, Smidfelt-Rosqvist, & Hiselius, 2015).

Other surveys stress the gender differentials in travel behaviour in terms of CO^2 emissions and show that women tend to choose less polluting forms of transport than men. It is well-known that public transport is often preferred by women if it is safe. Paterson (2007) explains this as a result of norms of masculinity—freedom and autonomy being related to the ecological and cultural economy of the automobile. In other words, motorized vehicles have become part of masculine identity and what it means to be a modern man. Mobility is therefore associated with identity. Transport equality is partly about the realization of female values since the way they are reflected in transport behaviour is known to be environmentally beneficial (Kronsell et al., 2015). There thus appears to be a transformative potential in the values evident in women's mobility choices. This could be used to enhance transport equality and sustainable transport. The mainstreaming of women's needs in transport policies and urban planning could enhance women's safety in the transport system and in public space more broadly. This could give rise to greater cultural acceptance of mobile women and thus contribute to women's empowerment (Uteng, 2011).

We now turn to policy responses by some of the influential global economic and political actors: The World Bank and the UN.

3.2. Development Bank Policies

Motorized mobility is a global business in which large financial institutions have invested. From 2005 to 2009 the Asian Development Bank (ADB) invested 11.3 billion US dollars in Asia (Lohani, 2010). By 2013, another

2.5 trillion US dollars were needed in Asia alone (UNCRD, 2013). The development banks have recognized that "creating opportunities for women is clearly smart economics" (Wolfowitz, 2006) and several policies have consequently been launched. For instance:

> "For the World Bank Group, promoting gender equality is a central component of fighting poverty. Therefore we need to focus on mainstreaming gender in non-social sectors that support shared growth—such as infrastructure, energy and transport—and improve data collection to understand women's participation in these sectors." (Wolfowitz, 2006)

The poor transport facilities found in many rapidly developing cities represent significant losses in terms of economic opportunities. Although developing countries often fail to manage their urban transport needs, the funding of transport systems by the World Bank or other institutions, is generally highly valued as a spur for economic growth and urban development. These investments are often seen to bring greater benefit to the poor than to the wealthy (Vasconcellos de Alcantara, 2001). Good, safe transport would improve the prospects for a large number of women and low-income families. However, if policy is to be based upon scientific knowledge, local surveys are required to gather information about women's travel behaviour, needs, priorities, opportunities and constraints and to take into consideration factors such as income, age, disabilities, ethnic minorities (World Bank, 2010). The World Bank aims to achieve poverty reduction by enabling better urban access and supporting transport projects that may generate employment opportunities and in so doing reducing poverty (Gannon & Liu, 1997).

However, the ADB recognizes that investments alone will not improve welfare, "we need complementary measures to help translate growth into better living standards. The way to do that is to include those on a lower income in the growth process" (Vasconcellos de Alcantara, 2001). The ADB thus opens the way for inclusive social and gender policies. In the ADB strategy for 2013–2020, the objective of achieving gender equity was defined as a major incentive for changing public transport systems so as to unleash their socio-economic potential. In Asia, there are around 1.7 billion people who live in poverty and are unable to access the essential goods, services, and opportunities to which every human being should be entitled (Vasconcellos de Alcantara, 2001). Improved access to good urban transport could make a significant difference. Later on United Nations Chronicle stated that "a well-designed transportation system that supports walking, cycling and public transit use will allow all people to fully participate in community life and creates safer, cleaner, healthier, and more social places" (2015).

The World Bank's 'Smart economics' has reduced the role of women to that of facilitating economic growth. This means that "women are enlisted as foot soldiers to serve in battles whose aims are not related directly to their interests" (Cornwall & Molyneux, 2006). This economic and top-down perspective overlooks the complexity of the relational and structural factors inherent in the transport sector. 'Smart economics' has therefore been viewed as the "business case for gender equality [that is] concerned with building women's capacities in the interests of development rather than promoting women's rights for their own sake….To increase equality in traffic and transport the primacy of gender justice and rights will have to reasserted in a manner which eschews the notion that it is only worth investing in women if they can 'fix the world'" (Roberts & Soederberg, 2012, pp. 527, 954).

3.3. The UN, Sustainable Transport and the Bali Declaration

Rapid motorization and a dramatic increase in the need to transport goods and people in the last century meant that priority was given to solving technical and economic transport problems. However, the UN has also introduced the goal of developing 'sustainable transport' systems with low carbon emissions. The discourse this has given rise to has thus focused far more upon environmental, technical and economic problems than social factors. The "basic access needs of individuals and societies to be met safely" (Litman, 2006) requires greater knowledge and elaboration so that human health and environmental wellbeing are dealt with in tandem. Equality of access and gender mainstreaming must therefore be included alongside affordability and efficiency as the goals of healthy economies (Ki-Moon, 2013).

In 2013, the UN Secretary-General, Mr. Ban Ki-Moon, declared: "Transport is a key building block for sustainable development. Access to goods and services through efficient means of transport and connectivity is essential for poverty reduction. On a global scale it is essential to design and build safe and environmentally friendly transport infrastructure and to minimize vulnerability to climate change and natural disasters" (Ki-Moon, 2013). The Bali Declaration (2013) represented a formal recognition of the need to develop transport systems based on zero tolerance of congestion, pollution and traffic accidents. This declaration also called upon countries to devise and implement appropriate policies, programmes and enforcement measures to protect their citizens, environment and property while strengthening socio-economic sustainability. Topics include: a) Public health, b) Land-use planning, c) Environment and people-friendly urban transport infrastructures, d) Public transport planning and transport demand management (TDM), e) Non-motorised

transport (NMT), f) Social equity and gender perspectives, g) Road safety and maintenance, h) Strengthening roadside air quality monitoring and assessment, and, i) Strengthening the knowledge base, awareness, and public participation.

The shift in focus towards environmental sustainability means that analytical attention must now also be paid to gendered mobility in relation to the environment and technology. Studies of how women and men relate to the physical environment, urban design, city density, accessibility issues concerning environmental sustainability (e.g. energy, pollution, climate) are necessary to enhance current knowledge. In line with the discussions the Asian Development Bank launched a Gender Tool Kit in 2013, and the UN presented the Sustainable Development Goals in 2015 where the different needs of women and men were recognized in the following way: "unfortunately, the transportation systems in cities are often built to address the needs of men with little consideration of the needs of women. When compared to men, women move about cities at different times, for different reasons, in different ways, and have fewer financial resources; they are less able to afford many of the transportation options available to them". The notion of empowerment is helpful in understanding how urban mobility is gendered: "to be disempowered means to be denied choice, while empowerment refers to the processes by which those who have been denied the ability to make choices acquire such ability" (Kabeer, 2005). The concepts of empowerment, risk and agency may therefore be employed to inspire change that will result in the 'equal access' and sustainable transport systems demanded by the United Nations Intergovernmental Panel on Climate Change (2014).

Thus we find that the international and global perspectives all agree about the importance of supporting women's mobility and equal access to the city. The next section presents some conclusions and points at (some) future issues.

4. Conclusions

Understanding the way in which mobility is gendered is critical for finding ways to improve women's position in society and for creating equality in Asia's growing cities. The lack of equality in the transport sector has been a problem for decades and several initiatives have been launched to enhance women's influence and involvement, though they have largely failed and masculine norms persist.

Top-down, international and national perspectives focus on women's economic role in poverty reduction, whereas the sustainability discourse stresses equity, social cohesion and livable cities. The Sustainable Development Goal Number 11 highlights the demand to "make cities inclusive, safe, resilient and sustainable". It builds upon work carried out in several parts of the world, including Asia, by organizations such as UNCRD and others. The messages from the World Bank and the UN presented above alert us to the need for gender-sensitive transport policies that also respond to sustainability goals. Researchers, economists and political organizations are already looking at how to design such policies but the concept of sustainable transport has proven difficult to put into action and the local dimensions of transport equality are complex. This means that it remains unclear exactly how gender-sensitive policies should be shaped in order to meet women's mobility needs in rapidly developing Asian cities.

Overall, top-down initiatives to mainstream gender policies tend to be similar. Further research is required to clarify the relationship between women's participation in the development of cities and societies, their mobility patterns and the gender norms that affect them in growing Asian cities. More in-depth knowledge about the conditions for women who commute or make other kinds of journeys in cities is more likely to help bring about desirable long-term change than simply implementing practices of gender separation, such as 'pink solutions', which increase women's safety temporarily. Universal policies for increasing equality should be favoured over exclusionary practices, which may simply lead to future conflict instead (Kabeer, 1999, 2002).

Because of their global or national nature, big economic and political institutions have largely failed to respond to women's mobility needs at the local level. Awareness is gradually growing about the importance of local conditions and the Bali Declaration is unique in that it builds on a comprehensive understanding about challenges related to climate change, environmental issues and basic social needs such as access to work, services and opportunities in different contexts. The methods used in gender studies inquire into geographical and social variation and explore local views of women's mobility. Beyond the question of economic policy remain that of rights and the ability to voice concerns and exercise choice. More inclusive urban access would enhance conditions for women and enable them to make choices according to their needs. The policies of development banks for women's roles in modernizing cities are thus litmus tests for 'true' empowerment (Cornwall & Brock, 2005).

Contributions from research and from financial and political institutions may together help promote the development of gender-sensitive transport policies. In this way, science and policy may cross-pollinate one another and result in well-informed decisions.

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Conflict of Interests

The author declares no conflict of interests.

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Article

Bicycle and Car Share Schemes as Inclusive Modes of Travel? A Socio-Spatial Analysis in Glasgow, UK

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Abstract
Public bicycle and car sharing schemes have proliferated in recent years and are increasingly part of the urban transport landscape. Shared transport options have the potential to support social inclusion by improving accessibility: these initiatives could remove some of the barriers to car ownership or bicycle usage such as upfront costs, maintenance and storage. However, the existing evidence base indicates that, in reality, users are most likely to be white, male and middle class. This paper argues that there is a need to consider the social inclusivity of sharing schemes and to develop appropriate evaluation frameworks accordingly. We therefore open by considering ways in which shared transport schemes might be inclusive or not, using a framework developed from accessibility planning. In the second part of the paper, we use the case study of Glasgow in Scotland to undertake a spatial equity analysis of such schemes. We examine how well they serve different population groups across the city, using the locations of bicycle stations and car club parking spaces in Glasgow, comparing and contrasting bike and car. An apparent failure to deliver benefits across the demographic spectrum raises important questions about the socially inclusive nature of public investment in similar schemes.

Keywords
bicycle-sharing system; car-share; Glasgow; inclusive; modes of travel; shared transport; social inclusion; spatial analysis

Issue
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1. Introduction

Public bicycle sharing schemes and car clubs have proliferated in recent years and are increasingly part of the urban transport landscape (Enoch & Taylor, 2006; Fishman, Washington, & Haworth, 2013). There are car clubs in over 1,100 cities worldwide (Shaheen, Martin, Cohen, & Finson, 2012). Similarly, bicycle share schemes have grown both globally and in the UK: there are now nearly 900 bicycle share schemes worldwide (DeMaio & Meddin, 2015), including 3,000 vehicles in locations across the UK (CarPlus, 2015a). This growth in shared transport schemes is underpinned by considerable policy interest. From an urban transport management perspective, shared transport has the potential to reduce congestion and alleviate pressure on parking (Shaheen, Cohen, & Martin, 2010). Considered at a strategic level, these schemes can be seen as a means of encouraging modal shift towards more sustainable—and healthier—modes of transport (Dowling & Kent, 2015; Marsden, Mullen, Bache, Bartle, & Flinders, 2014; Ogilvie & Goodman, 2012; Parkes, Marsden, Shaheen, & Cohen, 2013). Within this context, car and bicycle sharing could offer a pathway towards lower levels of car ownership (Kent & Dowling, 2013). This, in turn, should achieve reduced fuel consumption and lower emissions of greenhouse gases and damaging particulates within the urban environment, simultane-

ously supporting environmental and health policy agendas.

As well as providing potential health benefits by increasing access to active travel and decreasing levels of pollution, it can be theorised that shared transport options have the scope for supporting social inclusion. In parallel with the growth of the compact city agenda towards the turn of the 21st Century, there was an upsurge of interest in transport disadvantage (DETR, 2000; Sinclair & Sinclair, 2001; Social Exclusion Unit, 2003). A growing understanding of the recursive relationship between urban form and modal choice shed light on the economic, educational and social disadvantages suffered by those unable to fulfill their mobility needs (Hine & Mitchell, 2003; Lee & Murie, 1999; Lucas, 2004; Turner & Grieco, 2000). Part of the promise of shared transport modes is that they offer a level of mobility which might otherwise be unaffordable, and in doing so, can mitigate financial disadvantage for less affluent members of society (O'Brien, Cheshire, & Batty, 2014; Shaheen et al., 2012).

Together, policy interest, the growth of shared modes, and the scope for enhancing levels of social inclusion seem a promising combination. The objectives of such schemes can be unclear; furthermore, there is little precedent for the evaluation of schemes against any objectives which might have been set (Ricci, 2015). This paper argues that there is a need to evaluate how socially inclusive transport sharing schemes are and, further, to develop appropriate evaluation frameworks. We open by considering car and bicycle schemes, outlining inherent tensions within transport and social inclusion. Thereafter, we propose a framework of what might constitute inclusivity in shared transport modes. In the next part of the paper, we undertake a spatial equity analysis of the schemes in terms of how well they serve different population groups across the city, using the locations of bicycle stations and car club parking spaces in Glasgow, comparing and contrasting bicycle and car.

2. Shared Transport and Social Inclusion

2.1. Shared Transport: Car and Bicycle Schemes

Car share schemes, often called car clubs, offer access to a fleet of vehicles without the need to own a car. The defining characteristics of both for- and not-for-profit schemes are that they involve short-term rental, with a range of charging structures adopted by different organisations at different times. Participation in a car club generally requires some form of registration and membership. Participants are then charged on duration of hire, distance travelled or some combination of these (Dowling & Kent, 2015). Users collect a vehicle from dedicated parking bays. Parking stations tend to be located in either city or neighbourhood centres or beside major employment areas (Dowling & Kent, 2015). More sophisticated, 'free-floating' schemes can accommodate a one-way trip, with the vehicle returned to another approved parking spot rather than the original parking bay (Firnkorn & Müller, 2011). Despite struggling in the UK, schemes where people share private vehicles have been particularly successful in the US; nevertheless, these peer-to-peer schemes require both an adequate proportion of car owners who are willing to share and setting agreements that allow a baseline of revenue to be generated (Stephany, 2015).

Evidence suggests that car schemes are predominantly used by employed men, aged 26–49 (Loose, 2010), who are also more likely to be well-educated, business users, and from the higher end of the income spectrum (Rabbitt & Ghosh, 2013). Compared with other drivers, those using car share schemes are likely to have lower levels of car ownership, take fewer private car trips, drive shorter distances, and exhibit more multi-modal and intermodal behaviours, in particular, holding public transport season tickets and having greater bicycle use (Kent & Dowling, 2013; Kopp, Gerike, & Axhausen, 2015; Loose, 2010). Evidence indicates that people who participate in a car share reduce the distance they travel by car by up to 45%, and, furthermore, that up to 55% will give up their private vehicle, while others abandon plans to purchase a new vehicle (Loose, 2010). As well as having lower levels of car dependency, car sharers generate significantly lower annual CO2 emissions (Rabbitt & Ghosh, 2013). Although there has been recent growth in the availability and popularity of car clubs, adoption of car sharing is still at relatively low levels (Loose, 2010).

Bicycle sharing involves access to bicycles docked at relatively 'desirable' points. Central locations and ease of access also make this a mode which is particularly appealing for visitors to the city. As with car share, no ownership is required and the schemes cover the cost of storage, maintenance and parking (Shaheen et al., 2012). Bicycle share has evolved from early honour or coin operated systems to more sophisticated electronic docking stations, utilising smart cards and requiring either short-term or annual memberships (Buck et al., 2013). Most recently, some schemes have made a further shift, from registration and membership business models to more casual usage, facilitated by the spread of smart, mobile technology, where anyone with access to a debit card can access a hire bicycle (Lathia, Ahmed, & Capra, 2012). Although bicycle share has been around for longer than car clubs, cycling remains a minority mode in many urban environments and some commentators consider that Europe is still amidst the adoption process of bike-share systems, with the US lagging behind by a further 5–7 years (Parkes et al., 2013).

While the economic barriers to participation in bicycle share are lower than with car share, there are still significant socio-economic and spatial variations in up-

take (Pucher, Buehler, & Seinen, 2011). Bicycle scheme users are predominantly male, of relatively high income and, as with car club members, aged around 25–44 (Buck et al., 2013). Women and people from deprived areas are likely to be under-represented (Ogilvie & Goodman, 2012). Additional to gender, age and income, cultural factors may also be an issue; a Dutch study of urban policy and cycle use has found that immigrants with a different cultural background were less likely to cycle, while US research has also found that bicycle sharers were predominantly white (Buck et al., 2013; Rietveld & Daniel, 2004). Furthermore, although the proportion of white residents in a neighbourhood was found to be insignificant during research into car share usage in New York, the author theorised that the 'real' car share members were recently arrived young, white residents in gentrifying low-income areas (Kim, 2015).

Bicycle share participants in a major North American study of over 10,000 riders 'overwhelmingly' reported less driving, with concomitant reductions in vehicle kilometers and emissions (Shaheen et al., 2012). Additionally, cycling can be used as a secondary mode, travelling to train stations (Heinen, van Wee, & Maat, 2010), indicating that schemes can also support the use of public transport.

2.2. Transport and Social Inclusion

Recent decades have seen an increase in awareness of the social dimensions of mobility and accessibility (Lucas, van Wee, & Maat, 2015). However, while the growing field of environmental justice deals with the spatial patterning of amenities, transport exclusion constitutes both a literal and metaphorical disconnect which renders people unable to participate in society (Church, Frost, & Sullivan, 2000). Welch (2013) contends that the equity impacts of mismatched service needs and distribution are still under-researched. The rise of digital connectivity notwithstanding, physical co-presence remains a necessity for multiple aspects of social inclusion. While virtual contact can replace physical mobility, particularly for more affluent members of society, many require to 'go' to work, visit medical services or attend places of education. Likewise, virtual contact might be best considered an enhancement of actually meeting with friends and family, rather than a substitute. For all the heralded 'death of distance', the digital age has, thus far, most favoured those who already have the greatest level of resource (Cairncross, 1997; Kenyon, Rafferty, & Lyons, 2003).

Many studies of accessibility-related exclusion focus on those without a car, which can, to some extent, be considered an implicit endorsement of the car as a solution to transport-related social exclusion. Access to private transport unquestionably provides benefits; however, the dominance of the car and the wider impacts of car ownership give rise to a number of environmental, economic and social concerns (Black, 2003; Goodwin, 1999; Hine & Mitchell, 2001). Fuel, maintenance, and running a car all generate externalities in terms of emissions covering air, water, noise, and ground pollution (Reid, 1995). Congestion is a stress on infrastructure, drivers, other road users including pedestrians, and business (Grant-Muller & Laird, 2006). Beyond environmental impacts, injuries and fatalities entail economic and human costs, and traffic creates an uncongenial environment, inimical to everyday exercise and social interaction (Appleyard, 1981). Furthermore, demand for private transport diverts resources from other modes (Pucher & LeFevre, 1996).

The role of place in disadvantage is a well-established feature of social inclusion/ exclusion discourse (Kristensen, 1995). Perhaps the most far-reaching impact of the dominance of the car lies in its effect on land use patterns. Freed from the constraint of following established public transport routes, urban activities become dispersed (Muller, 2004). Additionally, the increasing separation of work and home from social and leisure activities fosters isolation and a polarisation between those possessing and those lacking access to private transport, problematising the status of the private car within the modal mix of transport options.

It has been argued that urban compaction can have positive equity effects, in that dense, mixed use development can increase accessibility and reduce car dependence (Burton, 2001). Preston & Rajé (2007) identify three criteria as important in identifying the degree of transport-related social exclusion: area mobility (the level of travel in an area as a whole); individual mobility (the level of travel made by particular individuals or groups); and the overall accessibility of the area. Within a relatively dense urban environment, it might be hoped that car and bicycle schemes would mitigate exclusion along all of these dimensions. However, the growth of shared transport schemes has also been associated with the hollowing out of the state, as public provision has been withdrawn in favour of expectations the private sector should have primary responsibility for managing transport (Aldred, 2012). This perspective serves to undermine any easy assumption that shared transport will necessarily support greater social inclusion, in that less affluent members of society will be less able to participate in market-based activities.

Policy levers are crucial in supporting modal shift. Considering car club schemes, there are a number of business models: they might be for-profit, co-operatives or non-profit; they are also sometimes associated with a particular public transport network (Hampshire & Gaites, 2011). Like car clubs, bicycle share schemes have garnered significant policy support and are generally regarded as an uncontentious intervention because of their perceived social and environmental advantages (Parkes et al., 2013). In some cases,

when parking spaces are converted from general use to 'car share only', public bodies have levied a charge on car share operators to compensate for lost revenue (Shaheen et al., 2010). However, it has been argued that many schemes can only be economically viable given a particular blend of cultural, economic, political and transport contexts and that policy collaboration and support are necessary for shared transport to flourish (Enoch & Taylor, 2006; Parkes et al., 2013; Ricci, 2015). Promotion, marketing and provision of parking bays, signage and cycling infrastructure are all means through which policy support for shared transport schemes can be demonstrated (Moore, Rodriguez, Tokuhiro, & Wang, 2012; Pucher, Dill, & Handy, 2010). In some schemes, this amounts to a de facto state subsidy of private enterprise for the public good. This can be considered questionable, in that the existing evidence base indicates an apparent failure to deliver benefits across the demographic spectrum, raising important questions about the equity of public investment in similar schemes. We therefore develop a framework of what might constitute inclusivity in shared transport modes. In the second part of the paper, we undertake a spatial equity analysis of the schemes in terms of how well they serve different population groups across the city, using the locations of bicycle stations and car club parking spaces in Glasgow, comparing and contrasting bike and car.

