Deriving and Validating Performance Indicators
for
Safe Mobility of Older Road Users in Urban Areas

By

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Doctoral Thesis

Submitted in partial fulfilment of the requirements for the award of
Doctor of Philosophy of Loughborough University.

November 2013

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ACKNOWLEDGEMENTS

The completion of this thesis is down in no small part to the help and support I was lucky enough to receive from so many people. I am particularly indebted to my supervisor Dr Andrew Morris, whose advice and encouragement has been invaluable. My sincere thanks also go to the many other former colleagues at Loughborough University, UCL and Centro whose insightful comments (and tea-making skills) were such a help, including Dr Andrew May, Dawn Chambers-Smith, Dr Elizabeth Dodson and Katie Jeffers.

I should also like to acknowledge the practical and financial support of the Rackliff family, and especially my husband Toby, without which I simply could not have completed the work.

Finally I should like to thank all those friends who ever feigned an interest in the thesis, proof-read a chapter, re-paginated a section or just “cheer-leaded” from the sidelines. You know who you are.

ABSTRACT

This thesis derives and validates Performance Indicators for Safe Mobility for Older Road Users in Urban Areas. Performance Indicators are objective, auditable parameters, which when used as a set can provide additional information to decision-makers about the operation of the transport system.

Great Britain, in common with many countries across Europe has an ageing population. The proportion of older people who hold a driving licence and have the use of a car is also expected to rise, with future generations of older people travelling further and more frequently than previous generations. Older road users are already over-represented in traffic fatalities, particularly in urban areas. Measures to protect older road users from risk in traffic will be of crucial importance as the population ages. However, against this background the need remains for them to access key facilities such as shops, leisure activities and health care. Maintaining independent mobility is essential in maintaining mental and physical health.

Traditionally, outcomes-based measures such as accident or casualty figures have been used to monitor road safety. Techniques such as “hotspot” analysis have identified locations on the road network where accident numbers are high, allowing modifications to road infrastructure to be designed and implemented. Using outcomes measures alone however, it is difficult to ascribe improvements in accident or casualty figures to particular policy interventions. Moreover, the effect of road safety interventions on other related policy areas – mobility being one – is impossible to assess without access to detailed, disaggregated exposure data. To make fully informed policy decisions about infrastructure design and how it affects older users, a better understanding of the linkages between safety and mobility is required. Performance Indicators offer the possibility to look at these linked policy objectives within a single framework.

Focus group data was used in conjunction with the results of previous studies to identify the infrastructure features which present a barrier to older users’ safe mobility in urban areas. These included factors which increased risk, such as wide carriageways, complex junctions and fast-moving traffic, and factors which hindered mobility, such as uneven or poorly maintained pavements, poor lighting and traffic intrusion. A thematic audit of infrastructure in a case study city (Coventry) was undertaken, in order that the incidence of such infrastructure could be recorded. It was found that in many areas of the city, safe mobility for older road users was not well provided for, with the majority of locations having barriers to safety and/or mobility for both drivers and pedestrians.

The audit data was then used to calculate a set of Performance Indicators, presented via spider graphs, which describe the degree to which the infrastructure caters for the safety and mobility of older drivers and pedestrians. The spider graphs allow for easy comparisons between the different geographical areas, and also between the different policy areas, allowing policy priorities to be identified.

The calculated Performance Indicators were validated using case studies collected from the focus group participants. The case studies identified features that affected travel habits by causing a change of route or change of mode, providing evidence of the link between infrastructure design and safe mobility for older users. The results of the Performance Indicator analysis were then compared to accident figures, in order to identify differences between the two approaches, and to understand what policy implications would result from a monitoring framework that used Performance Indicators for safe mobility, rather than outcomes-based measures alone. One implication of the Performance Indicator approach is that it may identify different areas for priority action from those identified by accident or casualty figures. A location which does not have high accident numbers may nevertheless perform poorly on a Safety Performance Indicator measure. This is because older users who feel at risk make different route or mode choices to avoid the infrastructure, the lower accident rate being explained by lower exposure to risk. Conversely, measures to promote independent mobility for older users may increase their accident involvement, not because the environment becomes more risky, but because the exposure of older users to risk increases, because they are willing and able to walk or drive in an area they previously avoided.

The thesis concludes that infrastructure design does not currently cater well for the needs of older pedestrians and drivers, and that a framework which incorporated Performance Indicators could make more explicit the trade-offs between safety and mobility, and between different categories of user. This additional information would enable policy makers and practitioners to make more informed decisions about how to prioritise competing objectives in complex urban areas.