3. Evaluation Framework for Equity Analysis of Shared Transport Schemes

This section offers a preliminary evaluation framework for examining shared transport schemes in terms of inclusivity. While each scheme operates under different model of delivery and access, here we conceptualise how such schemes *might* be inclusive and what factors should be considered in an assessment of inclusivity, before focusing more specifically on the case of Glasgow in later sections. We draw on concepts from accessibility planning and equality impact assessments, discussing these with reference to shared bicycle and car schemes. Accessibility Planning is an approach to inclusive transport, designed to reduce barriers to access and address issues of social exclusion. The Social Exclusion Unit (2003) specifies barriers to accessibility, which we consider in analysing shared transport schemes as potentially inclusive modes of travel. Focusing on bicycle and car club parking stations as destinations in their own right, we evaluate their accessibility in relation to other modes, predominantly walking. Additionally, we consider how shared modes might improve accessibility to other destinations in the city, such as providers of employment, education or healthcare. Equality impact assessments evaluate how the positive and negative impacts of proposed transport schemes are distributed across population sub-groups. We therefore complement the accessibility planning approach by considering the distribution of shared transport facilities across the population.

3.1. Cost

The cost of transport is a potential barrier to movement which, on the basis of the relative cost of transport as a proportion of income, impacts unevenly upon lower income households (Hine & Mitchell, 2001). Car ownership is often used as a proxy for income and lack of car ownership is generally associated with lower income and risk of social exclusion (Goodwin, Hallet, Kenny, & Stokes, 2012; Hine & Mitchell, 2001).

High 'entry' costs present one of the key problems associated with private car ownership. This also means that once a vehicle has been purchased, it is usually more economical to use it as the main source of transport, rather than to engage with multiple modes. Within this framework, car ownership can be considered as a threat to sustainability and multi-modality agendas that seek to promote alternative modes of transport. In contrast, car clubs are marketed towards those whose transport needs might be partially or incompletely met by car ownership. These might be people who use cars infrequently, who might give up a car, or decide not to purchase a second car (e.g., City Car Club, 2015a). We posit that they also provide the potential to meet the transport needs of those who cannot afford a private vehicle and associated costs but who may require a car for some journeys, thus also having a role to play in transport justice by improving car-based accessibility. However, even though car clubs might offer a more financially viable means of accessing a car, a driving licence is a prerequisite in taking advantage of the opportunity and it should be remembered that the distribution of licences, as well as car ownership, is patterned by socio-economic status.

Similarly, bicycle schemes may provide a lower cost means of entry for those wishing to cycle, and hence can widen available transport options. Nevertheless, particularly in the UK, cycling is now commonly associated with middle class men in lycra (Daley & Rissel, in press; Goodman, Green, & Woodcock, 2014) and is likely to be seen as a mode of choice, rather than the 'necessity' which the car is considered by many (Sloman, 2006). However, although lack of car access due to affordability problems might be widely accepted as a problem of transport equity/justice, it can be forgotten that in deprived communities, a bicycle can also be an appreciable expense, especially for multi-member households (Clark & Kearns, 2014). Therefore, as noted by Goodman, Green, & Woodcock (2014), there is some evidence to suggest that bicycle sharing schemes can promote inclusivity by ameliorating the issue of entry cost and normalising cycling. However, as with car

schemes, shared bicycle schemes usually entail user registration, and can require the use of a credit or debit card for access, as insurance or as a deposit. Similarly, internet access, a smart phone or a bank account can be necessary. While it is possible to find schemes that do not have these requirements, given that geography is a pertinent issue, many people may find access either more difficult or impossible, for practical purposes.

The cost of using shared transport, relative to other alternatives, is therefore a crucial consideration when addressing whether shared transport schemes can be seen as an inclusive mode of transport.

3.2. Physical Access

When considering physical access to public transport in the UK, the Disability Discrimination Act imposes duties on transport providers to support transport users who have a disability. These include: wheelchair space; step free access; priority seats; size and height of steps; handrails; colour contrast; and information displays (Metz, 2003). Concerns with regard to disability access and shared transport schemes might range from a complete lack of accessibility in relation to some car or bike sharing schemes because the vehicles themselves are unsuitable, to barriers imposed by the way in which schemes are operated.

Physical disabilities can restrict the ability of some individuals to drive or cycle and, although adaptable vehicles may mitigate this, it is perhaps unrealistic to assume that vehicle design will be versatile enough for all potential user needs. However, vehicle design can be inclusive as possible. For example, shared bicycles can be sturdy, have adjustable-height seats and typically have three gears, making them easy to use (Midgley, 2011) . There are increasing numbers of e-bike sharing schemes, removing some individual and built environment physical barriers to access. However, there needs to be wider debate about the extent to which such schemes should or can be designed to cater for all, for example, widening provision by offering a range of bicycles such as tricycles, e-bikes and children's bicycles or children's seats.

The discussion above relates mainly to medically diagnosed physical disability, which may lead to specific mobility requirements. Access to car and bike share schemes can also be restricted by other requirements: there are often age restrictions, excluding those below or above certain ages relating to car clubs. However, with regard to bicycle sharing in particular, physical *ability* is also a consideration. Concerns with physical health and fitness, both actual and perceived, may be a barrier to some people using these schemes. It might be possible to address this through marketing, to normalise the image of cycling (Goodman et al., 2014) or through training schemes such as 'bikeability' (Johnson & Margolis, 2013). However, to be truly inclusive, marketing and training must go alongside re-design of the built environment, including appropriate and well-maintained cycle infrastructure.

3.3. Safety & Security

Safety and security can be barriers to the use of certain modes of transport. For shared bicycle and car schemes there are issues of both actual and perceived safety, relating to the location of the stations, which may determine whether they are deemed safe to use. Furthermore, there are temporal considerations, which may make a location, for practical purposes, inaccessible at different times throughout the day. It is recommended that stations are both well lit and under surveillance (Midgley, 2011) .

In addition to the static location of facilities, safety concerns related to infrastructure and the wider built environment can act as a barrier to participation in cycling (Saelens, Sallis, & Frank, 2003) as well as having a role to play in driver safety (Ewing & Dumbaugh, 2009; Ewing, Hamidi, & Grace, 2014) , although we are not aware of any evidence as to whether road design acts as a deterrent to driving. Furthermore, infrastructure may have differential benefits or adverse impacts on different groups, leading to inequality in access and highlighting a need for inclusive design of the built environment. Finally, helmets are often perceived necessary for safety. These can be provided under some bicycle sharing schemes, usually in countries with compulsory helmet laws. In other instances the lack of a helmet may be a perceived barrier to using bicycle hire schemes.

3.4. Information

Awareness of shared transport schemes and understanding of how they operate may limit participation for individuals. There is evidence that private car owners have difficulty grasping the total cost of car ownership (Turrentine & Kurani, 2007) and so may not appreciated the cost-saving potential of car share. As noted previously, information about share schemes is usually provided online, which can be an exclusionary medium for those without internet skills or access. Furthermore, consideration should be given to who is the target audience of information campaigns. Given public investment, there should be consideration and targeting of groups to ensure inclusivity; however, this many not be a high priority from a commercial perspective.

3.5. Provision of Services

Bicycle share stations and car club parking spaces are unlikely to be evenly spread across the city they serve and will thus necessarily favour some population groups more than others. It is therefore important to consider whether the spatial patterning of provision ex-

cludes some groups from accessing these modes, as a factor which may explain the inequalities in usage patterns identified by others (Ogilvie & Goodman, 2012).

The location of destinations or geographical provision of services is an important component of accessibility to destinations and, as such, the component most usually measured by accessibility metrics. In the case study following, we use 400m as a walk distance to a bicycle or car. Of necessity, we consider the bicycle stations and car club parking spaces as destinations relative to the characteristics of the residential population; in reality these modes may form part of multi-modal journeys. Home, therefore, may not necessarily be the location from which we should be considering accessibility. However, in the absence of more detailed journey information we use this as a starting point.

3.6. Journey Time

Journey time is one of the most studied aspects of accessibility (Curl, Nelson, & Anable, 2013). It might also be important to consider how provision of shared transport modes contributes more widely to city level accessibility to destinations by making some destinations more accessible in terms of journey time to those without a private vehicle.

3.7. Travel Horizons

Travel horizons constitute another important aspect of accessibility, especially in relation to inclusion. Perceived accessibility may differ to that measured by any metric because individuals do not know or do not feel comfortable travelling to certain areas. Lack of awareness of transport options might be related to information or feeling uncomfortable related to safety, as previously discussed. Although shared transport modes have the potential to expand travel horizons, they may also exclude some by being located in destinations outwith their travel horizons.

3.8. Summary

Although each scheme will be different, we have outlined ways in which shared transport schemes in general might be considered inclusive or exclusive. In some respects, share schemes can be seen to be inclusive, through promoting cycling, normalising cycling (Goodman et al., 2014), widening travel horizons or adding to transport mode choices for those without access to their own car or bicycle. However, in many respects they can also be considered exclusive, benefitting some more than others. We have outlined the main aspects of inclusivity that we consider to be important for shared transport modes. In the following section we take two aspects, provision of services and cost, and examine these in relation to a case study.

4. Case Study: A Socio-Spatial Equity Analysis of Shared Transport Schemes in Glasgow

4.1. Introduction

This section presents a case study of socio-spatial analysis of car club and shared bicycle locations in Glasgow, Scotland. Glasgow is a post-industrial West European city, with a population in the metropolitan area of just over 1.1 million and approaching 600,000 in Glasgow City (National Records of Scotland, 2015). Over four in ten Glaswegians (41%) commute to work as a car driver or passenger, while smaller proportions use public transport (30%) or walk (26%), and only 1.6% cycle (Understanding Glasgow, 2015a). There are marked economic and health inequalities in Glasgow, with almost half of those within the city boundary living in the 20% of most deprived areas in the country (Understanding Glasgow, 2015b). Glasgow provides an interesting case study in that it was host to the 2014 Commonwealth Games, one of the world's most well-established multi-sport events. In support of a promised Games physical activity 'legacy', the city introduced a mass automated bicycle hire scheme, run by 'nextbike' in 2014. The city also has a car club franchise, which has recently changed from 'City Car Club' to 'Co-wheels' (Carplus, 2015b). However, 'City Car Club' has retained some operations in the city meaning there are now two schemes, 'Co-wheels' run under the City Council franchise and 'City Car Club'[1] operating privately. At this stage, the authors have been unable to obtain information relating to the way in which locations of car spaces or bicycle share stations are determined or to the usage of the schemes. However, we hope to pursue this in the future.

In this case study, we assess how the locations of these cars and bicycles are distributed relative to the resident population. Existing evidence suggests inequalities in who uses bicycle sharing (Buck et al., 2013; Ogilvie & Goodman, 2012; Pucher et al., 2011) and car sharing (Loose, 2010; Rabbitt & Ghosh, 2013) schemes. We seek to address whether the physical location favours such demographic groups and therefore whether the schemes can be considered inclusive on the basis of their distribution across the city. Then we consider the pricing structure and whether this promotes inclusivity.

4.2. Methods

Distance to stations has been reported as a significant predictor of usage of car and bicycle share schemes (Daddio, 2012; Katzev, 2003). In a study by Daddio

[1] Since the research was undertaken City Car Club has changed to Enterprise Car Club. We refer to City Car Club as this was the name, and therefore locations and costs, which were applicable at the time of research.

(2012), respondents took an average of 10.75 minutes to access a car sharing bay, 76% of users walked to the car station and 15% cycled. However, in other research, 400m has been used as a threshold for walking to car share stations (Abraham, 1999; Celsor & Millard-Bell, 2007). Loose suggests that a distance of 500m is optimal, with usage of car share schemes falling appreciably at higher distances (Loose, 2010). While recognising that there is a need for more research into acceptable walk distances to bicycle stations, we elected to adopt the lower 400m threshold for both analyses, given that a relatively dense urban environment means that there are likely to be alternative public transport options within the same distance.

The locations of the bicycle stations and car club car park spaces were manually geocoded in QGIS using the location information from the company websites (Nextbike, 2015a; Co-wheels, 2015a; City Car Club, 2015a). We then used the Network Analyst extension in ArcGIS to create 400m service areas, using the ITN road and path network, around each station as an approximation of the distance people are willing to walk to connect to another mode of transport. The service area polygons were imported back into QGIS and overlaid with datazones, which are a small-area geography used for census data in Scotland. The proportion overlaps between our service areas and datazones were calculated using polygon to polygon matching. We calculated both the proportion of each datazone which fell into service areas, and the proportion of the total service areas covered by each datazone so that we could apportion population data to the buffer zones around stations. This overlap was then exported to Excel and population calculations using census data were undertaken in Microsoft Excel.

For the majority of census groups, we report the proportion in each demographic category which can access a bicycle or car station within a 400m walk, relative to the total citywide population of each group. We calculated the number of each group living within the overall area covered by the service areas and then divided this by the total population of that demographic group in the city. The example below illustrates this calculation process (Figure 1).

As with any geographic analysis, there are issues related to the modifiable area unit problem. We are restricted by datazone geography for census data and our approach in matching this to service areas assumes that populations are spread evenly across each datazone, when in reality the population as a whole or certain sub-groups may be clustered within datazones. Secondly, by comparing to the population of Glasgow we face the issue that comparing with other geographical areas, such as the city centre only, or the greater Glasgow travel to work area, would yield different results. However, we chose this comparison given the allocation of public money to such schemes across the City Council area, so wish to understand whether the benefits are evenly spread across the population.

In the following sections, we use census data to compare the demographic composition of people living within 400m of car, bike or car and bike stations in Glasgow with the population of Glasgow City Council area as a whole. A schematic representation of the location of car club parking spaces and bicycles is given in Figure 2.

If a datazone contains 600 females, and 5% of the surface area of the datazone overlaps with the service area then 30 females are assumed to live within the area accessible to a station. This is repeated for all datazones which overlap the surface area to calculate the total of each demographic group living within the 400m buffer.

For continuous data, cars per household, cars per person and mean age we instead used the proportion of the service area covered by each datazone to weight the mean for each overlapping datazone according to the amount it 'contributes' to the total service area, based on surface area.

For example: *If datazone 1 (mean age 57) accounts for 45% of the total service area and datazone 2 (mean age 65) accounts for 55% overall mean age for the service area is (57×0.45)+(65×0.55)=61.4.*

Figure 1. Calculation Process for matching of census data to service areas.

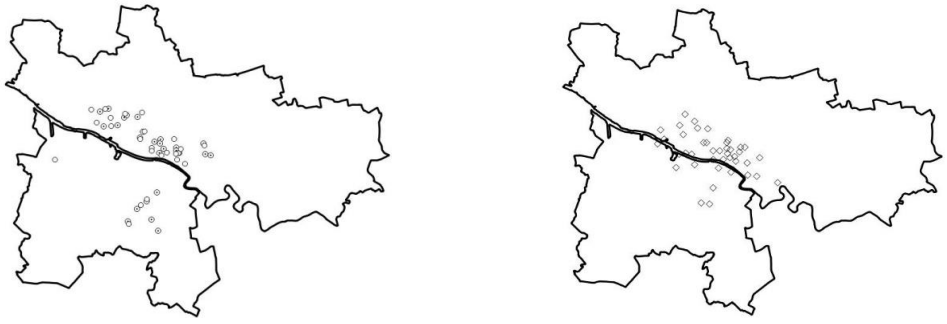

Figure 2. Location of car share (left) and bicycle share (right) schemes in Glasgow.

As might be anticipated, there is a clustering around the city centre. This is more pronounced in the case of bicycle stations, while there is a greater spread of car clubs, particularly towards the heavily residential south side of the city.

4.3. Glasgow City Population

We open by presenting Glasgow City population characteristics believed to be relevant to transport inclusion and associated with cycling. These include gender, age, ethnicity, and socio-economic indicators such as housing tenure, car ownership, qualifications, employment status, as well as main mode of travel to work (Ricci, 2015, Table 1).

Table 1. Population characteristics of Glasgow. Source: Census 2011.

	Glasgow City Council Area
Population	593,862
Households	285,899
Female	52%
Male	48%
Mean age	38
Age 0–15	4%
Age 16–29	24%
Age 30–45	22%
Age 45–65	24%
Age 65+	19%
white British	83%
non white British	17%
Owned	46%
social rented	37%
private rent	15%
no car	51%
at least one car	49%
cars per person	0.31
car per hh	0.64
No Qualifications	32%
Qualifications	68%
Employed	36%
Unemployed	6%
PT	28%
Car	42%
Other	20%

Table 2. Mean age and cars per person and household for those living within 400m of shared car and bicycle schemes.

	Bike share	**Car club**	**Car club & bike share**
Mean age	34	35	25
Mean cars per person	0.25	0.31	0.25
Mean cars per household	0.49	0.60	0.49

The reporting of this data is by necessity simplistic: we recognise the limitations, for example, of using binary variables for ethnicity, employment and education level in that such an approach does not offer depth of understanding; nevertheless, it has the merit of clarity and ease of comparison. Furthermore, our methodology assumes that the population within each datazone is homogenous: this is not the case, biasing the results to some extent. However, datazone geographies are decided on the basis of areas which are relatively homogenous in terms of socio-demographic characteristics. That some characteristics are reported at the household level and some at the individual level also introduces difficulties in terms of interpretation. Additionally, while household car ownership may benefit all household members, it is not necessarily the case that all individuals within a household will have access to a car. We do not have scope to examine these intra-household dynamics here. However, we can nevertheless offer important insights into which groups of people may have lower access to car and bike sharing stations.

Across Glasgow City, 9% of the population (10% of households) live within 400m of a bike share station. 14% of the population (14% of households) live within 400m of a car club space and 5% of the population (5% of households) are within 400m of both. The following sections show how access to car and bicycle sharing schemes varies by socio-demographic group. If all population groups had an equal level of access to car and bike stations, we would expect the proportion of the group which can access a station or parking bay to equal that of the population as a whole. Where there are differences, this can be considered an indication of socio-spatial inequality of access and an indication of potential exclusion of some groups with respect to accessing shared transport modes. Additionally, Table 2 shows the mean age, cars per person and cars per household of those who can access shared car and bicycle schemes within the specified walk radius.

4.4. Access to Bicycle Sharing Stations

There is some variation in access to bicycle station by gender, although the difference is slight (see Figure 3): 8% of females are within 400m of a bike station compared with 10% of males. The 16–29 year old population has greater access to bikes than other age groups. Perhaps surprisingly, higher percentages of the non-white British population fall within the specified walk radius. Furthermore, private renters have greater access than those who either own or are social renters. This can be considered a reflection of tenure patterns around the city centre and before suburban areas are reached.

Those households without car access have greater access to bicycle share stations (11%), in comparison with a figure of 10% for households across the city.

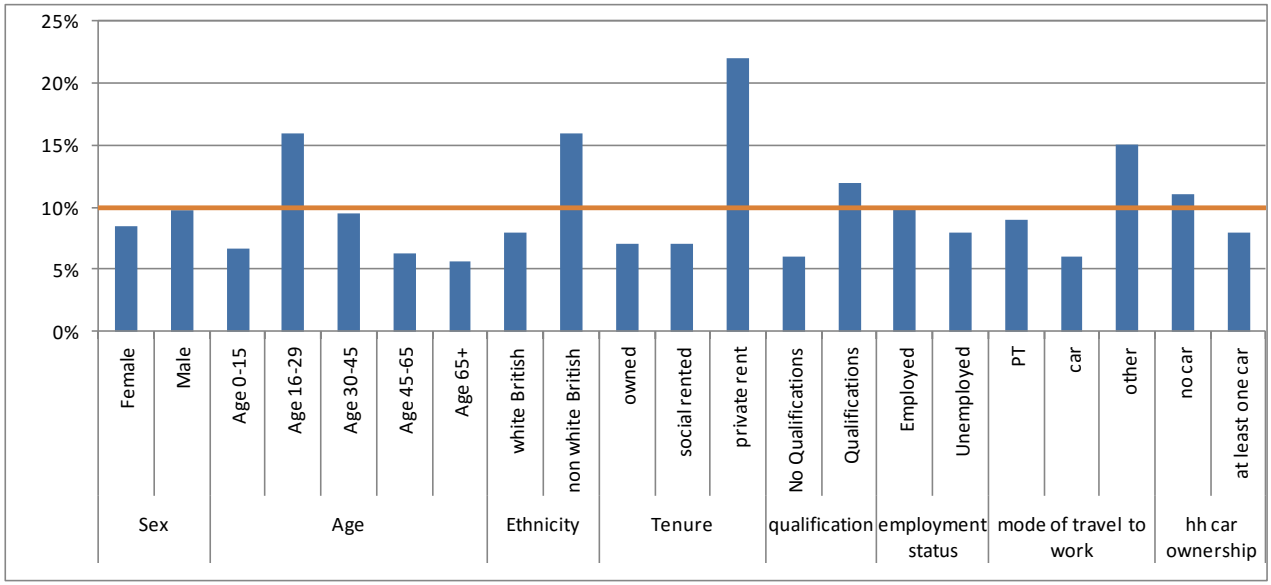

Figure 3. Proportion of the population who can access a bicycle sharing station within a 400m walk.

That the number of cars per household is lower than the Glasgow average for households within 400m of a bicycle station suggests bicycle share can be seen as inclusive, offering the option of another mode of transport for those without access to a car. However, given the clustering of stations in the city centre, it may also be that low levels of car ownership in the area reflect a lifestyle choice, rather than an issue with affordability. The latter possibility is strengthened when the demographic profile of those nearer stations is considered: people with qualifications and in employment also have higher rates of access to bicycle share, but in general are substantially more likely to be car owners than those without work or qualifications. This favours the possibility that, for at least some of this group, their education and employment might make car ownership an option which they have chosen not to exercise.

We analyse travel to work mode under three categories: public transport; car; and 'other', which would include walking or cycling. These data are from the 2011 Census, which was taken prior to the inception of bicycle share schemes in the city. Across Glasgow as a whole, an average of 9% of the population has access to a bicycle station within 400m. Of people who fall into the category of being relatively close to a bicycle share station, the proportion of public transport users is the same as the population average but considerably lower with respect to car users. For people who fell into the 'other' category at the 2011 Census, which would include those who walk or cycle to work, the proportion of people with ready access to bicycle rental is considerably higher. This indicates that the scheme appears to favour those who already live in areas where a high proportion of people cycle to work—a potentially fertile target market in terms of encouraging new users through social norms. Nevertheless, it also raises questions as to the ability of the schemes to achieve modal shift from car use.

4.5. Access to Car Club Parking Bays

Given the similarities in distribution of car and bicycle share stations, many of the patterns identified for bicycle sharing stations are similar for car club parking bays (see Figure 4). As might be anticipated, men have slightly better access than women. Similarly, when looking at age, people in the 16–29-year-old category have greater access than other age groups, although this is more evenly spread than for bicycle stations and, notably, a greater proportion of 30–45 year olds have access to cars than to bicycles.

As with the bicycle stations, the non-white British population have greater access, as well as there being considerably higher access among private renters than those who are either homeowners or social renters.

Access to car club cars is equivalent between car and non-car owning households. If car clubs were to be viewed as inclusive we might assume that access should be greater for non-car owning households, so that people without a private vehicle could benefit. However, household car ownership does not mean that all individuals have access to that vehicle and, for those within 400m of car club bay, the mean figure for cars per household is lower than the Glasgow average, 0.60 compared to 0.64 (Table 1 and Table 2).

Similar to bicycle stations, those with at least a school level qualification and who are in employment have greater access to car club bays.

Of those who travel to work by a mode other than car or public transport, 20% can access a car club bay within 400m. Again, this raises the issue of environmental sustainability as, on this basis, car clubs may actually lead to higher car use by attracting people who do not currently drive. On the other hand, in contrast to bicycle sharing schemes, there is no difference in access

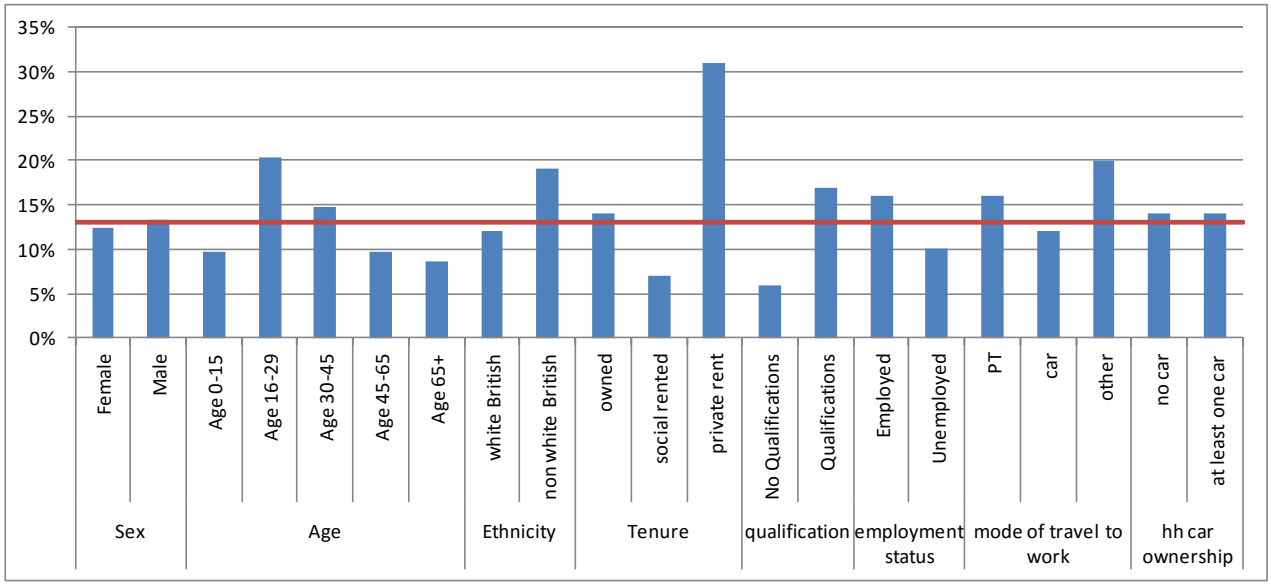

Figure 4. Proportion of the population who can access a car sharing bay within a 400m walk.

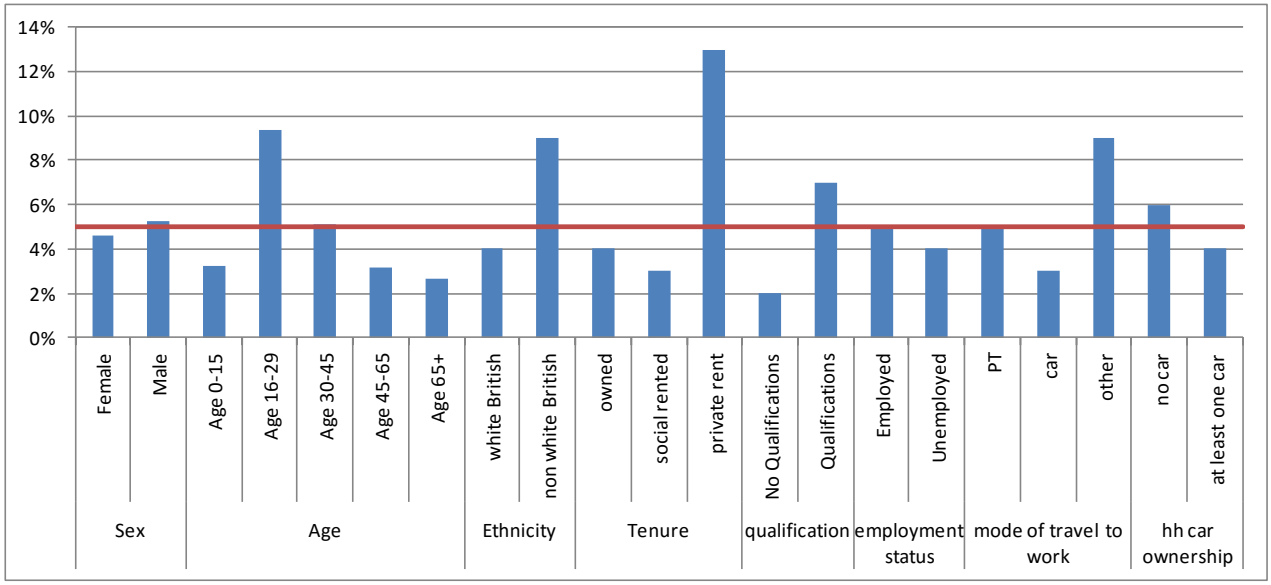

Figure 5. Proportion of the population who can access both bicycle and car share schemes within a 400m walk.

to car sharing bays between groups who do or do not have a car. The mean figure for cars per household and per person are both greater for people in areas where there are car parking bays than areas where bicycle share is available.

4.6. Access to Both Bicycle and Car Club Stations

Although fewer people (5%) can access both car bays *and* bicycle stations than either car or bicycle stations individually, the socio-spatial patterning remains similar: people who are aged 16–29, non white British, private renting, with educational qualifications, in employment and not travelling to work by car or public transport or owning a car have greatest access (see Figure 5).

We suggest that these results are a reflection of the clustered nature of the bicycle and car stations in central locations, which by default means that some population groups will have better access. At this point it is important to remember that proximity to stations does not equate to usage, although it is an important explanatory factor (Katzev, 2003). Groups show to have greater access in this analysis can be considered comparable to those who we identified as users of such schemes in the literature review, insofar as there is a slight predominance of men and those in younger age groups, and in some form of employment, with qualifications. Although these are not necessarily particularly affluent areas, they are also not areas of high deprivation, in that people within the walk radius tend to rent privately or own their homes, rather than live in social housing. This would suggest that targeting stations and parking bays in certain areas may lead to usage, and

therefore act as a policy mechanism for furthering transport inclusion. Furthermore, targeting at areas with existing poor accessibility and higher unemployment *could* be one means of promoting these schemes as inclusive modes of transport, especially given that access is poorer for the unemployed and those without qualifications.

From a commercial perspective therefore, the spatial location of both car and bicycle schemes might make sense: they are in locations likely to lead to higher usage of the schemes, highlighting the role of market forces. However, given the public investment we need to consider whether they can be considered socially inclusive. Additional to considering the economic dimensions of social inclusion, our research shows relatively large proportions of non-white British residents living close to share stations, and factors affecting usage for these populations are unknown.

We have assessed the spatial accessibility by demographic group to the fixed locations where car and bicycle sharing can be accessed. However, we have not considered the fact that vehicles may not always be available at these locations and whether a lack of alternative transport modes may be a hindrance to using or relying on such modes.

4.7. Cost-Structure

As discussed in Section 3, cost is also a key consideration when evaluating the inclusivity of shared transport schemes. In theory, such schemes have lower entry costs than upfront car or bicycle ownership and therefore potentially present a low-cost means of using either a car or bicycle. The pricing structures for bicycle sharing and car clubs in Glasgow are shown in Figures 6–8.

Bicycle sharing offers a membership or non-membership option with slightly different usage rates. One of the car clubs charges an hourly or daily rate plus a mileage rate alongside a membership fee, whereas the other has a minimum monthly spend of £5, and hourly or daily rate plus a mileage rate. The daily and hourly rates depend on the type and size of vehicle.

A single bus fare within the city costs £2 (approximately €2.55/ $US2.90). This is likely to be more expensive than a bicycle hire for equivalent distance, but is substantially cheaper than a car club journey, although this is a broad comparison and will vary by journey and by time of day. Annual public transport tickets would provide savings, though we do not feel this is an appropriate comparison: if an individual were to purchase an annual public transport ticket, the assumption would be they would use it every day; using the shared car scheme every day would likely involve an unattractive (if not prohibitive) cost in comparison with actually buying a car. Comparing the daily fare provides a better reflection of the on-the-spot costs for casual users. Furthermore, paying annual or similar long-term advance charges for public transport travel tickets is also likely to be a problematic issue for those on lower incomes, even although daily fares may be more expensive on a per trip basis. The cost of an annual public transport 'zonecard', covering the city centre zones including the bicycle and car sharing schemes areas is £721 (approximately €910/ $US1045). We therefore feel that this is a more realistic comparison. On this basis, the bus is more inclusive than car sharing in terms of walk-on fares and no upfront membership fees. However, bicycle sharing offers both options.

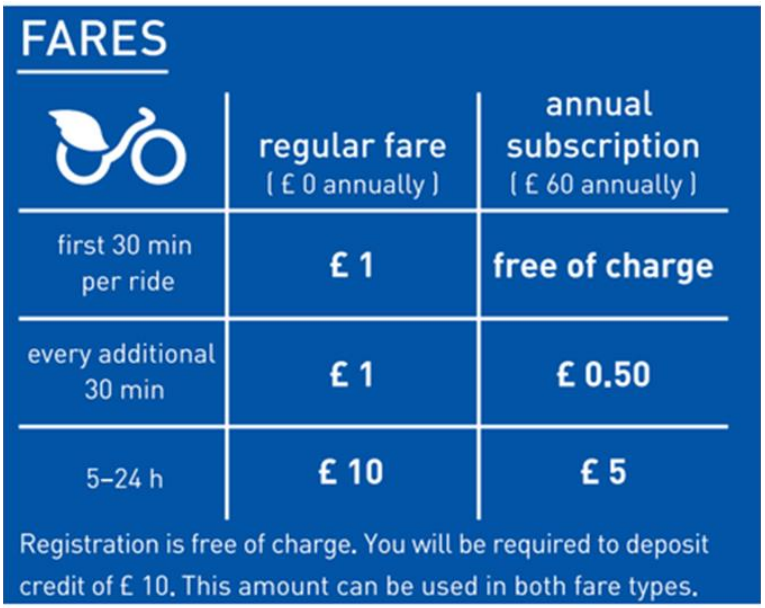

Figure 6. Nextbike cost structure. Source: Nextbike (2015b).

Vehicle type	New hourly rate	New daily rate
Small	£3.95	£25
EV	£3.20	£20
Medium	£4.45	£30
Large	£5.45	£35
7 Seat	£6.95	£40
Vans	£6.95	£40

Mileage rates:
No mileage fee for electric and Prius Plug-in! | 13p/mile for small, medium, large & 7 seat cars | 13p/mile for vans The daily rate is the maximum you pay in any 24 hour period, plus the mileage charge when applicable. Please refer to our FAQ's for more information

Sign up

Select your rate plan

Personal

Standard Select | Under 22 Select | Van only Select

Business

Standard Select | Van only Select

Payment plan

This rate plan offers an annual or monthly membership fee.

Please select your preferred option: ◉ £60 annually ○ £7 monthly†

† 30 day minimum term applies

Figure 7. Cost structure for City Car Club. Source: City Car Club (2015b).

	Individual	Organisation
Joining fee	£25	£25
This one-off fee covers the cost of your application, smart card and welcome pack.		
Additional driver	£15	£12
You can add as many drivers to your account as you wish.		
Monthly minimum spend	£5	-
This is like a membership fee, except if you make a booking that costs at least £5, you effectively don't pay it!		

Size	Small	Medium	Large	7 seater	Electric
Car type	Aygo	Yaris Hybrid	Auris Hybrid	Prius+	Nissan Leaf
Per Hour	£4.50	£5.25	£6.00	£7.25	£3.75
Overnight	£9.00	£10.50	£12.00	£14.50	£7.50
Per Day	£27.00	£31.50	£36.00	£43.50	£22.50
Per Mile	£0.13				Free

Figure 8. Cost structure for Co-wheels. Source: Co-wheels (2015b).

The high entry costs, and relatively high usage costs for some of the car schemes may be a barrier to usage among those who do not have access to a vehicle. Furthermore the costs associated with driving lessons and a driving licence mean that this may not feasibly be seen as an inclusive mode of travel in terms of cost.

The costs associated with the bicycle scheme, on the other hand, are relatively low and, although the membership fee may be a deterrent to some, there is an option to avoid this. Anecdotally, we know that the bicycle share company is offering concessionary memberships through some employers (including some universities). This might limit its status as equitable in that all customers are not treated equally and those who may least need subsidised membership are being offered it, perhaps at a cost to other users, although we do not know this.

Both the car and bicycle schemes require individuals to be registered with the company and have a bank account. This excludes those without bank accounts, which is 12% of the population of Glasgow and 14% of those in the most deprived parts of Glasgow, compared with 7% in Scotland as a whole (Scottish Household Survey, 2015) therefore limiting the inclusivity of such schemes. In reality internet access may also be required.

4.8. Summary

On the basis of residential location, relatively low percentages of the population (10–15%) have the potential to benefit from bicycle and car sharing stations across the city as a whole, raising questions as to the inclusivity of the schemes. However, it is important to note that, while proximity is important in predicting use, access does not equal usage. Not all those who can access a bicycle or car will use them, and others may use share vehicles to travel further or use employment-location stations as hubs. It is therefore important to study usage alongside the provision, comparing the demographics of users to the demographic of the areas where stations and parking bays are located. Although we believe this data to be available for our case study area, we have as yet been unable to access it.

We have presented an aggregate level socio-spatial analysis of car and bicycle sharing schemes in terms of proximity to access points in Glasgow. This gives a broad overview of how the spatial locations of these schemes are distributed across the population. More detailed, mixed methods analysis, including speaking with users of each mode, would allow firmer conclusions to be drawn.

5. Conclusions

There has been a recent surge of academic interest in shared transport modes. However, limited attention has been paid to how inclusive car and bicycle sharing schemes are, and to whether they might contribute to or address problems of transport-related social exclusion. In this preliminary work, we have applied learning from the fields of accessibility and equalities impact analysis to consider shared transport schemes. In doing so, we aim to problematise the easy assumption that shared transport will necessarily support social inclusion and mitigate transport disadvantage.

Although there is evidence to suggest that the benefits from bicycle sharing schemes are unevenly distributed across socio-demographic groups (Ricci, 2015), it is not clear whether this is because the schemes themselves are unevenly distributed, spatially and socially, thereby influencing who can access shared modes of transport and perpetuating inequality of access. In our case study, the demographic characteristics of those with access to both car and bicycle schemes are broadly similar, reflecting the central location of the stations. Car sharing schemes may be able to contribute to transport justice by improving car-based accessibility for those without access to a private vehicle. However, we found no evidence of differences in household car ownership for those with ready geographic access to the car sharing schemes. Furthermore, given the cost structure, it seems unlikely that car share will fulfil this role in the city. Overall, the location of the stations for both car and bicycle schemes makes sense from both commercial and mode-shift perspectives, appearing to favour those most likely to participate. Nevertheless, in this case, the market imperative means that share schemes are less likely to extend to those most at risk of transport-related social exclusion. This raises questions as to whether there are ongoing tensions between sustainability and social justice agendas. Achieving modal shift targets related to sustainability requires limiting travel, whereas social justice possibly requires increased travel among some socio-demographic groups. Overall, we would assess bicycle sharing schemes as being more inclusive, in that they involve fewer barriers to participation, particularly in relation to cost. However, there are serious limitations to inclusivity in relation to both actual and perceived safety concerns, which may be a major factor; for those less physically able, or parents struggling with shopping and children, bicycles may be less practical.

We intend that this paper will act as a catalyst setting a research agenda for more critical consideration of social inclusion, equity and justice related to emerging forms of transport. Given that some level of public investment is required to support shared transport schemes, issues of equality and inclusivity should not be ignored. Related to this, more consideration needs to be given to policy structure, governance and regulation and whether such schemes should be considered as quasi-public transport, which will increasingly be-

come part of the urban transport system and can be used to meet transport policy goals related to sustainability and inclusion. We have discussed the inclusive nature of shared transport schemes in relation to a number of dimensions of what might constitute inclusive transport and then empirically examined spatial access and cost, but there is a need for more empirical work examining the other aspects such as physical access, information and safety and security. There is a need for more research to understand who and more importantly *why* people are (or are not) using shared transport schemes. In particular, this study highlights a need for mixed methods research, investigating the extent of share scheme usage by non-white British residents and exploring any barriers to use. While many studies have looked at the demographic of users, further comparison of this data with the demographic of the areas in which schemes are provided would reveal who is *not* using them and so make known more regarding the inclusive and equitable nature of delivery. Qualitative engagement with individuals across the socio-demographic spectrum would help illuminate the points we have raised here regarding how the schemes may or may not be considered inclusive modes of transport. Further work might be approached from two angles: firstly, whether the schemes are delivered in an inclusive manner; and secondly, whether shared modes might contribute more broadly to an inclusive transport system.

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Conflict of Interests

The authors declare no conflict of interests.

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About the Authors

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Article

Mobility, Transport and Social Inclusion: Lessons from History

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Abstract
This paper argues that although it is now possible to travel more quickly and easily than ever before, transport-related social exclusion is more likely than it was in the past. Using evidence drawn from life writing and oral testimonies I examine the ways in which people accessed everyday transport over the past two centuries. In the early nineteenth century mobility options were limited and most people travelled in similar ways, though the rich always had access to the fastest and most comfortable transportation. From the mid-nineteenth century the railways provided fast travel for most people. Progressively, in the twentieth century British society became car dependent so that those without access to a car were disadvantaged. Such transport-related social exclusion was exacerbated by the denuding of public transport, and by heightened expectations for mobility which often could not be achieved. It is argued that a return to a less differentiated mobility system could increase transport-related social inclusion.