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CHAPTER 1: INTRODUCTION

1.1 Background and Introduction

Increases in the proportion of the population that is over 65 are predicted for many countries, including Great Britain. According to the Office for National Statistics

"A consistent year-on-year increase can be seen in the life expectancy of men and women. Men were estimated to live for a further 13.0 years at age 65 in 1981, rising to 17.2 years in 2006. Women have experienced a similar increase in life expectancy over this period with life expectancy at age 65 in 1981 of 16.9 years, increasing to 19.9 years in 2006….. Over the same period there have also been increases in the number of years that men and women at 65 in Great Britain can expect to live in good or fairly good health as measured by estimates of healthy life expectancy". (ONS, 2010) Coupled with this are increases in the proportion of the population holding a driving licence: In 2006, 63% of women and 81% of men in Great Britain held a full car driving licence. This compares with 29% of women and 69% of men in the years 1975 and 1976. (ONS 2008). According to O'Neill (2000) between 1965 and 1985 there was an increase of 200% and 600% respectively in the number of men and women drivers over 65 in the UK.

The number of older people is expected to rise, the proportion of those people who hold a driving licence and own a car is expected to rise, but it is also predicted that future generations of older people will be accustomed travelling further and more frequently than previous generations. (Brace et al, 2006). This suggests that designing measures which help people to continue to travel, whilst at the same time, ensuring that they are safe in traffic should be a policy priority.

In Great Britain in 2009, 1361 pedestrians and 623 drivers over 60 years old were killed or seriously injured. (Department for Transport, 2010). European data suggests that 19.2% of road fatalities in Europe in 2006 were aged 65 or over. Whilst the number of fatalities involving over-65s has fallen in recent years, as a proportion of total fatalities there has been no improvement. The European Transport Safety Council (ETSC) (2008) point out that whilst older people account for one sixth of European population, every fifth person killed in road traffic is aged 65 or over. In 2006, the biggest single group of road users amongst older fatalities was pedestrians. Table 1 (below) shows the proportion of older road user fatalities by road user type for Europe[1].

Table 1; Older road user fatalities by road user type

Road User Type	**Percentage of fatalities**
Pedestrians	38%
Car drivers	26%
Car Passengers	14%
Motorcycle/moped	5%
Others	17%

Source; ETSC, 2008

Compared to the overall population, older people have a lower share of fatalities on motorways and rural roads but a higher share on urban roads (Leitner et al, 2008) It is likely that this results from the relative lower mobility of older people, who are more likely than other age groups to be pedestrians. They are also more likely to have crashes at complex intersections and junctions (Hakamies-Blomqvist 2003).

Older drivers also have an increased risk of accident involvement per kilometre driven. According to data from the Netherlands, the fatality rate for car drivers is more than five times higher for the 75 years and older than for the average for all ages. (ERSO.2006)

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[1] This is for the countries which submit data to the CARE database. For details refer to

www.ec.europa.eu

Against this background, the need for older people to maintain access to key services remains. In addition to serving practical needs such as attending medical appointments and buying provisions, continued mobility is important to enable older people to access social activities, which in turn helps to prevent the isolation and loneliness that can lead to mental health problems. According to Clarke and Nieuwenhuijsen (2009), older people are particularly affected by physical barriers in the local environment, as a result of their declining mental and physical capabilities, financial pressures and social isolation. A number of important physical barriers exist, including heavy traffic, discontinuous or poorly maintained pedestrian facilities and noise. However, some features which are introduced in order to improve road safety may also act as a barrier to mobility for older users. Examples of this might include pedestrian guard rail and dedicated pedestrian crossing facilities, which may force pedestrians to walk further to cross the road; subways or under-passes, which usually involve a change of level via steps or a ramp, which could be problematic for mobility-limited older pedestrians; or roundabouts, which may be safer for the majority of drivers, but which are difficult for pedestrians to cross, and may be harder for older drivers to negotiate safely. The problem which this research addresses is how to determine the appropriate balance between the need to protect older people from traffic risk, and the need to provide for their continued independent mobility. Table 2, below, summarises some of the trade-offs between safety and mobility, and between drivers and pedestrians.

Table 2; Safety and Mobility trade-offs

	Safety Feature	Mobility trade-offs
Pedestrians	Guard rail Subways	Increased walk distances. Issues with personal safety (or the perception of it) Requires changes of level via steps or ramps
	Mobility feature	Safety trade-offs
Drivers	Roundabouts. Higher speed limits. Wider carriageways	Increased mental workload. Requires faster decision-making. Increased traffic complexity.
	Pedestrian safety feature	Driver mobility and safety trade-offs
Safety	Signalised crossings. Pedestrian-only lights phase.	Increased journey time. Increased traffic complexity.
	Driver mobility feature	Pedestrian mobility and safety trade-offs
Mobility	Higher speed limits. Wider carriageways. Merging traffic.	Increased difficulty with road crossing. Increased road crossing risk.