Keywords
Britain; historical perspective; mobility; social inclusion; transport policies; travel diaries

Issue
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1. Introduction and Context

Social inclusion and exclusion have figured prominently on both political and social agendas in twenty-first century Britain, with numerous reports highlighting the continuing nature and implications of social exclusion. Although not always explicitly highlighted, exclusion from travel and transport lies at the heart of most of the issues that are discussed. For instance, the Joseph Rowntree Foundation (2000) identified four dimensions of exclusion: 'impoverishment, or exclusion from adequate income or resources; labour market exclusion; service exclusion; and exclusion from social relations'. Lack of access to transport contributes significantly to all these issues. Several studies have focused specifically on transport and social exclusion, with the Social Exclusion Unit report (2003) highlighting the issues and proposing an agenda for planning authorities to tackle the problem. However, a decade later there was little sign of significant change as demonstrated by a Sustrans report (2012) which showed that some 1.5 million people in Britain were experiencing serious transport poverty which cut them off from employment and services. This was defined as experiencing a combination of low household income which made running a car difficult, living more than a mile from the nearest bus or railway station, and living in areas where it takes more than an hour to access essential services by public transport, cycling or on foot. The persistent nature of transport-based social exclusion has also been highlighted in recent academic studies (Hine, 2012; Lucas, 2012; Mattioli, 2014). However, one dimension that has been lacking from most recent research and policy papers is an historical perspective. This paper seeks to redress the balance by demonstrating that an understanding of the ways in which transport-related social inclusion and exclusion have changed over time can inform twenty-first century transport policies.

An historical dimension is rarely considered in any arena of contemporary policy, although some histori-

ans have begun to highlight the relevance of an historical perspective (Guldi & Armitage, 2014; History and Policy, n.d.). With respect to transport, Colin Divall and colleagues have recently focused on the ways in which an understanding of transport history can inform current policy (Divall, 2011, 2015; Divall, Hine, & Pooley, 2016), but for the most part present-day policies seem to be formulated in an historical vacuum. It is not always easy to identify relevant data and demonstrate past trends and interventions that could be relevant today. In the context of social inclusion and exclusion this is further complicated by the complexity of the issues involved. Social exclusion is a multi-dimensional process (Popay et al, 2008): gaining good data on a complex range of issues, and untangling their interrelations in an historical context, can be daunting. Nonetheless, I suggest that it is possible to construct an argument about social inclusion in Britain that does have a strong historical dimension. All the complexities and contradictions that beset the analysis of transport-related social exclusion in a contemporary context also apply to the past. For instance, principles of social justice and environmental justice do not sit comfortably together, as social justice demands enabling maximum access to the fastest and most convenient forms of transport (for most people today motor vehicles) whereas environmental justice would require strict controls on such vehicles. As personal transport has become faster and more convenient it has also produced more pollutants, causing harm to both global and local environments and to individual health and quality of life for those most affected, usually those with least access to fast and convenient transport (Lucas, 2004, 2006; Pooley, 2016). Transport-related social exclusion has never been solely about transport itself, and often is more properly explained by associated non-transport factors and, particularly, by issues of power, accessibility and choice. Thus in rural areas, lacking most services, transport deprivation and 'forced' car ownership are well documented (Ahern & Hine, 2012; Currie et al., 2009; Johnson, Currie, & Stanley, 2010; Shergold & Parkhurst, 2012), but those with the money, time and good health to be able to drive have the luxury of choosing to live in an attractive rural environment while also accessing all the services they need. Only those whose mobility is constrained by poverty, ill health or other factors experience transport-related social exclusion. Even living close to services and facilities does not guarantee access. For instance, while distance and travel costs may be a disincentive for using health services for some, for others inconvenient opening hours, feelings of alienation or perceived social and cultural differences may be more important (Goddard & Smith, 2001; Gulliford et al., 2002; Gulliford & Morgan, 2013; Pooley et al., 2003). Thus social or cultural factors that discourage travelling even short distances to access services may be more important than the cost or convenience of the transport itself. However, separating the effects of such factors is difficult and there is an extensive transport literature discussing mobility and accessibility issues (e.g. Moseley, 1979; Preston & Rajé, 2007). Additionally, prejudices against, or preferences for, particular forms of transport may cause reluctance to travel if a more acceptable alternative is not available (Beirão & Cabral, 2007; Pooley & Turnbull, 2000a). For instance, public transport (especially the bus) is often perceived (particularly by men) as less attractive than driving or even cycling. In situations where the preferred form of transport is not available accessing services may be deferred. Notwithstanding the complexities outlined above, this paper argues that historical evidence suggests that, as transport options have increased, so too has transport-related social exclusion become more common. Although the very rich have always had access to the fastest and most comfortable forms of transport, in the past when modal choices were limited it can be assumed that most people travelled in much the same way. As transport choices increased, and some faster and more convenient modes became more widely available, differences in travel opportunities between different sectors of the population, and different parts of the country, became more obvious. It is argued that in twenty-first century Britain a more socially inclusive transport system, at least in terms of personal mobility, would be one that was more uniform and which therefore offered easy accessibility but less modal choice. Although no doubt perceived as less convenient and congenial for some, differences in travel opportunities and experiences could be minimised. Such a system, if based mainly on low-carbon public transport, walking and cycling, would also more closely meet the requirements of a more environmentally just transport system.

2. Sources of Evidence

Evidence about the patterns and experiences of past mobility is not readily available. Basic information on inter-area journey-to-work flows was first collected in the 1921 census and again in various forms from 1951 (Office for National Statistics: census 1911–2001). More details of everyday movements (including mode, purpose, distance etc.) have been collected in the National Travel Survey, first conducted in1965–66 and repeated at increasing frequency up to the present (Department for Transport [DfT], 2016a). Additionally, one-off surveys and planning reports from the first half of the twentieth century can provide some information on everyday travel (especially travel to work including the development of workmen's trains in London), but by their nature these are sporadic and do not provide readily comparable data (for instance Abercrombie, 1945; Abernethy, 2015; Barlow, 1940; Jones, 1934; Liepmann, 1944). Prior to the 1920s little readily-

available data exists apart from data on passenger loads by mode for municipal providers of trams and motor buses (Barker & Robbins, 1963; Pooley & Turnbull, 2000b). However, most of these sources provide only aggregate level data and few give any evidence on the social composition of travellers or the purpose of the journey. In this paper the principal sources consulted are personal diaries, letters, autobiographies, life histories and evidence from oral history. Only by using life writing and, for the more recent past, oral evidence, do we have any chance of reconstructing the range of mundane and everyday journeys that most people regularly undertook.

There are, of course, many problems inherent in using such sources. Their survival is sporadic and random, and it is impossible to assess the representativeness of any set of sources used. All life writing is likely to be biased towards those who had both the literacy and leisure time to write a diary or life history, and some such writing comes from elites who were in the public eye and whose life writing was designed both for public consumption and as a justification of actions taken. Such sources are avoided in this research. There is no way of judging what was included and what was excluded from any form of life writing, and it is likely that unusual events were recorded more assiduously than mundane and repetitive occurrences. Thus a daily journey to work may be rarely commented on but exciting holiday travel recorded in full. In general, diaries which were written up daily, or at least frequently, were more likely to record immediate reactions to everyday occurrences than more considered and retrospective life histories and autobiographies. There is also some evidence of gender differences in life writing, with women more likely to write diaries and men autobiographies (Humphries, 2010, pp. 12-48; Lejeune, 2009; Smith & Watson, 2010; Vickery, 1998). Similarly, evidence from oral history depends on the skill of the interviewer, the relevance of the questions asked and the memory of the respondent. Recollections may be coloured by information gained later in life and, as with life writing, it is impossible to assess the representativeness of those interviewed (see for instance Fields, 1989; Perks, 1992; Ritchie, 2014; Thompson, 2000; Thomson, Frisch, & Hamilton, 1994).

Research reported in this paper draws mainly on evidence collected from three separate research projects concerned with different aspects of everyday mobility in the past and the present. Each has been reported elsewhere and only the briefest of details are presented here. First, on-going research is using a range of life writing (diaries, letters, life histories) to examine aspects of everyday life, including mobility, in Britain from circa 1800 to 1950 (Pooley & Pooley, 2015). Analysis of these diaries provides the basis for most of the discussion of social inclusion and transport prior to the availability of oral evidence and more widely-available twentieth-century sources. Second, research carried out in the 1990s on the journey to work in Britain in the twentieth century collected oral and survey evidence from three large cities (Glasgow, Manchester and London) on the ways in which travel to work has evolved over a century (Pooley, Turnbull, & Adams, 2005). This source is used for much twentieth-century evidence. Finally, more recent research on sustainable urban travel, especially walking and cycling, provides data on contemporary mobility patterns and their implications. A large database of oral evidence was collected from four English urban areas (Lancaster, Leeds, Leicester, Worcester) during 2008–11, and is fully reported in Pooley et al. (2013). Although none of these projects originally had social inclusion/exclusion as a main focus, and care must be exercised when making generalisations from a small body of data, all provide data that can be used productively to demonstrate the ways in which changing travel opportunities and experiences have affected access to everyday travel and transport over the past two centuries. Due to constraints of space only a small sample of the evidence available can be quoted here.

3. Before the Railway

In nineteenth-century Britain the railways provided a transport revolution at least as significant as the motor car in the first half of the twentieth century and low-cost air travel in the late-twentieth century (Kellett, 1969; Perkin, 1971; Simmons, 1968, 1986). By the 1850s most major cities, and many smaller settlements, were connected into the rail network, but prior to this the options for travel within Britain were limited. Movement was either by road (on foot, on horseback, in a farmer's or carter's waggon, by mail coach or in a private carriage), or on water (by canal barge or on a coastal vessel) (Albert, Aldcroft, & Freeman, 1983; Dyos & Aldcroft, 1969). All were relatively slow, and most meant that the traveller experienced some discomfort from the weather, and occasionally on poorly regulated and minimally-maintained roads, some danger from highwaymen or accidents. There were improvements in both the speed and safety of vehicles before the mid-nineteenth century as major roads came under the control of Turnpike Trusts, with improved surfaces but a toll to pay, and with improvements to the design of carriages. However, the fastest, most comfortable and most convenient means of transport could for the most part be accessed only by an affluent minority, with the bulk of the population travelling on foot, cart or, occasionally for longer journeys, by mail coach, though access to a horse would have been more widespread in rural than in urban areas (Albert, 1972; Bogart, 2005; Chartres & Turnbull, 1983; Freeman, 1980; Pawson, 1977). Thus, although there were certainly both social and spatial inequalities

in access to travel and transport, for the vast majority of the population mobility experiences were quite similar. In this sense it can be argued that levels of transport-related social exclusion were relatively low or, to put it a different way, most people were equally excluded from the fastest and most comfortable forms of transport.

Scarce evidence from life writing in the eighteenth and early-nineteenth centuries confirms the extent to which travel was usually slow and potentially uncomfortable but was also taken for granted as the normal way of moving from one place to another. For instance, when Ellen (Nelly) Weeton, mistress in a small village school in South Lancashire, decided to move to Liverpool in 1808, she travelled with minimal belongings first on foot (walking some 18km on the first day) and then another 5.5km to catch the Wigan Packet boat to Liverpool along a portion of the Leeds-Liverpool canal. Her journey was recorded in a series of letters she sent to friends and relatives. Relevant extracts include: 'On 22nd inst. I left Leigh, walked to Holland, staid all night at my Aunt Barton's, and on the following morning set sail for Liverpool from Apply Bridge;'[1] and 'I left there [Up Holland] the next morning all in the rain, and how it begun to be fair soon after I got into the boat, and what an agreeable sail I had.'[2] After spending some 15 months in Liverpool Nelly Weeton took a position as a governess to the daughter and companion to the new (young) wife in a wealthy family who lived on the shores of Windermere in Cumbria. On this occasion she travelled by coach, possibly paid for by her new employer (though this is not stated), and she described her journey from Liverpool to Windermere in a series of letters: 'I left Liverpool on Tuesday the 12th and staid all night at Mr Barton's at Walton; the next morning he and I left Preston in the mail and arrived at Kendal soon after two that afternoon. We dined there and then took a post chaise to Mr Peddar's of Dove's Nest twelve miles from Kendal.'[3]

More celebrated diarists such as Dorothy Wordsworth have also described both their regular lengthy walks and more occasional longer journeys by coach (Owen, 2003; Wordsworth & Woof, 2002), and even for the affluent elite journeys by carriage could be uncomfortable and potentially hazardous. Raleigh Trevelyan, the son of Sir John Trevelyan whose London home was adjacent to New Bond Street, briefly kept a diary as a 13/14 year old schoolboy, and vividly described a winter journey by chaise (part of his trip back to boarding school after the Christmas holidays): 'Got up at 5 was in the chaise at 7 & at St Lawrence in 20 minutes. The snow there is 4 feet deep the road cut through it. Past the turnpike the snow is very deep in a road not used in winter & a deep chalk pit is full of water on account of the snow having melted into it. In another place the snow is 2 feet deep & the road cut through it. By 2 mills we went a little out of the road into a field for some way on account of the snow. In another place the snow is 5 feet & the river has overflowed several fields. The snow by Faversham is 3,4,5,6 feet & about the same depth all the way to Gravesend particularly on Chatham hill w[h]ere it is almost 7 feet & the road cut through almost all the way. Arrived at Charlton at 6 PM (when we dined) having had the same chaise all the way from Canterbury with a crack at the bottom you could put your fingers through.'[4] For these diarists at least almost all journeys were undertaken either on foot, by horse-drawn vehicle or on water and, although the rich had more choice and a little more comfort, differences in everyday experiences of travel were relatively small.

4. Expanded Travel Options in the 19th Century

From approximately the 1840s to the early twentieth century travel choices in Britain expanded significantly but, arguably, access to the different forms of transport remained relatively undifferentiated. The growing rail network allowed people to travel long distances more quickly and in greater comfort than before, and although the rich could separate themselves from less wealthy travellers in first-class carriages, railway travel became more affordable than mail coaches had been in the early-nineteenth century. The poorest in society could rarely afford rail travel, and not all locations in Britain were connected into the rail network, but by the 1870s at least travel by train was a real possibility for a large proportion of the population (Divall & Shin, 2012; Leunig, 2006). Within urban areas walking continued to be important for many, but horse-drawn omnibuses and trams (first steam and then electric) rapidly provided increased travel options for most people. In London in particular, the expanding suburban rail network, both over ground and underground, provided further travel options. Although both the bicycle and the motor car appeared on British roads from the late-nineteenth century, their major impact came later (Armstrong, 2000; Cannadine & Reeder, 1982; Dyos & Aldcroft, 1969; Simmons, 1986). Clearly travel experiences for the very rich and the very poor were different, but the increased range of rela-

[1] Letter 80, Ellen Weeton to Miss Bolton, August 27, 1808. Ellen Weeton: Letters to correspondents (Vol 2) October 25, 1807–January 3, 1809. Edward Hall Diary Collection, Wigan Archive Service (Leigh). EHC 165a.

[2] Letter 81, Ellen Weeton to Mr Weeton, August 31, 1808. Ellen Weeton: Letters to correspondents (Vol 2) October 25, 1807–January 3, 1809. Edward Hall Diary Collection, Wigan Archive Service (Leigh). EHC 165a.

[3] Letter 131, from Ellen Weeton to Mr Weeton, December 25, 1809. Ellen Weeton: Letters to correspondents (Vol 3) January 14, 1809–February 4, 1811. Edward Hall Diary Collection, Wigan Archive Service (Leigh). EHC 165b.

[4] Diary of Raleigh Trevelyan, February 1814, Edward Hall Diary Collection, Wigan Archive Service (Leigh). EHC 191.

tively affordable means of travel over both long and short distances meant that few were excluded from mobility, most locations offered a number of different transport options, and many forms of transport were shared by travellers drawn from a range of social groups. Life writing from the period can again be used to support this argument.

At the time of writing his diary in the mid-nineteenth century John Leeson was in his 40s, and a relatively affluent manager of property living in central London. With family and friends John Leeson travelled widely through the city and further afield using a variety of forms of transport. Short local journeys (particularly for pleasure) were often undertaken on foot; for longer trips he would often hire a Hansom cab (he did not keep a carriage) but also used the omnibus and local trains. Longer trips out of the capital were mostly by train, though when convenient he also used coastal vessels from the Thames. For much of his everyday travel his experiences would have been little different from those of many other Londoners, including those of much lesser means. For instance, in August 1847 Leeson recorded: 'Mother came home by Railway from Norwich—I met her at the station at 2 of clock. Fred came with her. She looks well pleased with her excursion there and likes Railway travelling;'[5] and a couple of years later he wrote: 'Left London and I went by Railway from Euston Square to Derby and Ambergate, Matlock, to Buxton, got there at 5.'[6] Many everyday journeys were only recorded on the occasions when something went wrong, but it is clear from John Leeson's diary that bus use was routine. For instance: 'Charlotte lost £3 in an omnibus, going to her sister's at Walworth;'[7] and 'I slipped down in London—Euston Road—on leaving an Omnibus and sprained my left arm, was confined to the house a few days with the arm in a sling.'[8] Collecting rent from the properties he managed was often combined with social calls, and for such trips he often hired a cab: 'I went to the tenants for the rents—took Mrs L, baby and Kate in the cab with me;'[9] but holidays on the south coast were usually undertaken by coastal steamer: ' I left London with Mrs Leeson, Lotty and nurse and went from London Bridge by steamer to Margate, took lodgings on the front—stayed there six weeks…a pleasant rural country town with nice walks out of it.'[10]

John Lee, born in 1842, was a young apprentice draper living in north Lancashire when he wrote his surviving diary in the mid-nineteenth century. Although of much lesser means than John Leeson, he travelled in much the same way as his London-based contemporary. Short trips made by Lee were usually on foot, longer journeys by train, with some use of bus or tram when available. He travelled frequently and apparently without significant constraints. There is certainly no indication that he experienced any transport-related social exclusion despite his young age and relatively limited finances. For instance, in 1862 he made the short trip from south Lancashire to his home town of Burnley in north Lancashire by rail: 'Went by the first train to Burnley to get some of my school books &c out of my large box and a few other things for the Bazaar which we are preparing for in Heywood.'[11] However he usually chose the cheapest means of travel as indicated by an entry for later the same year: 'Stayed with aunt till noon, then I took the half past 12 train to Heywood. I was disappointed in finding that it was a second class train instead of a third as the Time Table stated.'[12] On occasion, old and new forms of transport could interact as when he missed the train and had to resort to horse-drawn transport: 'Got up to go by the six o'clock train to Ripon, but I was about five minutes too late. I fortunately got to ride in a dray;'[13] but when the opportunity arose he also sampled the newest transport available as on a visit to Birkenhead on Merseyside: 'Train to Liverpool, dinner with Aunt and Uncle Walter. Over to Tranmere, walked from there to Birkenhead and got into one of the Americain [sic] Railway carraiges [sic], that have just been made here to run through the streets on rails.'[14]

In small towns and rural areas old and new forms of transport continued to interact much longer than in larger urban settlements. Although by the 1880s the railway had reached many rural locations, travel to and from a railhead was usually on foot or by cart. Mary Ann Prout (born 1861) lived with her parents in Cornwall when she wrote a diary in 1882. Her father was a coal merchant with part ownership of a coal vessel that traded out of Perranporth, and Mary, her family and visitors, travelled by a mixture of rail, cart and on foot. The nearest station was about eight kilometres away (a distance that was comfortably walked when necessary) and the nearest town (Truro) some 14 km. Necessity meant that most people travelled in similar ways and, although transport was probably a little slower and less convenient than in large urban areas, the diarists studied were not prevented from undertaking everyday tasks or longer journeys by a lack of transport. Rural

[5] Diary of John Leeson, August 21, 1847, Bishopsgate Institute Archives, London. GDP/ 8.
[6] Diary of John Leeson, August 2, 1849, Bishopsgate Institute Archives, London. GDP/ 8.
[7] Diary of John Leeson, February 8, 1851, Bishopsgate Institute Archives, London. GDP/ 8.
[8] Diary of John Leeson, March 3, 1860, Bishopsgate Institute Archives, London. GDP/ 8.
[9] Diary of John Leeson, April 17, 1852, Bishopsgate Institute Archives, London. GDP/ 8.
[10] Diary of John Leeson, August 5, 1852, Bishopsgate Institute Archives, London. GDP/ 8.
[11] Diary of John Lee, April 1, 1860, Private collection.
[12] Diary of John Lee, October 15, 1860, Private collection.
[13] Diary of John Lee, August 25, 1859, Private collection.
[14] Diary of John Lee, October 14, 1860, Private collection.

travel in the 1880s is illustrated by the following diary extracts: 'Mother sent Telegram to Truro for Father to meet Mr Brunt at Scorrier and sent Roberts's trap to station for them. They went from Scorrier to Perran to see the Willie [a boat] and then came back here…Mr Brunt walked to Chacewater station;'[15] 'Mr Henwood left about dinner time. Mrs Mitchel from Hayle came in just before he left she walked from Scorrier station this afternoon…Father has left this evening in the Willie for Padstow;'[16] 'Father and me went to Truro today the Buss [sic] was very full. I bought a hat, window curtains and several other things.'[17] Despite relative rural isolation there is little sense that Mary Ann Prout and others mentioned in her diary experienced significant transport-related social exclusion.

5. The rise of the Motor Vehicle in the 20th Century

Twentieth-century travel in Britain was dominated by the rise of the motorised vehicle, though with a significant subsidiary role for the bicycle in mid-century. In 1920 there were 591,000 registered motor vehicles in Britain, rising to 3,970,000 in 1950 and 28,897,600 by the year 2000. Most significantly, in 1920 private cars accounted for only 31.6 per cent of registered vehicles (38.6 per cent were motor cycles and scooters), but by 1950 cars formed almost half of all registered vehicles and in 2000 80.3 per cent (DfT, 2016c). The story of the twentieth century is not just that of the rise of the motor vehicle but, especially, that of the private motor car. By 2000 there was almost one registered private car for every household in Britain. However, cars were not distributed evenly across the population with 26.8 per cent of households in England having no car while 29.5 per cent had access to two cars or more in 2001 (Office for National Statistics [ONS], n.d.-a). In addition to the private car twentieth-century travellers did have a wide range of other options if they chose to use them. The Victorian railway network remained at approximately the same extent until the reductions of the 1960s, long-distance motor coach services provided an alternative to rail travel from the 1920s, trams and motor buses could provide a dense network of services in urban areas, and for many men in particular the bicycle provided a high degree of personal mobility over short to medium distances, especially in the mid-twentieth century (Dyos & Aldcroft, 1969; Hibbs, 1989; Pooley et al., 2005). What impact did such changes have on transport-related social exclusion and inclusion in Britain? Selected life writing and oral histories can again be used to explore the everyday experiences of travel in the twentieth century.

For at least the first 50 years of the twentieth century car ownership remained restricted to the more affluent, and even those who did own a car rarely used it for mundane everyday trips (O'Connell, 1998). Private motor vehicles were primarily reserved for leisure activities and special occasions. Ida Berry (born 1884) lived with her widowed mother in south Manchester and kept a (surviving) diary from 1902–07. Though living comfortably (she did not work), she recorded no occasions when she rode in a car, and only rarely mentioned male acquaintances that did have access to a car in the first decade of the twentieth century. When recorded, car rides were always for leisure activities, as on this occasion when she and her sister met a male friend in a car as they returned from a cycle ride: 'As we came home we met Harry, motoring, so he turned back and rode between us down Northen Grove, and we had a little chat at the gate.'[18] Similarly, in the 1920s in London the much more affluent junior lawyer Gerald Gray Fitzmaurice (born 1901) also did not have access to a car and only rode with friends for leisure and pleasure, as on this occasion in 1926: 'Staying weekend with the Van Lessens to celebrate Gladys's and my joint birthdays. Yesterday we went for such a lovely drive in Prue's new car, a 5 seater Fiat Saloon, a sweet little thing…Prue drove so well.'[19] Oral evidence from the mid-twentieth century tells a similar story as stated by respondents in Manchester and London: 'If you had access to a car at that stage…you would have used that for leisure only. It would not have occurred to you to use it for work' (Interview RJ04, Manchester, male, 1950s); 'Now taking the car involved driving to the Blackwall tunnel and going round that way, so I would never take the car just to go to work. I would only take it if I was doing something else in the evening' (Interview RJ43, London, male, 1950s).[20]

The ability to make such choices about car use, or to live car-free, was made possible in the first half of the twentieth century by continued provision of good public transport in both rural and urban areas, together with a willingness to walk or cycle for many shorter journeys. Catherine Gayler (born 1919) was a schoolgirl living with her parents in rural Lincolnshire when she kept a diary in the 1930s. Her father did not have a car and all travel was by bike, bus or on foot. Her most frequent trips were the approximately ten kilometre journey from home to Grantham (where she went to school), and the 21 km to her grandmother's house. On

[15] Diary of Mary Ann Prout, April 22, 1882, Bishopsgate Institute Archives, London. GDP/58.

[16] Diary of Mary Ann Prout, May 8, 1882, Bishopsgate Institute Archives, London. GDP/58.

[17] Diary of Mary Ann Prout, May 17, 1882, Bishopsgate Institute Archives, London. GDP/58.

[18] Diary of Ida Berry, March 27, 1905, Bishopsgate Institute Archives, London. GDP/28.

[19] Diary of Gerald Gray Fitzmaurice, October 24, 1926, Bishopsgate Institute Archives, London. GDP/52.

[20] Oral history data in this section was collected as part of a project on the journey to work in twentieth-century Britain, funded by The Leverhulme Trust (1996–99).

school days she mostly used the bus, but both journeys were also regularly undertaken by bike: 'Didn't get up very early in morning and biked over to grannies with Mum in afternoon. It rained quite hard coming back. Got home just after six.'[21]; 'Went to Grantham on 1 bus back on the 4 to do Xmas shopping.'[22] Even in the much more remote Eskdale valley in Cumbria, Jill Caldwell (born 1937) had numerous travel options as a teenage girl in the 1950s. Her father and some other male acquaintances had cars in which she sometimes cadged a lift, but she mostly travelled by bus, train or (less frequently) by taxi, bike or on foot. She often juggled different forms of transport but always seemed to complete a journey without undue difficulty, as in this instance when returning from a shopping trip to Carlisle: 'I'd no sooner got to June's than we were off shopping and we were in plenty of time for the train at Carlisle….We managed to catch a bus to Gosforth and I also managed to persuade June that a taxi was a NECESSITY if I was to keep alive.'[23] Urban dwellers had even more transport choices, and oral history respondents regularly travelled by tram, bus, bike, train or on foot in mid-century. Although not all travel was trouble free, three brief examples show the degree to which easy urban travel was taken for granted by most people: 'Well tram cars was…the mode of transport….That was the normal mode of transport and it was very cheap in these days' (Interview RJ49, Glasgow, male, 1930s); 'Well I had ridden a bicycle to school and it was just slightly easier. I didn't have the long walk to the bus stop…I didn't have to change buses, it was just easier to go on the bike' (Interview RJ03, London, female, 1950s); 'Yes [there was public transport], but I could walk as quickly then. Those were the days!' (Interview RJ15, Manchester, female, 1930s).

However, by mid-century changes were occurring that by the 1960s led to a large increase in everyday car use as well as car ownership. Many factors drove increased car dependence, including greater affluence, but for routine travel to and from work the dispersion of employment to the periphery of cities was significant. As work places became less easily accessed by public transport the car rapidly became the preferred means of commuting. This was stated by oral history respondents in Manchester and Glasgow: 'Yes, I got a car at that point because to travel to x was quite awkward. To do it by public transport would mean…a bus journey, an underground journey, and another bus journey…so it really wasn't terribly convenient, so I'd managed to accrue a little capital and I bought a car' (Interview RJ39, male, Glasgow, 1950s); 'Yes I got my first car in 1954….I didn't want a car to travel through Manchester to get to Blackley, but I knew when I was offered this job at Alderley Edge that I would have to do it because there was no cross-country transport at all. It was just hopeless, so I decided to have a car' (Interview RJ15, Manchester, female, 1950s). The continued dominance of car-use for most everyday travel, first predominantly by men but by the later twentieth century also by many women, together with the erosion (and in some rural areas often complete removal) of public transport in the later twentieth century is well documented (Docherty & Shaw, 2008; Sheller & Urry, 2000; Urry, 2004). As one London respondent stated: 'The trouble is my little eight-minute journey, to do it by public transport would be two buses…there's no direct route for me from work.…It's door to door, it's just convenience' (Interview RJ92, London, male, 1990s). Gradually, travelling by any means other than a private car became more difficult and less attractive, and those without access to a car (especially in areas with the most denuded public transport) increasingly found their lives restricted by lack of everyday transport.

6. Conclusions: Into the 21st Century

In theory the twenty-first century traveller in Britain has more transport options than ever before, leading to enhanced expectations that movement both within Britain and internationally should be quick, easy and relatively cheap. Certainly the advent of low-cost airlines has enabled unprecedented levels of international travel for many (Lyth, 2016), and new mobile communication systems have further widened horizons and increased connectivity (Büscher, Urry, & Witchger, 2011). We live in an increasingly mobile world in which there is an assumption that travel and communication over both long and short distances should be unrestricted (Larsen, Urry, & Axhausen, 2007; Urry, 2007). However, one consequence of such high expectations is that disappointment and frustration is that much greater if expectations are not fulfilled. Those unable to participate fully in a highly mobile twenty-first century society are likely to experience both absolute and relative transport-related social exclusion, leading to reduced employment and social opportunities and, potentially, to ill-health due to feelings of frustration and isolation. While health effects of isolation have been most extensively studied among older people (Luo, Hawkley, Waite, & Cacioppo, 2012; Victor & Bowling, 2012), transport-related social exclusion can cause problems for any age group. Such sentiments were expressed by a number of interview respondents in a recent study of everyday travel in four English towns.[24]

[21] Diary of Catherine Gayler, September 29, 1934, Bishopsgate Institute Archives, London. GDP/16.

[22] Diary of Catherine Gayler, December 21, 1934, Bishopsgate Institute Archives, London. GDP/16.

[23] Diary of Anne (Jill) Caldwell, April 28, 1952, Bishopsgate Institute Archives, London. GDP/1.

[24] Interviews cited in this section were carried out as part of an EPSRC-funded research project on walking and cycling, 2008–11.

For instance: 'People still assume that there's something wrong with you if you don't drive' (Interview P121, Leeds, married couple interview); 'Personal safety is an issue and the car, people feel safe in their own car' (Interview P139, Leicester, male); 'Living without a car would be a high maintenance lifestyle' (Interview P80, Worcester, family interview). Although many respondents did seek to minimise car use (and some lived car-free), others clearly articulated their perceived need to have access to a car when needed.

Seen through an historical lens travel in the twenty-first century is something of a paradox. Travel and communication is easier than it has ever been and most people in Britain have access to transport that would have been beyond the imagination of most two centuries ago. However, at the same time a combination of heightened expectations and car dominance has meant that those who cannot access fast and convenient travel may experience some effects from transport-related social exclusion. In the past, when travel options were fewer, expectations were lower and travel experiences more uniform across much of the population. In 2011 approximately one quarter of English households did not have access to a car or van, but access to appropriate transport depends on more than just household car ownership. In large urban areas which have retained good public transport networks (especially London) a car is not needed for most everyday journeys. In contrast in many small towns and rural areas a car is essential. Age restrictions on car driving were enforced in Britain from 1930 and a driving test introduced in 1935 (Driver and Vehicle Standards Agency, 2016); thus in contrast to almost all other forms of transport certain groups are by definition excluded from driving. In all locations the young and the old (often excluded from driving by ill-health) will be most dependent on forms of transport other than the car, or on lifts from those who can drive. Although the gap is narrowing, women are also less likely to have a driving licence than men. In 1975–76 only 29 per cent of females aged 17 or over had a driving licence compared to 69 per cent of men. By 2014 the figures were 67 per cent and 80 per cent respectively (DfT, 2016c). To some extent variations in access to transport and mobility by location, age, gender and income have always been present but, as demonstrated by the evidence presented from life writing and oral testimonies, for the most part transport choices and opportunities in the past appear to have been more inclusive than is the case today. It can be argued that a society which is less car-dependent, and in which there are either fewer choices (for instance through greater restrictions on car use) or more evenly distributed choices, can produce greater transport-related social inclusion.

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Conflict of Interests

The author declares no conflict of interests.

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Article

Does a Rise in Income Inequality Lead to Rises in Transportation Inequality and Mobility Practice Inequality?

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Abstract
Social and economic inequalities have sharpened in the late 20th century. During this period, Europe has witnessed a rising unemployment rate, a declining wages for the least qualified workers, a slowing of income growth, and an increasing gap between the richest and the poorest. Based on the hypothesis of the relation between socio-economic condition and mobility behaviour, it is necessary to ask how these socio-economic inequalities manifest themselves in transportation: does a rise in income inequality lead to a rise in transportation inequality and mobility practice inequality? This question is particularly relevant today as some European countries are facing high socio-economic inequalities following the financial crisis that started in 2008. Using results from transport, car ownership and mobility surveys as well as household surveys from the Paris (Île-de-France) region between eighties and late nineties, this paper tries to answer this question. The results show how inequalities in transportation and mobility practice have decreased during the period in spite of an increase in income inequalities. We find that the evolution of socio-economic inequality, most specifically income inequality was simply one of the determining factors of the evolution of inequalities in transportation and mobility practice. In fact, the most important role in that evolution is not played by the evolution of income inequality but by the evolution of elasticity between transportation and income. Reducing the effects of this elasticity should be the main target of transport policies to diminish inequality in transportation and mobility practice.

Keywords
car ownership; income inequality; mobility practice; Paris region; social inequality; transportation; travel budget; travel costs; travel time; trips frequency

Issue
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1. Introduction

In the last 30 year period, Europe has witnessed an increase in economic and social inequality. These problems take several forms, for example, the growth of unemployment especially within the poorest population categories, the fall in real wages of the least qualified workers, the general deceleration in income growth, and the increasing income gap between the richest and the poorest. Piketty (2002) has found that inequality in the distribution of income per consumption unit in France has been constant since the eighties after having undergone a strong decrease during the previous decade. A weak trend of increasing inequality can, however be detected since the nineties. Based on this phenomenon, one can now ask if these inequalities in social and economic sectors have an impact on mobility. Can a relationship between them be explored?

In order to answer this question, this paper presents an analysis of the dynamic of inequality by using the method of concentration index decomposition developed by Podder (1993) and by Wagstaff, Van Doorlaer and Watanabe (2003). This method allows us, first, to analyse the contribution of each socio-economic and demographic factor to the inequalities in mobility in static terms: at a given point in time and, second, in dy-

namic terms: between two points in time. Finally, this method helps analyse the impact of policies by separating out the effects on inequality of various changes.

This paper will first present three sources of data that concern the Paris region (L'Île-de-France) of France to support this work. Subsequently, using the above three types of data we present an analysis of the economic inequalities of the Paris region followed by an exploration of the demographic and socio-professional characteristics of the households. Finally, it will introduce the concentration index decomposition previously mentioned as the main method. This method application allows us to come to some conclusions as answers to the main question of this research.

The phenomenon of inequalities in mobility in its various forms, among others, the mobility characteristics of people coming from different socio-economic classes is in fact closely related to spatial segregation issues such as socio-spatial exclusion. In the context of the relationship between spatial segregation and inequalities in mobility, this paper helps prepare a framework of analysis for social exclusion from the starting point of mobility. More specifically, this paper shows the potential of using an econometrical methodology to describe the role of the different socio-economic factors that contribute to inequalities in mobility and its evolution.

2. Data

Having chosen the Paris region of France as a case study, the analysis was based on the results of three kinds of survey as explained in the following three subsections.

2.1. Global Survey of Transport

The first type of survey was the *Enquêtes Globales de Transport* or Global Survey of Transport of the years 1983, 1991 and 1997 (Direction Régionale et Interdépartementale de l'Équipement et de l'Aménagement, 1983, 1991, 1997). Abbreviated as EGT, it is a background survey on trips of people living in the Paris region (Île-de-France) which includes most of the basic themes of a mobility survey: number of trips, choice of mode, types of connections, patterns, lengths, travelling speed, and time budget. 10027 households (23601 individuals and 80181 trips) were surveyed in 1983, 11291 households (26009 individuals and 91243 trips) in 1991, and 4285 households (9681 individuals and 35907 trips) in 1997. The survey questionnaire focuses on three types of information concerning the interviewee's trips during one particular working day, the day prior to the interview, outside the holiday season: the general characteristics of the household, the characteristics of people aged more than 5 years old, and the trips of persons.

In this survey, each household was required to indicate their total annual household income, including: bonuses, the "13th month" salary, all other secondary activity income, all income related to movable and non-movable property, social benefits and so on. The definition of income in this survey is not elaborated upon, i.e. interviewees had the liberty to interpret it. No deduction due to direct taxes is taken into account in this income definition. Each household interviewed was required to answer this question by selecting one of the annual household income classes. 1983 survey consists of 13 income classes while that of 1991 and 1997 consist of 10 classes.

Two problems have been detected in relation to income information of EGT.

The first problem concerns the use of per household income as the living standard indicator.

Income per household information might give some idea of how much a household disposes in term of financial resource; however this information is a poor indicator of living standards. For example the standard of living in a household composed by a single person earning a monthly wage of €3,000 is not equal to the living standard of a household with three or four children whose parents earn the same monthly income as the previous household. To obtain a better living standard indicator, we need to take into account at least two additional aspects, household size and composition, for example by calculating the household average income per consumption unit. Unfortunately the information available in EGT does not allow us to calculate the consumption unit value per household as in this survey we cannot distinguish the age of each household's member. The best that we could do in this case was to calculate the average income per capita of the household.

For this work the average per capita income of the household is calculated by assigning the average per household income value of each class to every household belonging to that class and then dividing this value by the household size. Once the income data has been reordered in function of per capita income classes it is possible to see that this distribution had too many biases, for example through checking on the per household and per capita car ownership level in function of their income. The Appendix 1 shows an example of these biases based on 1997 EGT result.

In spite of some fluctuations, Appendix 1 shows that per household and per capita car ownership levels have increased in general with the household income level. This relationship becomes erroneous when trying to represent these car ownership levels in function of per capita income. In Appendix 1 it can be seen that the per household and per capita car ownership level of the 6th decile households are lower than those of the other deciles. This has to do with the high percentage of single person households that belong to the 6th decile.

To cope with this problem, the method used in Claisse et al. (2000) has been adopted and assigned to each household a theoretical and random value of income within the concerned income class. First, it is necessary to determine the percentage of households found theoretically below and above of the central (income) value of the concerned income class. This percentage is calculated in function of the slope of the cumulated distribution curve of the household population according to their income. An example of the estimated percentages for 1997 EGT is given in the Appendix 2.

The second problem detected was that of non-response.

The non-response percentages on the income question were respectively 11.7%, 11.4% and 9.8% for 1983, 1991 and 1997 EGT. These non-response households did not fundamentally correspond to any category representing homogenous characteristics. However, it was found that the majority of these households (52%) were families whose heads were older than 50 years old (against 39% of the households that have answered the income question). 30% of these non-response households had retired heads (against the average of 22%) and 45% of these non-response households had non-active heads (against the average of 34%).

To deal with this non-response problem, we used one of imputation of missing-data methods proposed by Richardson & Loeis (1997) and Armoogum & Madre (1997). Imputation of missing-data are methods of dealing with item non-response by imputing (estimating) values for the missing data based on some other source of information. Among these imputation methods is the "class mean imputation". Based on this method we first divided the sample population into strata based on other variables in the dataset, and then calculated the mean of the variable to be imputed within each strata. More precisely, we divided the households having replied the income question based on their car ownership level. In each car ownership level class, we calculated the average per capita income by distinguishing the households composed by only one person. The objective was to take into account the household structure effect in order to get a better homogeneity between the households found in the same class of car ownership. We finally imputed the average income per person for the non-response households as a function of their car ownership level.

2.2. INSEE Household Budget Survey (BDF)

The second type of survey was the *Enquêtes Budget de Famille* or the Household Budget Survey of the French National Institute of Statistics and Economic Studies (INSEE). Abbreviated as BDF, INSEE conducts this survey every 5 years and covers households living in France. For the purpose of this research it has only taken an extract of data consisting of households living in the Paris region or *francilien* household. The amount of these *franciliens* households covered in the survey are 1999, 2180, 1455 and 1706 respectively for the survey years of 1979, 1984, 1989 and 1994.

The main objective of this survey is to analyse the expense and the income resources of the observed households in order to allow comparisons between the different living standards and consumption choices of the different household categories. The main information gathered in the BDF is the nature and totality of households' expenditure, consumption and income resources. In this research, only some descriptive information of the households such as family composition, education level, type of employment of each family member as well as their mobility characteristics and budget have been used.

BDF has income information in terms of total annual household income. As opposed to EGT, BDF interviewees are asked to give their income information precisely instead of selecting a class of income. The interviewed households provide this information for each of the 73 household income types. These 73 types are grouped into three main categories: activity income, social benefits and capital income. Activity income is the sum of all salary including those of independent (liberal profession) income and income coming from secondary activities. Social benefits include retirement benefits, unemployment benefits, scholarships, familial social benefits, housing subsidies, subsidies or financial support in relation to invalidity, to specific family composition, other social benefits and the RMI or the *Revenu minimum d'insertion* which is a French form of social benefits aimed at people without any income who are of working age but do not have any other rights to unemployment benefits. Capital income is the sum of all income coming from tradable financial assets or securities and all income coming from real-estate assets. The sum of these three main income categories is the total annual household income. It is possible to consider this total yearly household income the household net income after obligatory tax deduction at source. However, direct taxes such as income, property and housing taxes are not yet excluded. The definition of household income in BDF is relatively comparable then to the one of the EGT.

Having income information declared specifically (rather than in income classes) allows us to proceed directly to living standard measures. In this work we present data from BDF not only in its original unit (per household income) but also in more living standard related measures, namely per person income and per consumption unit income. The latter is possible as we find household information in BDF not only in terms of size but also in terms of structure, such as the age of each household member.

We used the Eurostat consumption unit scale to

calculate per consumption unit income. This scale gives weight of 1 (one) to the household head (or the first adult member of the household), weight of 0.5 to each of the remaining adult members and 0.3 to each of the child members. Adult members are all persons of 14 year-old and older living in the household. This choice of scale is made solely on the base of comparability. INSEE and Organisation for Economic Co-operation and Development or OECD also use the Eurostat scale for their work.

2.3. INSEE Parc Auto Surveys

The last type of survey was the *Enquête INSEE de conjoncture auprès des ménages* or INSEE's households situation survey between 1972 and 1994 followed by the *Panel Parc-Auto* or Car Fleet Panel Survey conducted between 1994 and 1998 by three French institutes INRETS, ADEME and SOFRES.

In this survey and panel, household income is declared in 12 classes. We have implemented an imputation method upon these 12 classes in order to obtain 4 quartiles of household income and per consumption unit income. This particular imputation method consists of interpolating the distribution of a variable of interest, i.e. car ownership level per household, in order to define the limit between each income quartile and calculating the average car ownership level in each quartile. Here we made the rather strong assumption that within each income quartile, the household car ownership level did not vary in function of income.