The degree to which road users are at risk when using the network is usually monitored using outcomes-based measures such as accident or casualty counts. These are useful for comparing safety for different categories of road user (children as opposed to adults, those in urban areas compared to rural), for comparing the risks to users of different modes (car occupants compared to bus occupants for example), and to assess changes in risk levels over time. However, except in cases where suitable, detailed exposure data such as time spent in traffic or distance travelled are available, outcomes measures cannot easily assess safety in conjunction with a broader range of factors such as levels of mobility. What this means in practice is that when accident totals fall, it is not always possible to determine the degree to which the fall can be attributed to an increase in safety (for example, through improvements to road or vehicle design, or better driving) and to what degree it is explained by a reduction in users' exposure (for example, accidents involving older pedestrians fall because fewer older people walk, or they walk shorter distances).

This research looks at older road users, as predicted increases both in their numbers and their desire to travel are likely to result in them becoming an important policy priority. The specific focus is on car drivers and pedestrians, as Table 1, above, shows that together these account for the majority of older road user fatalities, and on urban areas, as Leitner et al (2008) suggest that this is where older road users are most at risk. It is also where the services and facilities older road users need to access (shops, health care, leisure activities) are most likely to be concentrated. As outcomes-based measures such as accident or casualty counts require detailed exposure data, and thus cannot easily assess the impact of a broader range of factors (mobility being one of them), the potential of additional measures, called Performance Indicators to enhance understanding of the interactions between safety and mobility will be explored.

1.2 Historical Perspective

Traditionally policy-makers have used outcomes measures in order to frame targets for improvements in road safety. In 1987, the UK government made a commitment to reducing road accident casualties by one third by the year 2000. This commitment was followed in 2000 by "Tomorrow's Roads – Safer for Everyone", a series of similar targets, to be achieved by 2010, the headline targets being; a 40 per cent reduction in the number of people killed or seriously injured in road accidents, compared with the average for 1994-98; a 50 per cent reduction in the number of children killed or seriously injured; and a 10 per cent reduction in the slight casualty rate, expressed as the number of people slightly injured per 100 million vehicle kilometres.

This target-setting approach has also been used by the European Commission, which adopted a road safety action programme in 2003, based on the 2001 White Paper. The main objective to be achieved was a 50% reduction in the number of road fatalities. Progress against these targets is discussed in more detail in the following sections.

In 2011 the government published a new “Strategic Framework for Road Safety” (Department for Transport, 2011). Unlike the approach taken previously, this framework did not specify casualty reduction targets, the justification being that “overarching national targets or central diktat” constrain local authorities. Instead, a number of “key themes” was outlined, which included;

- Make it easier for road users to “do the right thing”
- Better education for children, learners and inexperienced drivers
- Tougher enforcement
- More local and community action

These more nebulous ideas arguably fit in well with the “Big Society” idea of the Conservative party’s 2010 election manifesto.

Previous casualty reduction targets have been set against a background of steadily falling fatalities. The number of people killed in road accidents fell by 17 per cent from 2,222 in 2009 to 1,850 in 2010, with the 2010 total being the lowest figure since national records began in 1926 (DfT, 2011)

In some respects the progress towards the targets has been impressive. However, there are a number of reasons for looking at supplementary ways of assessing the success of road safety. The aggregate statistics highlight an impressive fall in overall fatality figures, but they mask an enormous amount of detail. Camouflaged by the broad trends are changes in society, changes in personal habits, improvements in automotive engineering, and massive advances in the treatment of casualties. Possible explanations for the recent dramatic falls include current challenging economic conditions, which mean that people cannot afford to make as many journeys by car, or they make fewer leisure journeys because they cannot afford to participate in activities. In addition, two winters with several weeks of severe weather (2009/2010 and 2010/2011) may have contributed to falling traffic volumes (Dft 2011, http://www.dft.gov.uk/statistics/tables/rdc0301), which in turn result in fewer accidents.

All of these factors must be borne in mind when examining accident statistic because of the impact they have on people's exposure to risk in traffic. This will be discussed in more detail, but consider the following example which helps to illustrate some of the limitations of focusing solely on outcomes-based measures of road safety: Between 1987 and 1994 the number of children between 8 and 11 who were fatally injured as pedestrians fell from 2334 to 1474. However, according to Davies (1996), between 1971 and 1990 the proportion of 8 year olds allowed to walk to school unescorted fell from 80% to just 9%.