The use of this simple method which is based on the interpolation of income class distribution can be generalized without problem to all orders of quantiles (tertile, quintiles, decile, etc.) under the condition that the number of original classes always be higher than the number of quantiles. Madre & Purwanto (2003) show the application and validation of this method by using as a case study a sample of households that have declared their total income (in number) in the INSEE-INRETS National Survey of Transport and Communication (*l'Enquête Nationale INSEE-INRETS Transports et Communications de*) 1993-1994.

3. Economic Inequalities in Paris Region

The *Île-de France* or Paris region is the region with the highest living standard in comparison to the other French regions. According to the *Institut National de la Statistique et des Études Économiques* (1998), the living standard level of Paris region is on average twice that of French overseas departments and 1.4 times of that of the other French departments' altogether.

However, in the interior of the region that can be divided into three concentric geographical zones, i.e. municipality of Paris or *Intramural Paris*, *Petite Couronne* (the Inner Circle) and *Grande Couronne* (the Outer Circle), the inequality in income distribution is quite strong. Appendix 3 shows how, between its three concentric geographical zones, Paris is the zone with the lowest average per household income. However as Intramural Paris households are composed by strong proportion of single person families, the living standard of the zone, calculated in term of per-unit consumption income, is the highest in the region. Households living in the Outer Circle, the zone with the weakest urbanization level in the region, have the lowest living standard.

The *Institut National de la Statistique et des Études Économiques* (1998) also remarks that the average per consumption unit income in France increased by an average of 4% per year during the seventies followed by a growth deceleration during the eighties when annual growth was merely 0.85%. The living standard growth remained constant between 1990 and 1996.

During the same period, the Paris region had a different evolutionary curve: based on calculations using BDF data as shown in the Appendix 3 the region underwent a period of stagnation or slight drop of per consumption unit between 1979 and 1989 followed by a rise between 1989 and 1994. It can also be observed that the per-household income grew less than the per person income during the whole observed period. This phenomenon was caused by a significant drop of the household size in all zones during the same period as shown in the Appendix 4.

Observing imputation method calculation results of EGT (Appendix 5), we see an increase in both levels of income, i.e. per household and per person income in Paris region between 1983 and 1991 followed by a weak drop or stagnation between 1991 and 1997.

At first sight, income data shown by two different data sources appears to have different evolution curves. In order to understand this one should remember that the income structures in the two surveys are not the same. The average incomes calculated from BDF are generally lower than those calculated from EGT. It is not easy to track down the evolution of the household income between 1979 and 1997, for example, using these two sources.

3.1. Income Distribution Analysis Based on Three Sources of Data

According to Piketty (2002) inequality of income per consumption unit in France was in stagnation in the eighties, after undergoing a sharp drop in the seventies. Still according to him, a slight rising trend can be detected since the beginning of nineties and this dynamic evolution of income distribution inequality in France was consistent with the trends experienced by all Western countries: income inequality especially in wage stopped falling in the eighties and nineties.

Moreover, the *Institut National de la Statistique et des Études Économiques* (1998) finds that income ine-

quality today between 1990 and 1996 increasingly affected young families. Income continued to rise for older age groups while it stopped growing for younger age groups: households with a family head age between 25-35 years had the same income per consumption unit (in constant currency) as the same category ten or twenty years earlier.

Are these phenomena seen over the same period in the Île-de-France (Paris region)?

In the following paragraphs we will see an analysis of the Paris region using three different sources of information: EGT, BDF, and INSEE Parc Auto.

First, the analysis based on three comprehensive surveys of transport (EGT) shows that there was a significant increase in inequality of household income distribution between 1983 and the nineties (1991 and 1997).

The increase in household total income distribution and per person income distribution inequality was confirmed by calculating Gini coefficients. We see that changes in Gini coefficients (Appendix 6) and 10th/1st decile ratios (Appendix 7) between 1983 and 1991 in the Paris region as well as in its three geographical subregions were more significant compared to those coefficients and ratios from the 1991–1997 period. Inequalities of household income distribution increased more during the 1983-1991 period than during the following period. The same evolutionary trends are found in inequalities in terms of per person income distribution as shown in the Appendix 8 and the Appendix 9.

It is noticeable that income distribution inequalities among Parisian households were always higher than those between peri-urban households, i.e. households within the Inner and Outer Circle of the region.

The analysis from the four BDF surveys confirmed how inequalities in household income distribution among Parisians are greater than those that occur among peri-urban households. The results of these surveys also confirm that inequalities among the Outer Circle households are the lowest in the region (see Appendix 10 to Appendix 15).

There is no observable singular and clear trend of inequality evolution in Paris region between 1979 and 1994 from Gini coefficient and $10^{th}/1^{st}$ decile ratio appendix above, that has been calculated using BDF results. It is also possible to see a slight inversing trend on per-person and per-consumption unit income distribution: while Gini coefficients of the total household income distribution (Appendix 12) and the per-unit consumption income distribution (Appendix 14) in the whole Paris region (see Île-de-France columns) and in the Inner Circle were decreasing between 1979 and 1984, the $10^{th}/1^{st}$ ratios were increasing, as shown in the Appendix 13 for per person income distribution and the Appendix 15 for per-unit consumption income distribution. This shows how the inequality in general might decrease at the same time as the disparity between the richest and the poorest grows larger.

One significant finding from those Appendices is the trend that inequality in income distribution at all levels (namely, household, per capita and per consumption unit) in Intramural Paris increased between 1989 and 1994 as shown by the two inequality indicators, i.e. Gini coefficients and $10^{th}/1^{st}$ ratios. In the two other regions, the inequality indicators show rather stagnation and even slight decrease of income inequalities.

Finally, analysis of inequalities in household income distribution by applying the interquartile ratio ($4^{th}/1^{st}$) based on the *Parc Auto* Survey data shows three things. First, the $4^{th}/1^{st}$ ratios were in general lower for the 1980's relative to the 1970's, second, that the ratios were stagnant between the second half of the 1980's and the first half of the 1990's, and third, that starting from 1995, the magnitude of the ratios returned to the levels seen at the end of the 1970's (see the Appendix 16).

A calculation done using the same ratio based on household surveys (BDF) confirms these results and reconfirms that inequalities in household income distribution were the strongest among central Parisian households and the weakest among the households living in the outer circle area (Appendix 17).

In general, we can confirm a trend of reducing inequalities in income distribution among households in the Paris region from the seventies to the eighties, stagnation during the eighties, followed by an increase from the eighties to the nineties especially in Intramural Paris.

3.2. Demographical and Socio-Professional Characteristics of the Households

Elderly households, namely households with head of the family being 66 years old or more, composed the majority of the first decile in the distribution of income per consumption unit. The Appendix 18 however, shows a significant drop in the share percentage of these elderly households in the 1^{st} decile from the first survey in 1979 (44%) to the forth survey in 1994 (13%). During the same period, we see an increasing percentage of younger households in this lowest income group, particularly those with heads under 25. This rejuvenation of the poorest households can imply the existence of two factors: employment or wage inequality that touches mostly younger people and the extension the study period. The *Institut National de la Statistique et des Études Économiques* (1998) shows this: the age at which more than 50% of young people had stable employment is 25 years (23.5 years in 1970), while the median age of school leavers was 21 years (20.5 years in 1990).

Regarding inequality in employment, Chauvel (1998) finds that during the 1990's in France, when the unemployment rate reached 13% of the working population, 25% of active people under 24 years old were

unemployed. Wage inequality in France has worsened since 1975: while wages for older people continued to increase, wages of hiring younger people steadily declined. In 1995 the average living standard of households with heads aged between 50 and 59 years old was 40% higher than those with heads of 30 years old while in 1975 it was only 10-15% (Baudelot & Establet, 2000).

Younger families, in particular those whose head was aged younger than 31, were very poorly represented among the wealthiest households (10th decile). An increase in the proportion of very elderly households (≥66) in this decile was visible between 1979 and 1994.

We conclude that in Île-de-France there was a rejuvenation of the poorest households and an aging of the wealthiest households. The *Institut national de la statistique et des études économiques* (1998), moreover, finds that this aging was due to two factors: the increase in the average income of all pensioners and progression of capital income or heritage towards end-of-life.

The increase in average income for all pensioners' resulted solely from generational replacement, for example, a household with a 60 year-old head at a given date, had an average per consumption unit income higher than a household with the head of family of the same age at an earlier date. From one period in time to another, we are no longer in the presence of the same people. In 1996, people reaching retirement age may have benefited from more favourable retirement regulations, and often belonged to couples receiving two pensions.

Regarding socio-professional category, Appendix 19 shows a significant decrease in the percentage of retired households among households of the 1st decile 1984 (37%) to 1994 (15%) which was consistent with the results of Appendix 18. In 1984, 37% of households in the 1st decile were households with retired heads, whereas in 1994, 47% were households of with employees and/or workers at their heads. What can be seen is that these last two categories of actives were the most disadvantaged professional categories. Yet the total percentage of workers in the Ile-de-France experienced a real decline since the early 1980's.

Despite the 30% increase of the minimum wage in 1968, according to Piketty (2002), France was the country with the highest wage inequality in the western world in 1970, this inequality decreased rapidly during the seventies and then stabilized during the eighties and nineties, with a very small increase from 1983 to 1984. Piketty suggests, this stability was due primarily to the ongoing differences in the level of education and qualifications which explains the permanence of wage gaps. While the least skilled wage passed the certificate of study in brevet, the most qualified employees also lengthened the duration of their studies, attaining diplomas of higher education. The whole hierarchy of qualifications and wages moved up without notable change in difference. Secondly, this stability seems due to social perceptions that likely play a role in wage hierarchies. What a society considers a "fair" inequality probably contributes to the inertia of this wage inequality (see Jardin, 2003).

Over half of households in the 10th decile belonged to executives and liberal professions. The percentage of retired person households was rather important among this richest group that increased from 19% in 1984 to 23% in 1994. On the other hand, the proportion of retired households in the 1st decile of households experienced a significant drop from 37% in 1984 to 15% in 1994. Fournier (2003) finds that these retirees were mostly those people who have received the best share of the cake at the end of their working life. Although strong inequalities existed within this category, the revaluation of pensions made in the 1980's led to a revenue increase of senior citizens at the same time when the active youth incomes stalled.

Finally, Appendix 20 shows that the 1st decile of per consumption unit income were composed of households consisting of first singles, then unemployed, large and single parent households. Between 1979 and 1994, we find that the share of single households among first decile households decreased while it also increased in the 10th decile. In contrary, the share of 'unemployed' households among the poorest households doubled during the same period which is consistent with the phenomenon of inequality in employment.

4. Concentration Index Decomposition

The basis of the method is linked to the need to incorporate the analysis of mobility distribution to the econometrical framework through a simplified model of mobility. In principle, this analytical work requires a twofold approach.

First, the identification of sources of mobility inequalities is based on a formulation of concentration index as an indicator of its determinants. Assuming that during a given period, the relation between a mobility indicator *y* of a person *i* and a set of *k* individual factors x_k is represented by the following linear equation:

$$y_i = \alpha + \sum_k \beta_k x_{ki} + \varepsilon_i \quad (1)$$

where β_k are the coefficients and ε_i is the random term. When equation (1) has significant relationship, it can be used to decompose the socio-economic cause of inequality in mobility.

Wagstaff, et al. (2003) show that based on the relationship estimated in equation (1), the concentration index *C* of the variable *y* can be written as

$$C = \sum_k (\beta_k \bar{x}_k / \mu) C_k + GC_\varepsilon / \mu \quad (2)$$

where μ is the average of y, x_k is the average of x_k, and C_k is the concentration index of x_k. Residual or GC_ε (generalized concentration index for the error term) is defined in the last part of equation (2) as:

$$GC_\varepsilon = \frac{2}{n}\sum_{i=1}^{n}\varepsilon_i R_i \quad (3)$$

with n being the total number of population segments and R_i being fractional rank of the ith person in the income distribution. Equations (1) and (2) show how the concentration index C is in fact composed of two elements, the deterministic and the residual. The first element is the deterministic element, equal to the weighted sum of the concentration index relative to regressors k. The weight is simply the elasticity of y with respect to x_k, calculated at the sample average. The second element is the residual element that represents the mobility inequalities not captured by the factors x_k.

Secondly, where data allows, it is important to understand the causes of changes in mobility inequalities over time. Several approaches can be used for this purpose. The simplest option consists of evaluating the discrepancy between inequalities in two different points in time assuming that all components of social, economic and demographic inequalities are changing.

$$\Delta C = \sum_k (\beta_{kt}\bar{x}_{kt}/\mu_t)C_{kt} - \sum_k (\beta_{kt-1}\bar{x}_{kt-1}/\mu_{t-1})C_{kt-1} + \Delta(GC_{\varepsilon t}/\mu_t) \quad (4)$$

However, this approach does not allow one to specify if variation in the inequality of mobility ΔC is due to change in inequalities (concentration index) of its determining factors, C_k, or if it is due to change of other influences—β_k and x_k. For this reason, a decomposition of mobility inequality using the method developed by Oaxaca (1973) appears to be slightly more fruitful. Assuming η_{kt} as the elasticity of y with respect to x at time t, the decomposition structure of Oaxaca can be written as follows:

$$\Delta C = \sum_k \eta_{kt}(C_{kt} - C_{kt-1}) + \sum_k C_{kt-1}(\eta_{kt} - \eta_{kt-1}) + \Delta(GC_{\varepsilon t}/\mu_t) \quad (5)$$

or

$$\Delta C = \sum_k \eta_{kt-1}(C_{kt} - C_{kt-1}) + \sum_k C_{kt}(\eta_{kt} - \eta_{kt-1}) + \Delta(GC_{\varepsilon t}/\mu_t) \quad (6)$$

or according to Lachaud (2003):

$$\Delta C = \sum_k 0{,}5(\eta_{kt} + \eta_{kt-1})(C_{kt} - C_{kt-1}) + \sum_k 0{,}5(C_{kt} + C_{kt-1})(\eta_{kt} - \eta_{kt-1}) + \Delta(GC_{\varepsilon t}/\mu_t) \quad (7)$$

Equations (5) to (7) allow tracing the double sources of variation in mobility inequality: (i) variations of inequality of the determining factors of mobility and (ii) variations of elasticity of the determining factors. It is worth noting that the method of decomposition proposed by these equations weights the variation of inequalities by the average of elasticities and the variation of elasticities by the average of inequalities (concentration indexes).

5. Inequalities in Transport and Mobility

In equation (1), y_i, the dependent variable measures of mobility. Ten indicators of mobility are considered:

- Number of trips per day per person (all modes)
- Number of trips by car per day per person
- Number of trips by public transit per day per person
- Number of trips on foot per day per person
- Distance travelled (km) per day per person (all modes)
- Distance travelled (km) by car per day per person
- Distance travelled (km) by public transit per day per person
- Average speed (km/h) per day per person (all modes)
- Average speed (km/h) by car per day per person
- Average speed (km/h) by public transit per day per person

To explain variations of these mobility variables, we adopt a classic model of trip generation. This model explains the number of trips produced per household by using several explanatory variables. According to McNally (2000), these variables are: the car ownership level of the household, household income, household size, the number of actives per household, etc. We have generalized this model by converting it to the "individual" level and by using it to estimate other indicators of mobility.

We retain several explanatory variables as follows:

- age and the square of age
- average income per person in the household
- social professional category of each individual: active (worker), retired, unemployed, student, and staying at home (inactive) where male and female are distinguished in each type
- dwelling zones in Paris region: Intramural Paris or Paris Inner circle and Outer circle

The independent variable of "age" does not enter the equation linearly. This allows one to incorporate the effect that mobility increase with age up to a certain point and then gradually drops.

The average income per person represents the living standard of the household in which the person belongs to. We used the inactive individual ("F-at home") as the referenced social professional category and the

Outer Circle ("F-Outer Circle") as the referenced dwelling zone.

These independent variables do not fully explain the variation in mobility as given in Appendix 21 to Appendix 23. The coefficients of determination R^2 were relatively low, especially for the frequency of trips and walking. The regression results are summarized in the following paragraph.

First, mobility indicators depended directly on the age of individuals. Coefficients on age are almost all positive. In fact, except for walking related indicators, the age squared was significantly involved in a negative way. Secondly, contrary to popular belief, per capita income played a small role. This was indicated by the values of estimated coefficients that were low compared to other coefficients of variables. However, these coefficients were generally positive. Third, the coefficients of the number of cars per person are generally highest in absolute terms compared to those of other variables. Except in frequency and distance in public transport and in frequency of walking, these values were always positive. Fourth, being a professionally active man actually promotes mobility by car. This was indicated by the high positive values of the coefficients in this category for frequency, distance and travel speed by car. Being a professionally active woman or a student promoted mobility by public transit. Housewives and other non-active categories show positive strong coefficients in walking frequency. Fifth, living in the Outer Circle seemed to be a factor that boosted mobility, in particular in terms of distance and speed. We find the opposite characteristics of living in Intramural Paris, which boosted trip frequency in public transit and walking. Living in the Inner Circle was always found between these two extremes.

Before analysing the decomposition of inequalities of the different mobility indicators, it is important to look at the indicator of inequalities that we used. In this analysis, it is the concentration index or concentration coefficient of mobility in comparison to individual income distribution. Inequality is then measured by a variable, in this case the mobility indicators, which is distributed between the different persons ranked according to their individual income. We observe then for example, if this variable of mobility is more concentrated among individuals with low income or among individuals with high income or if it is distributed proportionally according to the individual income.

Appendix 24 shows the concentration index of several mobility indicators. The positive values of these indexes suggests in most of the indicators that these variables were more concentrated among the individuals with high income. The higher the index value, the more concentrated this variable was among "rich" people and the inequality was more pronounced. On the contrary, negative values, which is found in the indicator of the "number of trips on foot per day per person" means that this variable was concentrated more among the individuals with low incomes.

In observing the fluctuation of these coefficients in time, it can be seen that most of these values were decreasing inversely to the trend of increasing inequality in the distribution of income per capita. The latter has been calculated in term of Gini index of the income per person distribution which grew from 0.315 in 1983 to 0.359 in 1991 and finally to 0.360 in 1997.

Does the fact that mobility indicators become in general less concentrated amongst wealthier people, necessarily mean that inequality of mobility has decreased during the observed period?

The answer to this question is rather difficult. For example, the decreasing concentration of trip frequency per day, by any modes, amongst the rich means that low income people have been moving with increasing frequency. On one hand, this might mean reduction in mobility inequality as we can interpret this as an increase in the mobility capacity of low income people but on the other hand, it might mean that low income people are "obliged" to make more frequent trips per day in order to fulfil their needs. The same also applies to other variables such as the distance travelled, by any mode, i.e. long distance travel might suggest freedom for some people but at the same time this might mean burden as low income people which are forced to live in the outskirts, far from their places of work or study. Finally the average speed might be the only indicator where a reduction of concentration among the rich people is always positive.

The aim of this research is, however, not to make a normative judgment on which level a concentration index of particular mobility indicators is fair or unfair. The aim is to discover how the different determining factors influence the final value of the concentration index.

6. The Role of the Evolution of Socio-Economic Inequalities on Transportation and Mobility Practice Inequalities

Detailed results of the decomposition method application, in relation to the equations (1) to (4) are given in Appendix 25 to Appendix 27. The Appendices show that inequality in the distribution of per capita income and per capita car ownership were the two main factors that explained the cause of inequalities in mobility at a particular point in time. For example, as shown in the Appendix 26, the inequalities of the income per person distribution explained 44%, 29%, and 38% of the cause of inequalities in travelled distance distribution of all modes respectively for the year 1983, 1991, and 1997. Inequality in the distribution per capita of car ownership was in fact the factor that explained most the causes of inequalities in the distribution of three variables, namely, travelling speed (Appendix

27), trip frequency by car (Appendix 25) and travelled distance by car (Appendix 26). It is interesting to note that this factor explained most of the causes of inequalities in the distribution of trip frequency on foot (57%, 48%, and 48% for the three observed years) as shown in Appendix 25, in other words, the more private cars were concentrated among the high income people, the more low-income people walk.

In Appendix 26 we see how in the previous example inequalities in per capita income, per capita car ownership and socio-professional category, reinforced the concentration of the travelled distance by private cars among high income people. Inequalities in car ownership show negative values of contribution to the distribution of trip frequency (Appendix 25) and distance travelled (Appendix 26) in public transport. This means the more concentrated among rich people car ownership was, the less rich people used public transit.

Inequality in age distribution contributed positively to mobility inequalities, meaning that the tendency that older people were richer than younger people contributed to the concentration of more mobility towards the rich (or, in case of frequency of travelling on foot, towards the low income people).

Finally, except for the trip frequency in all modes and in public transit, inequality in the distribution of geographical area of the household contributed negatively to the mobility inequalities. This means that the trend where rich people lived more in Intramural Paris than in the Inner and Outer Circles weakened the concentration of mobility among the rich.

One problem has been found in relation to the residuals that for some mobility indicators were high, such as in the case of trip frequency per day by public transit (1991 and 1997), travelled distance per day by public transit (1991, 1997) and average travel speed by car and public transit (all observed years). These high residuals mean that the independent variables used were not sufficient to explain the concerned dependent mobility indicator variables.

Transversal analysis above reveals elements that constitute inequalities of mobility at a given point in time. In fact, the main objective of the use of this decomposition method is found in its dynamic analysis between two points in time. Results of this dynamic analysis are given in the following Appendices.

Between 1983 and 1991, it can be seen that inequalities decreased for all mobility indicators as shown by the Appendix 24. An explanation for this decrease can be found again in the evolution of two factors: income and car ownership level.

First, it was noticed that the evolution of inequality in the distribution of car ownership during this period largely determined the evolution of inequalities in the distribution of travel speed and trip frequency by car. The evolution of this factor was responsible also for 105% of the reduction in inequalities in the trip frequency by car (Appendix 28). A percentage higher than 100% means that there were other factors whose evolutions in time contributed negatively to the inequalities of the corresponding mobility indicator.

Second, the evolution of inequality in per capita income distribution played a very important role in the evolution of inequalities in mobility on foot and on public transit. For example, it was responsible for 85% of the reduction of inequalities in trip frequency by public transit (Appendix 28) and for 104% of the reduction of inequalities in the travel distance (all motorized modes) during the same period (Appendix 29). Apart from that, it was responsible for 105% of the increase of inequalities in trip frequency on foot (Appendix 28).

During the following period (1991–1997), it was discovered that the role of the evolution of per capita income distribution inequality decreased significantly. Noticeably this evolution contributed negatively to changes in the inequality of many mobility indicators: on the one hand, it counterbalanced the reduction of inequalities in particular as regards those of travelled distance of all motorized modes, by car and trip frequency by public transport but, on the other hand, it offset the rising inequality in the average speed distribution of all motorized modes and car.

Inequality in the distribution of car ownership continued to play an important role in the evolution of inequality in mobility. The dynamic variations of this factor were responsible for reduction of inequalities for the number of trips of all modes, in public transport and on foot and the travelled distance in public transport. In addition, it contributed significantly to the rising inequality of the average speed of all motorized modes and car.

The evolution of the inequality in the distribution of different socio-professional categories contributed to reducing inequalities in the number of trips and distance by car. But it counteracted the reduction of inequalities in the distance and trip frequency by public transport.

The evolution of the inequality in the distribution of age contributed significantly to reducing inequalities in the total distance of travel (all motorized modes) and to offset the rising inequality in the trip frequency on foot.

Finally, the evolution of the inequality in residential location distribution, unlike the previous period, was in most cases, consistent with the overall trends in inequalities of mobility. In other words, changes in the distribution of people living in three areas (Intramural Paris, Inner and Outer Circles) between 1991 and 1997, generally contributed to reducing inequalities of mobility.

As in the previous discussion on the static contribution, there is found a problem that concerns the residuals. High residual values are found in some mobility indicators such as trip frequency per day on foot (1991–1997), travelled distance per day by public transit (1991–1997), and the average travel speed by

public transit (both periods). Other dependent variables are needed to explain the concentration index evolution of those mobility variables.

Although the analysis of the total variation of the factors contributing to the dynamics of the concentration index is interesting, it does not itself differentiate changes due to the effects of elasticities and inequalities.

Concerning income per capita, we found that the effect of elasticities determined the contribution of this factor to the equalities of mobility indicators. According to the Oaxaca-type decomposition results, this contribution reduced inequality in all indicators, except the average speed for all motorized modes. In other words, instead of rising inequality in per capita income distribution between 1983 and 1991, income factor actually helped reduce inequalities in the travel distance by decreasing the elasticity of trip distance with respect to income. The same was also found in almost all indicators of mobility: neutralizing or reducing the effects of the elasticity of mobility with respect to income appeared to be one of the reasons for the reduction of inequalities in mobility between 1983 and 1991. Exceptions might occur when it comes to the number of walking trips: a decrease in the effects of elasticity contributed to the reduction of the concentration index of the frequency of walking trips which means more concentration of walking trips among low income people and more inequality.

Reductions in the effects of elasticity of mobility compared to the number of cars per capita also contributed in reducing inequalities in mobility, especially in car trips. Neutralizing or reducing the effects of the elasticity of mobility, especially by private car, with respect to the number of cars per capita, appeared to lead to the reduction of inequalities in mobility.

Finally, as raised in the previous section, changes in residential location altogether offset in most cases, changes in inequality. The change in the proportion and distribution of people living in Intramural Paris between 1983 and 1991 contributed in general to increasing inequalities in mobility during the same period. For the Oaxaca method, it is revealed that this increase was due firstly to the increase of the effects of the elasticity of mobility with respect to the fact of living in Intramural Paris between 1983 and 1991.

During the following period, between 1991 and 1997, the overall trend continued. In general, the effect of elasticity was higher than that of inequality. However, in cases of conflict which were somewhat more frequent, sometimes it was the effect of inequality that prevails, especially for the distance travelled by public transport.

7. Conclusions

Inequalities in mobility are determined by different socio-economic and geographic factors and income distribution inequality is only one of the important determining factors.

This study found that on any given date, inequality in the distributions of income per capita and car ownership per capita were the two primary factors that help explain most of the inequalities in mobility. Dynamically, the evolution of the inequality of these two factors was also the most important element in reducing inequalities in mobility between 1983 and 1997. The evolution of inequality in the distribution of car ownership during this period greatly affected the evolution of mobility inequality, speed and mobility by private car in particular, while evolution in the inequality of per capita income distribution during the same period determined the evolution of inequality in mobility on foot or by public transport in particular. During the following period (1991 - 1997), the role of the evolution of inequality in the per capita income distribution decreased while that of the per capita car ownership remained important.

It was also noticeable that the contribution of the evolution of determining factors to the evolution of inequality in mobility was driven mostly by the evolution of the effects of cross-elasticities of the indicators of mobility with respect to their determinants. This was especially true for income and car ownership. Between two dates, reducing the effects of cross-elasticities of mobility with respect to income and/or the rate of car ownership seemed to be a means for lowering the concentration indices of mobility and reducing inequality. Lowering the effects of the cross-elasticities can be done, for example, by reducing the regression coefficient of the different mobility indicators with regard to their determining factors, namely income and car ownership. In the real world, policies such as subsidizing public transport tickets with regard to the different income or socio-professional groups should lead to reducing mobility inequality directly and also that of spatial segregation, such as the socio-spatial exclusion phenomenon, indirectly.

The method of decomposition of inequality developed by Oaxaca (1973) and Wagstaff et al. (2003) is valid to decompose the causes of inequality of an object or a variable that is normally distributed or can be expressed by explanatory variables through a model of ordinary least square (OLS). The indicator of mobility as the frequency of travel, or indicator of car ownership level as the number of cars in a household is distributed following multinomial law. A modification of the model of decomposition of inequality for variables whose distributions are abnormal is a subject for future research. This change will allow a better understanding of the contribution of each explanatory variable whose distribution is abnormal.

The use of a better data source is also a point of improvement. The information recorded in the Global Survey of Transport (EGT) is the description of mobility on

one particular weekday. The reliability can be expected from its sample size: the number of households, individuals, and trips being recorded. However, it might not be a stable representation of mobility behaviour, because mobility can vary from one day to another, from one week to another and from one season to another during the same year. The use of averaged information over a longer time period might improve this aspect.

Finally, there is a difficulty that can be quite disturbing in implementing this approach with regard to the level of mobility itself. Firstly, mobility can be considered as a dependent variable, determined by factors such as income. However, mobility can also be considered as one of the explanatory variables that affects income. In fact the two-way-relationships are valid but in this paper, only the first one has been given attention. Furthermore, this study has presented a set of mobility indicators as dependent variables which have been explained by the same independent variables. The low determination coefficients and the high residual values for some mobility indicators show the consequence of this choice. Future study focusing on fewer mobility indicators explained by more carefully selected independent variables should give more meaningful results. Despite this drawback, our study has shown the potential of the decomposition method used to analyse mobility inequality.

Secondly, mobility level is ambiguous. It is not easy to determine whether a very low trip frequency is the result of some constraining situation suffered by an individual. It is also difficult to determine whether low-mileage travel means the mobility coercion of an individual. Similarly, it is also difficult to say if high mileage undertaken by an individual signifies constraint or freedom for that individual. It is likely that high mileage is the phenomenon of over-mobility (Gibout and Toupin,(2002)). Indicators of mobility remain fairly trivial for this approach. Paulo (2007) states that it is impossible to elaborate precise quantitative criteria or indicators that allow us to order the mobility situation in terms of inequality but we can at least use the most frequently observed trends in individual practice of mobility as references. While Purwanto (2009) gives some preliminary hints on how to set a framework for these criteria, Jouffe, Caubel, Fol and Motte-Baumvol (2015) indicate that mobility inequalities are often interpreted normatively in terms of “lack” which is simply based on the assumption of lower mobility capacity of the poor in one hand and on the other hand, the domination of the rich in terms of movement. This interpretation, according to them, risks reducing the complexity of the phenomenon.

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Conflict of Interests

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About the Author

Joko Purwanto obtained his Degree in Civil Engineering in 1997 and is experienced in transport infrastructure project feasibility studies in Indonesia. He pursued Masters (2000) and Doctoral (2004) degrees in transport economics in France. Between 2005 and 2008 he worked as a research fellow in transport and energy sectors modelling at the DG Joint Research Centre of the European Commission in Seville, Spain. In 2008 he joined Transport & Mobility Leuven in Belgium and works as senior researcher.

Appendix 1. Incoherencies due to transforming household income class to per capita income decile. Source: 1997 EGT result based calculation*.

Household income class	Car ownership level	Car ownership level per capita	Household income per capita in decile	Car ownership level	Car ownership level per capita
Less than €5700	0.21	0.18	D1 (1st decil)	0,57	0,17
€5700-€11400	0.27	0.17	D2	1,01	0,30
€11400–€17100	0.43	0.26	D3	0,71	0,26
€17100–€22800	0.74	0.40	D4	1,14	0,39
€22800–€28500	0.92	0.46	D5	1,14	0,45
€28500–€34200	1.17	0.50	D6	0,78	0,34
€34200–€45600	1.27	0.51	D7	1,27	0,55
€45600–€68400	1.54	0.58	D8	0,93	0,55
€68400–€114000	1.64	0.59	D9	1,12	0,65
More than €114000	1.89	0.63	D10	1,03	0,67
Average	0.97	0.43	Average	0,97	0,43

Note: * The original currency used in the data processing was 1998 French Franc. We perform a conversion into 2015 € (Euro) to be used as currency in this paper using methodology given by the *Institut national de la statistique et des études économiques* (Insee) website: http://www.insee.fr/fr/service/reviser/calcul-pouvoir-achat.asp?sommeDepart=1&deviseDepart=Franc&anneeDepart=1998&deviseArrivee=Euro&anneeArrivee=2015 (as retrieved on 13 May 2016). Given the currency depreciation due to inflation, the purchasing power of 1 (one) French Franc in 1998 is the same as that of 0.19 Euros in 2015.

Appendix 2. Theoretical estimation of household income distribution for each household income class of 1997 EGT. Source: EGT result based calculation.

Household income class	Theoretical percentage of household with income below the class central value	Theoretical percentage of household with income above the class central value
Less than €5700	Not available (NA*)	NA
€5700-€11400	0.39	0.61
€11400–€17100	0.48	0.52
€17100–€22800	0.51	0.49
€22800–€28500	0.57	0.43
€28500F–€34200	0.51	0.49
€34200–€45600	0.70	0.30
€45600–€68400	0.81	0.19
€68400–€114000	0.88	0.12
More than €114000	NA	NA

Note: * We need upper and lower values for each class in order to estimate the theoretical percentage. For the lowest and highest class we then assign arbitrary values.

Appendix 3. Average income in Paris region in 2015 Euros. Source: BDF 1979, 1984, 1989, 1994 results based calculation.

	1979	1984	1989	1994
	per-household income			
Paris	33693	36888	38055	44699
Inner Circle	41900	37602	39715	39782
Outer Circle	42434	39535	40912	40320
Île-de-France	39736	38188	39704	41127
	per-person income			
Paris	18511	20842	21569	25574
Inner Circle	17472	17332	18165	18576
Outer Circle	15430	15549	17383	17533
Île-de-France	17041	17485	18020	20770
	per-consumption unit income			
Paris	22950	25550	26324	31195
Inner Circle	24443	23247	24320	24524
Outer Circle	22838	22198	23857	24023
Île-de-France	23441	23395	24690	27018

Appendix 4. Average Eurostat scale consumption unit. Source: BDF 1979, 1984, 1989, 1994 results based calculation.

	1979	1984	1989	1994
Paris	1.46	1.45	1.42	1.41
Inner Circle	1.74	1.64	1.65	1.64
Outer Circle	1.88	1.81	1.75	1.72
Île-de-France	1.71	1.66	1.62	1.62

Appendix 5. Average income in Paris region in 2015 Euros. Source: calculation results of EGT 1983, 1991, 1997 results based calculation.

	1983	1991	1997
	per-household income		
Paris	28613	32212	31148
Inner Circle	30438	32944	31377
Outer Circle	32298	34743	34850
Île-de-France	30576	33430	32674
	per-person income		
Paris	17131	19326	19132
Inner Circle	14221	15833	15028
Outer Circle	12928	14296	14577
Île-de-France	14579	16143	15952

Appendix 6. Per household income distribution: Gini coefficients. Source: EGT result based calculation.

	Île-de-France	Paris	Inner circle	Outer circle
1983	0,30	0,34	0,29	0,28
1991	0,35	0,40	0,34	0,32
1997	0,36	0,40	0,33	0,35

Appendix 7. Per household income distribution: 10th/1st decile ratios. Source: EGT result based calculation.

	Île-de-France	Paris	Inner circle	Outer circle
1983	8,00	10,39	7,37	6,83
1991	11,21	17,90	9,74	9,00
1997	11,73	17,94	9,77	10,19

Appendix 8. Per person income distribution: Gini coefficients. Source: EGT result based calculation.

	Île-de-France	Paris	Inner circle	Outer circle
1983	0,32	0,33	0,31	0,29
1991	0,36	0,38	0,35	0,33
1997	0,35	0,38	0,33	0,34

Appendix 9. Per person income distribution: 10th /1st decile ratios. Source: EGT result based calculation.

	Île-de-France	Paris	Inner circle	Outer circle
1983	9,05	10,79	8,59	7,54
1991	12,01	16,89	10,83	9,55
1997	12,24	16,19	10,26	10,81

Appendix 10. Per household income distribution: Gini coefficients. Source: BDF result based calculation.

Year	Île-de-France	Paris	Inner circle	Outer circle
1979	0.37	0.38	0.39	0.34
1984	0.36	0.43	0.35	0.32
1989	0.37	0.42	0.37	0.32
1994	0.38	0.50	0.36	0.30

Appendix 11. Per household total income distribution: 10th/1st decile ratios. Source: BDF result based calculation.

Year	Île-de-France	Paris	Inner circle	Outer circle
1979	13.63	14.65	13.04	11.35
1984	13.60	23.04	13.49	9.64
1989	13.96	16.88	15.91	9.49
1994	14.40	50.11	11.59	7.81

Appendix 12 Per person income distribution: Gini coefficients. Source: BDF result based calculation.

Year	Île-de-France	Paris	Inner circle	Outer circle
1979	0.37	0.36	0.40	0.33
1983	0.36	0.41	0.35	0.32
1989	0.35	0.37	0.35	0.33
1994	0.38	0.48	0.35	0.31

Appendix 13. Per person income distribution: 10th/1st decile ratios. Source: BDF result based calculation.

Year	Île-de-France	Paris	Inner circle	Outer circle
1979	10.15	11.07	10.84	8.77
1984	11.91	18.68	11.51	8.61
1989	11.27	12.66	12.22	9.12
1994	13.40	37.33	10.89	7.76

Appendix 14. Per consumption unit income distribution: Gini coefficients. Source: BDF result based calculation.

Year	Île-de-France	Paris	Inner circle	Outer circle
1979	0.34	0.34	0.38	0.31
1983	0.33	0.39	0.32	0.29
1989	0.33	0.36	0.33	0.29
1994	0.35	0.47	0.33	0.27

Appendix 15. Per consumption income unit distribution: 10th/1st decile ratios. Source: BDF result based calculation.

Year	Île-de-France	Paris	Inner circle	Outer circle
1979	9.25	10.67	9.46	7.87
1984	10.24	17.35	10.25	7.23
1989	9.78	11.80	10.85	7.09
1994	10.94	36.16	8.91	6.19

Appendix 16. Per household income distribution: 4th/1st quartile ratios. Source: INSEE Parc Auto result based calculation.

Year	$4^{th}/1^{st}$	Year	$4^{th}/1^{st}$	Year	$4^{th}/1^{st}$
1974	5.77	1984	5.05	1994	4.91
1975	5.48	1985	4.50	1995	5.67
1976	4.90	1986	4.37	1996	5.05
1977	5.75	1987	4.83	1997	5.71
1978	5.62	1988	4.63	1998	5.52
1979	5.42	1989	4.66		
1980	5.34	1990	4.73		
1981	5.57	1991	4.56		
1982	5.65	1992	4.58		
1983	4.79	1993	4.78		

Appendix 17. Per household income distribution: 4th/1st quartile ratios. Source: BDF result based calculation.

Year	Île-de-France	Paris	Inner circle	Outer circle
1979	5.82	6.60	5.73	5.04
1984	5.62	7.69	5.49	4.71
1989	5.88	7.49	6.19	4.76
1994	6.12	12.58	5.72	4.25

Appendix 18. Distribution (%) of the different head of family age groups in per consumption unit income classes. Source: BDF 1979, 1984, 1989, 1994 result based calculation.

	1979		1984		1989		1994	
Age of the head of family	1^{er}	10^{th}	1^{er}	10^{th}	1^{er}	10^{th}	1^{er}	10^{th}
age<=20 years	1.9	0.0	2.6	0.0	3.7	0.0	5.0	0.0
21–25 years	7.0	1.3	7.8	1.0	10.6	0.9	17.2	0.0
26–30 years	0.9	5.7	8.9	9.7	6.9	5.7	8.1	5.0
31–35 years	9.2	14.5	7.4	11.1	9.5	11.2	11.6	7.1
36–40 years	6.7	10.5	8.1	11.8	10.2	9.4	7.8	7.3
41–45 years	9.4	10.8	4.3	9.6	7.1	14.3	10.5	10.5
46–50 years	4.3	7.4	7.4	7.1	5.0	10.4	9.4	16.3
51–55 years	5.2	16.0	5.4	14.6	7.2	11.4	8.4	11.8
56–60 years	6.7	13.0	7.1	11.0	8.4	12.7	4.7	13.7
61–65 years	4.8	7.5	8.0	11.1	5.6	9.3	4.5	8.1
66 years<=age	44.1	13.3	33.1	12.9	25.7	14.7	12.7	20.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Appendix 19. Distribution (%) of the different socio-professional categories in per consumption unit income classes. Source: BDF result based calculation.

	1984		1989		1994	
Socio-professional category	**1st**	**10th**	**1st**	**10th**	**1st**	**10th**
active: farmers	1.0	0.0	0.0	0.0	0.0	0.0
active : craftsmen, retail traders, liberal professions	5.6	3.2	8.3	6.9	5.5	8.8
active : executives, liberal professions	5.9	51.1	7.7	53.9	4.9	57.6
active : intermediate occupations	5.8	18.7	5.6	13.0	4.4	4.1
active : employees	11.8	4.7	13.5	1.4	24.9	2.7
active : labourers	13.6	1.4	15.3	0.9	22.2	1.2
inactive : retired persons	37.3	19.1	23.9	23.0	14.9	23.1
Other inactive	19.1	1.7	25.8	0.9	23.3	2.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

Appendix 20. Distribution (%) of the different household types in per consumption unit income classes. Source: BDF result based calculation.

	1979			1984			1989			1994		
Household type	**1st**	**10th**	**all**	**1st**	**10th**	**all**	**1st**	**10th**	**all**	**1st**	**10th**	**all**
Single person household	50.3	18.3	24.5	46.7	24.3	28.0	46.0	26.2	31.2	45.5	29.2	32.2
Mono-parental household	4.0	0.6	2.2	3.1	0.0	2.3	1.9	1.8	1.9	6.8	0.0	2.7
Large family household	6.9	2.1	4.8	6.9	2.8	4.6	3.9	1.5	3.4	6.3	3.1	4.2
Household with at least one unemployed	12.0	2.6	6.7	20.0	2.6	8.0	17.8	1.5	8.2	30.4	6.2	11.0

Appendix 21. Estimation results of trip frequencies. Source: EGT result based calculation.

	number of total trips/day			number of car trips/day			number of transit trips/day			number of on foot trips/day		
	1983	**1991**	**1997**	**1983**	**1991**	**1997**	**1983**	**1991**	**1997**	**1983**	**1991**	**1997**
Constant	3,0E+03***	3,2E+03***	3,1E+03***	9,7E-01***	1,4E+03***	1,5E+03***	-4,0E-01***	-7,4E-01***	-5,9E-01***	2,4E+03***	2,5E+03***	2,2E+03***
Age	1,4E-02**	3,5E-02***	6,1E-02***	5,0E-03*	1,2E-02**	1,8E-02**	2,9E-02***	5,0E-02***	4,7E-02***	-2,0E-02***	-2,8E-02***	-4,0E-03*
Age^2	-4,0E-04***	-6,0E-04***	-9,0E-04***	-1,7E-04***	-2,6E-04***	-3,1E-04***	-3,4E-04***	-5,5E-04***	-5,4E-04***	1,1E-04**	2,1E-04***	-5,6E-05*
Income	4,2E-06***	8,0E-07**	8,5E-07*	-2,3E-07*	-3,9E-07*	-6,1E-07*	3,4E-06***	1,5E-06***	1,8E-06***	9,9E-07**	-2,8E-07*	-3,6E-07*
M-active	-5,5E-02*	-2,3E-01***	-7,0E-01***	5,7E-01***	4,5E-01***	-2,5E-02*	4,1E-01***	4,3E-01***	3,8E-01***	-1,0E+03***	-1,1E+03***	-1,0E+03***
M-retired	5,1E-02*	-6,0E-03*	-1,6E-01*	-6,5E-02*	-1,5E-01*	-2,8E-01**	2,0E-01***	2,8E-01***	3,2E-01***	-8,0E-02*	-1,4E-01**	-2,0E-01*
M-unemployed	-2,7E-01**	-4,3E-01***	-4,0E-01**	-8,3E-02*	-3,4E-01**	-2,9E-01*	3,6E-01***	3,7E-01***	5,1E-01***	-5,4E-01***	-4,6E-01***	-6,2E-01***
M-student	-5,8E-01***	-7,3E-01***	-7,8E-01***	-7,3E-01***	-9,7E-01***	-9,9E-01***	5,7E-01***	9,2E-01***	5,9E-01***	-4,2E-01***	-6,8E-01***	-3,8E-01**
M-at home	-1,1E+03***	-1,3E+03***	-1,4E+03***	-1,3E-01*	-9,3E-01**	-8,6E-01**	1,4E-01*	7,9E-01***	5,2E-02*	-1,1E+03***	-1,2E+03***	-5,7E-01**
F-active	-3,2E-02*	-1,5E-01**	-3,3E-01**	5,0E-03*	-4,6E-02*	-1,6E-01*	6,0E-01***	6,1E-01***	5,2E-01***	-6,4E-01***	-7,2E-01***	-6,8E-01***
F-retired	-3,5E-01***	-4,3E-01***	-3,7E-01**	-1,3E-01*	-3,8E-01***	-5,0E-01***	9,9E-02**	2,9E-01***	3,0E-01***	-3,2E-01***	-3,4E-01***	-1,7E-01*
F-unemployed	-2,6E-01**	-2,5E-01**	-2,5E-01*	-2,9E-01**	-4,9E-01***	-2,3E-01*	3,9E-01***	4,2E-01***	2,9E-01**	-3,6E-01**	-1,7E-01**	-3,1E-01**
F-student	-5,3E-01***	-5,5E-01***	-8,0E-01***	-6,9E-01***	-9,4E-01***	-1,0E+03***	5,4E-01***	9,9E-01***	7,1E-01***	-3,8E-01***	-6,0E-01***	-4,8E-01***
F-at home	Category of reference											
Paris	4,23E-01***	3,14E-01***	3,23E-01***	-6,79E-01***	-8,98E-01***	-9,88E-01***	5,26E-01***	5,29E-01***	6,08E-01***	5,76E-01***	6,83E-01***	7,03E-01***
Inner circle	1,39E-01***	-4,70E-02*	1,17E-01**	-3,43E-01***	-4,81E-01***	-3,18E-01***	2,21E-01***	1,47E-01***	2,31E-01***	2,60E-01***	2,87E-01***	2,04E-01***
Outer circle	Category of reference											
Car ownership	3,86E-01***	4,17E-01***	2,46E-01**	1,94E+03***	1,75E+03***	1,80E+03***	-7,44E-01***	-6,73E-01***	-8,00E-01***	-8,04E-01***	-6,61E-01***	-7,54E-01***

Note: *t-student statistics ***p<0,0001 ** 0,0001<=p<0,05 * p>=0,05.*

Appendix 22. Estimation result of travel speed. Source: EGT result based calculation.

	average travel speed						average car travel speed						average transit travel speed					
	1983		1991		1997		1983		1991		1997		1983		1991		1997	
Constant	4,9E+03	***	5,3E+03	***	4,9E+03	***	1,2E+04	***	1,5E+04	***	1,1E+04	***	1,1E+04	***	1,1E+04	***	9,0E+03	***
Age	1,8E-01	***	3,9E-01	***	2,6E-01	***	1,5E-01	**	3,0E-01	***	2,7E-01	***	1,4E-01	***	3,9E-01	***	2,4E-01	***
Age^2	-2,0E-03	***	-4,8E-03	***	-3,2E-03	***	-1,6E-03	**	-4,0E-03	***	-3,4E-03	***	-1,6E-03	***	-4,5E-03	***	-2,8E-03	***
Income	2,4E-06	*	5,2E-06	**	1,1E-06	*	1,7E-06	*	3,8E-07	**	-9,8E-07	*	3,8E-06	*	3,4E-06	*	4,4E-07	*
M-active	5,9E+03	***	9,4E+03	***	6,2E+03	***	3,3E+03	***	5,7E+03	***	4,6E+03	***	2,6E+03	***	5,2E+03	***	3,2E+03	***
M-retired	8,6E-01	*	3,7E+03	***	2,1E+03	**	1,1E+03	*	4,0E+03	*	2,9E+03	**	9,3E-01	*	3,8E+03	**	1,3E+03	*
M-unemployed	2,4E+03	**	3,0E+03	**	1,9E+03	**	1,7E+03	*	2,7E+03	**	3,6E-01	*	1,2E+03	*	1,2E+03	*	1,0E+03	*
M-student	1,0E+00	**	2,7E+03	***	6,4E-01	*	8,0E-01	*	1,0E+03	**	1,3E-01	*	5,1E-01	*	1,7E+03	*	2,3E-01	*
M-at home	3,8E+03	**	4,4E+03	*	8,6E-01	*	3,9E+03	*	2,2E+03	**	2,1E+03	*	1,1E+03	*	4,7E+03	*	1,4E+03	*
F-active	2,9E+03	***	4,9E+03	***	3,3E+03	***	9,4E-01	*	1,7E+03	*	2,0E+03	**	1,5E+03	**	2,9E+03	**	1,5E+03	**
F-retired	7,1E-01	*	2,7E+03	***	1,8E+03	**	1,1E+03	*	2,9E+03	*	3,4E+03	**	5,2E-01	*	1,9E+03	*	5,7E-01	*
F-unemployed	2,8E+03	***	1,8E+03	**	9,2E-01	*	2,8E+03	**	2,1E+03	*	6,8E-01	*	8,0E-01	*	-3,9E-02	*	-2,9E-01	*
F-student	1,2E+03	**	2,4E+03	**	9,7E-01	*	1,1E+03	*	-3,3E-01	**	4,2E-01	*	-3,8E-01	*	1,8E+03	*	5,5E-01	*
F-at home	Category of reference																	
Paris	-6,0E+03	***	-8,4E+03	***	-7,0E+03	***	-6,5E+03	***	-8,3E+03	***	-7,4E+03	***	-7,3E+03	***	-1,0E+04	***	-7,5E+03	***
Inner circle	-4,3E+03	***	-5,9E+03	***	-5,2E+03	***	-5,3E+03	***	-6,3E+03	***	-6,1E+03	***	-5,6E+03	***	-6,6E+03	***	-6,2E+03	***
Outer circle	Category of reference																	
Car ownership	5,4E+03	***	4,8E+03	***	5,6E+03	***	2,6E+03	***	2,0E+03	*	2,6E+03	***	2,2E+03	***	1,8E+03	**	2,0E+03	***

Note: *t-student statistics ***p<0,0001 ** 0,0001<=p<0,05 * p>=0,05.*

Appendix 23. Estimation results of travel distance. Source: EGT result based calculation.

	total km/day						total transit km/day					
	1983		1991		1997		1983		1991		1997	
Constant	6,1E-01	*	-4,5E+03	**	-1,1E+03	*	-1,8E+03	*	-8,5E+03	**	-4,3E+03	*
Age	3,4E-01	***	9,3E-01	***	6,4E-01	***	2,4E-01	***	7,2E-01	***	4,4E-01	**
Age^2	-4,1E-03	***	-1,1E-02	***	-7,5E-03	***	-2,7E-03	***	-7,8E-03	***	-4,8E-03	***
Income	3,3E-05	***	2,3E-05	***	2,1E-05	***	2,7E-05	**	2,1E-05	*	1,6E-05	*
M-active	1,3E+04	***	2,2E+04	***	1,4E+04	***	5,5E+03	***	9,3E+03	***	6,3E+03	***
M-retired	2,2E+03	**	6,0E+03	***	3,8E+03	**	1,8E+03	*	4,0E+03	**	2,5E+03	*
M-unemployed	5,5E+03	***	8,4E+03	***	7,4E+03	***	3,7E+03	**	5,7E+03	**	4,7E+03	**
M-student	3,0E+03	***	9,3E+03	***	3,3E+03	**	4,4E+03	**	1,2E+04	**	5,5E+03	**
M-at home	3,2E+03	*	8,1E+03	**	1,5E+03	*	1,8E+03	*	1,0E+04	*	1,6E+03	*
F-active	7,0E+03	***	1,2E+04	***	8,4E+03	***	6,0E+03	**	1,0E+04	***	6,4E+03	**
F-retired	1,8E+03	**	4,6E+03	***	3,0E+03	**	1,3E+03	*	3,7E+03	*	2,4E+03	*
F-unemployed	3,9E+03	**	4,1E+03	**	3,1E+03	**	2,9E+03	*	4,5E+03	*	2,2E+03	*
F-student	2,9E+03	***	9,9E+03	***	4,8E+03	***	4,0E+03	**	1,2E+04	**	6,9E+03	*
F-at home	Category of reference											
Paris	-7,0E+03	***	-1,1E+04	***	-1,0E+04	***	-2,2E+03	***	-3,9E+03	***	-2,7E+03	***
Inner circle	-5,1E+03	***	-8,4E+03	***	-6,9E+03	***	-1,5E+03	***	-2,9E+03	***	-2,2E+03	***
Outer circle	Category of reference											
Car ownership	5,6E+03	***	5,2E+03	***	4,5E+03	***	-5,1E+03	***	-8,2E+03	***	-6,8E+03	***

Note: *t-student statistics ***p<0,0001 ** 0,0001<=p<0,05 * p>=0,05.*

Appendix 24. Concentration index of mobility indicators in comparison to income per person distribution. Source: EGT result based calculation.

Indicators of mobility	1983	1991	1997
Number of trips per day per person (all modes)	0.035	0.020	0.005
Number of trips by car per day per person	0.126	0.111	0.097
Number of trips by public transit per day per person	0.093	0.028	0.008
Number of trips by foot per day per person	-0.079	-0.100	-0.110
Distance travelled (km) per day per person (all modes)	0.125	0.096	0.092
Distance travelled (km) by car per day per person	0.168	0.155	0.155
Distance travelled (km) by public transit per day per person	0.102	0.041	0.013
Average speed (km/h) per day per person (all modes)	0.090	0.066	0.077
Average speed (km/h) by car per day per person	0.119	0.109	0.115
Average speed (km/h) by public transit per day per person	0.111	0.041	0.032

Appendix 25. Static contribution of factors to the concentration index of trip frequency per day. Source: EGT result based calculation.

Variable	All modes			Private car			Public transit			On foot		
	1983	1991	1997	1983	1991	1997	1983	1991	1997	1983	1991	1997
Age	31%	145%	1269%	8%	21%	43%	129%	714%	3600%	51%	66%	11%
Age2	-66%	-185%	-1481%	-20%	-32%	-60%	-105%	-571%	-3333%	-19%	-37%	12%
Income	77%	31%	123%	-3%	-6%	-10%	118%	196%	987%	-20%	6%	7%
M-active	-1%	-10%	-115%	11%	8%	0%	22%	68%	240%	30%	28%	23%
M-retired	0%	0%	-14%	0%	-1%	-3%	2%	13%	109%	0%	1%	2%
M-unemployed	2%	4%	23%	0%	1%	2%	-5%	-12%	-115%	-4%	-3%	-5%
M-student	16%	33%	148%	14%	18%	22%	-30%	-146%	-413%	-13%	-18%	-9%
M-at home	0%	0%	7%	0%	0%	0%	0%	0%	-1%	0%	0%	0%
F-active	-1%	-8%	-62%	0%	-1%	-4%	39%	111%	360%	23%	22%	17%
F-retired	-3%	-7%	-38%	-1%	-2%	-6%	1%	16%	117%	3%	3%	2%
F-unemployed	1%	2%	12%	1%	1%	1%	-3%	-10%	-52%	-2%	-1%	-2%
F-student	12%	25%	165%	11%	17%	25%	-23%	-154%	-547%	-9%	-15%	-13%
Paris	12%	13%	54%	-14%	-15%	-20%	29%	75%	373%	-18%	-16%	-15%
Inner circle	-1%	0%	-6%	1%	1%	2%	-2%	-3%	-45%	1%	1%	1%
Car ownership	26%	55%	121%	92%	90%	103%	-94%	-296%	-1467%	57%	48%	48%
Residual	8%	0.5%	-98%	2%	1 %	3%	23%	100%	200%	19%	18%	23%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Appendix 26. Static contribution of factors to the concentration index of travelled distance per day. Source: EGT result based calculation.

Variable	All modes			Private car			Public transit		
	1983	1991	1997	1983	1991	1997	1983	1991	1997
Age	58%	125%	163%	25%	35%	51%	120%	537%	2231%
Age2	-49%	-104%	-152%	-23%	-35%	-54%	-97%	-439%	-1923%
Income	44%	29%	38%	10%	3%	9%	110%	146%	562%
M-active	25%	32%	29%	20%	24%	18%	32%	73%	254%
M-retired	1%	3%	4%	0%	1%	1%	2%	10%	55%
M-unemployed	-3%	-3%	-6%	-1%	-1%	-2%	-6%	-10%	-68%
M-student	-6%	-14%	-8%	4%	4%	5%	-26%	-95%	-254%
M-at home	0%	0%	0%	0%	0%	0%	0%	0%	-2%
F-active	17%	21%	20%	4%	5%	6%	43%	95%	292%
F-retired	1%	3%	4%	0%	1%	1%	2%	11%	61%
F-unemployed	-1%	-1%	-2%	0%	0%	-1%	-3%	-5%	-25%
F-student	-5%	-15%	-12%	3%	4%	6%	-20%	-100%	-346%
Paris	-14%	-16%	-21%	-14%	-13%	-16%	-13%	-29%	-108%
Inner circle	1%	2%	5%	1%	1%	3%	1%	3%	28%
Car ownership	27%	22%	27%	71%	73%	73%	-73%	-188%	-769%
Residual	8%	17%	8%	-3%	3%	2%	32%	78%	147%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Appendix 27. Static contribution of factors to the concentration index of the average travel speed. Source: EGT result based calculation.

Variable	All modes			Private car			Public transit		
	1983	1991	1997	1983	1991	1997	1983	1991	1997
Age	52%	115%	116%	22%	37%	55%	30%	163%	269%
Age2	-42%	-105%	-109%	-16%	-37%	-55%	-25%	-139%	-244%
Income	6%	14%	3%	2%	0%	-1%	7%	13%	3%
M-active	20%	29%	22%	5%	8%	7%	7%	23%	28%
M-retired	1%	4%	4%	0%	2%	3%	0%	5%	6%
M-unemployed	-2%	-2%	-2%	-1%	-1%	0%	-1%	-1%	-3%
M-student	-4%	-9%	-3%	-1%	-1%	0%	-1%	-8%	-2%
M-at home	0%	0%	0%	0%	0%	0%	0%	0%	0%
F-active	12%	18%	13%	2%	3%	4%	5%	16%	14%
F-retired	1%	3%	4%	1%	1%	3%	0%	3%	3%
F-unemployed	-1%	-1%	-1%	-1%	0%	0%	0%	0%	1%
F-student	-3%	-8%	-4%	-1%	0%	-1%	1%	-8%	-6%
Paris	-21%	-24%	-25%	-11%	-10%	-12%	-20%	-41%	-66%
Inner circle	2%	3%	6%	1%	1%	3%	2%	4%	18%
Car ownership	44%	42%	57%	11%	8%	13%	14%	23%	50%
Residual	36%	20%	20%	83%	88%	86%	82%	49%	30%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Appendix 28. Dynamic contribution of factors to the concentration index of trip frequency per day. Source: EGT result based calculation.

	All modes		Private cars		Public transit		On foot	
	1983-1991	1991–1997	1983-1991	1991–1997	1983-1991	1991–1997	1983-1991	1991–1997
Age	-120,0%	-250,0%	-60,0%	-146,2%	-123,1%	-341,5%	123,8%	-540,0%
Age2	93,3%	270,3%	45,0%	176,9%	95,4%	439,0%	-104,8%	500,0%
Income	138,7%	-1,4%	13,5%	25,4%	84,6%	-92,7%	105,7%	14,0%
M-active	9,9%	27,0%	26,5%	70,6%	1,5%	4,9%	19,0%	-30,0%
M-retired	0,8%	5,0%	2,8%	15,6%	-2,8%	-22,0%	3,4%	15,0%
M-unemployed	-0,9%	-2,6%	-4,4%	-4,6%	-1,5%	25,4%	3,8%	-28,0%
M-student	-6,0%	-7,4%	-10,0%	-7,7%	20,0%	-48,8%	-38,1%	80,0%
M-at home	0,0%	-2,4%	0,0%	-3,7%	0,0%	0,3%	0,0%	-4,0%
F-active	8,1%	10,8%	6,3%	17,7%	7,7%	19,5%	19,0%	-30,0%
F-retired	3,3%	4,1%	9,1%	25,4%	-4,8%	-21,5%	5,2%	-5,0%
F-unemployed	0,4%	-2,0%	-1,5%	0,8%	-0,2%	5,9%	2,6%	-14,5%
F-student	-4,7%	-25,0%	-25,0%	-38,5%	33,8%	-9,8%	-36,7%	10,0%
Paris	11,3%	-1,4%	-5,0%	15,4%	9,2%	-34,1%	-9,5%	-10,0%
Inner circle	-1,6%	2,6%	-1,5%	-3,8%	-0,8%	12,1%	1,0%	6,0%
Car ownership	-13,3%	31,8%	105,0%	-7,7%	-6,2%	131,7%	14,3%	50,0%
Residual	-19,2%	40,7%	-0,7%	-35,6%	-13,1%	31,4%	-8,9%	86,5%
Total	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Appendix 29. Dynamic contribution of factors to the concentration index of travelled distance per day. Source: EGT result based calculation.

	All modes		Private cars		Public transit	
	1983-1991	1991–1997	1983-1991	1991–1997*	1983-1991	1991–1997
Age	-212,5%	-750,0%	-55,0%		-169,5%	-250,0%
Age2	170,8%	1000,0%	70,0%		140,7%	250,0%
Income	104,2%	-175,0%	60,0%		84,7%	-46,4%
M-active	-4,2%	100,0%	-10,0%		3,4%	-10,7%
M-retired	-6,3%	-32,5%	-5,6%		-3,2%	-11,4%
M-unemployed	-3,8%	65,0%	-4,0%		-2,7%	17,5%
M-student	23,3%	-140,0%	4,0%		22,0%	-21,4%
M-at home	0,0%	2,1%	0,0%		0,0%	0,9%
F-active	0,0%	50,0%	-9,0%		6,8%	3,6%
F-retired	-5,0%	-30,0%	-1,6%		-4,1%	-12,5%
F-unemployed	-2,3%	21,3%	-3,2%		-0,7%	3,9%
F-student	35,0%	-75,0%	-6,0%		35,6%	14,3%
Paris	-8,3%	100,0%	-20,0%		-1,7%	7,1%
Inner circle	-0,4%	-65,0%	1,0%		-0,3%	-8,2%
Car ownership	45,8%	-100,0%	50,0%		6,8%	82,1%
Residual	-36,5%	129,2%	29,4%		-17,8%	81,3%
Total	100,0%	100,0%	100,0%		100,0%	100,0%

Note: *concentration index of the corresponding variable does not change during this period.

Appendix 30. Dynamic contribution of factors to the concentration index of the average travel speed. Source: EGT result based calculation.

	All modes		Private cars		Public transit	
	1983-1991	1991–1997	1983-1991	1991–1997*	1983-1991	1991–1997
Age	-120,8%	118,2%	-150,0%		-49,3%	-211,1%
Age2	129,2%	-136,4%	220,0%		42,0%	233,3%
Income	-18,3%	-63,6%	17,1%		3,0%	47,8%
M-active	-4,2%	-18,2%	-20,0%		-2,9%	7,8%
M-retired	-7,8%	6,4%	-13,6%		-2,4%	2,2%
M-unemployed	-2,5%	-5,5%	0,0%		-0,6%	7,1%
M-student	10,8%	34,5%	0,0%		2,6%	-28,4%
M-at home	0,0%	-0,6%	0,0%		0,0%	1,3%
F-active	-4,2%	-18,2%	-7,0%		-1,7%	20,0%
F-retired	-5,9%	9,1%	-8,9%		-1,3%	3,4%
F-unemployed	-3,1%	-1,5%	-3,7%		-0,5%	-2,4%
F-student	8,3%	16,4%	-21,8%		6,2%	-16,7%
Paris	-12,5%	-27,3%	-20,0%		-7,2%	44,4%
Inner circle	0,4%	25,5%	1,0%		0,7%	-43,3%
Car ownership	50,0%	145,5%	47,0%		8,1%	-73,3%
Residual	80,5%	15,7%	59,9%		103,2%	107,9%
Total	100,0%	100,0%	100,0%		100,0%	100,0%

Note: *concentration index of the corresponding variable does not change during this period.

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