It is clear that some proportion of the reduction in child pedestrian fatalities achieved over this period could be due in part to a reduction in the exposure in traffic of children as pedestrians. This fall in walking has been accompanied by a corresponding increase in journeys to school by car. According to the DfT, National Travel Survey data supports the contention that children are now more likely than in the past to go to school by car. (DfT, 1998)

This increase in car-based school travel over the period may not have been an entirely positive thing. The increase in children travelling to school by car has been blamed for, amongst other things, poor air quality, traffic congestion, increases in obesity, poor concentration in children, and a reduction in personal mobility, independence and freedom. Advances in road safety may therefore be accompanied by less desirable changes in the traffic system (and indeed in society in general), which should be set against the improvements, in order for a full assessment of policy successes to be undertaken.

The example above illustrates how considerable progress can be made towards achieving a desirable policy objective (reducing child pedestrian casualties), but at the expense of other, arguably equally important ones (promoting physical activity such as walking and cycling and encouraging independent mobility.) In the case of older road users, physical activity has been shown to be important in helping to stay mentally and physically healthy for longer. Maintaining independent mobility is not only important for this reason, but is essential for those older people who do not have good networks of younger family or friends to rely on for transport. According to Siren, Anu et al. (2009) *"supporting older persons' mobility is a good way of supporting their independence in different aspects of everyday living. Independent mobility is... a means to achieve, maintain, and manifest many important dimensions of autonomous life"*

It is therefore desirable that some means be found of defining mobility and measuring the extent to which different policy options facilitate or hinder it. If the means by which safety is monitored were also capable of incorporating mobility, the trade-offs between these objectives could be explored, and more explicit decisions taken about the extent to which each should be promoted, and the related costs and benefits of different approaches.

1.3 Performance Indicators

A monitoring framework based on outcomes (casualties or accident totals) is not capable of incorporating wider policy objectives such as improved air quality or reduced traffic congestion. As a consequence it may result in an analysis which is over-simplified. Moreover, the framing of policy targets in terms only of accident or casualty totals could be likened to "driving using only the rear view mirror". In other words, of implementing policy that responds only to incidents in the past, rather than a proactive policy which aims to prevent undesirable consequences (such as accidents) occurring. According to Wegman (2003);

"We are not interested in screening of the roads for unsafety in the past, but for improvement possibilities in the future"

Outcomes-based measures also have limitations if a broader range of public health related policy objectives are considered to be as important as reducing casualties (for example, encouraging active and/or sustainable travel choices such as walking or cycling, preventing avoidable deaths from heart disease or asthma). They also give an incomplete picture, as a fall in casualty totals is difficult to ascribe to one particular policy intervention. Finally, by looking only at crash outcomes, one is analysing only the worst case scenario, and thus looking at relatively rare events. By looking instead at movements in elements of the traffic system, there is the potential to use a much wider range of information, and identify problems at an earlier stage. The design and implementation of interventions can then also be carried out earlier

An alternative (or complementary approach) that has therefore been suggested by the European Transport Safety Council (2001) is that of constructing and monitoring Performance Indicators (PIs). PIs are objective, auditable parameters, which, when used as a set, provide insights as to what is important, and provide usable information for stake holders (Dahlgren et al, 2005). In the context of road safety, indicators reflect factors which are causally related to crashes or injuries which can be used to describe the level of safety offered by the transport system.

Performance Indicators can break down the system into a number of components, such as presence and use of protective systems, vehicle speed and driver impairment. It is then possible to look at movement of one element in isolation. Performance indicators are thus especially useful for evaluating the success of policies to protect pedestrians, as they measure overall changes in the traffic system and do not depend on accidents occurring for conclusions to be drawn. As a result, they can be combined with other information (for example, the extent to which independent mobility for older road users is facilitated) to examine effects of policies on a broader range of objectives.

The European Transport Safety Council (ETSC), 2001, identified a number of reasons for developing and monitoring Performance Indicators for road safety. These were;

- Smoothing out of random fluctuations in crash or injury data, so that analysis can focus on underlying long-term trends;
- Minimising the effect of incomplete or inaccurate reporting of accidents and injuries;
- Identification of conditions that, despite being inherently hazardous, have produced no crashes so far (perhaps because of chance);
- A better description of the processes that lead to accidents.

One of the outcomes of this research will be a series of Performance Indicators. These will be compared with the more traditional approach of monitoring outcomes-based measures, in order to determine whether the suggested advantages of the performance indicator approach are realised and how significant they are.

1.4 Aims and Objectives

Against this background, the aim of this research is to explore the conflict that may arise between progressing road safety and facilitating continued mobility, specifically in the case of older road users.

The research aims to address the following research questions;

- What are the main safety and mobility issues which affect older road users in urban areas?
- Do analyses of the issues undertaken using a Performance Indicators approach offer a different perspective, for example, by identifying issues that are not apparent when outcomes-based measure are monitored, or by providing more detail about the underlying causes of the problem?
- Would an approach to road safety policy that was based on the calculation of Performance Indicators lead to changes in the design or implementation of urban transport policies?

The study will investigate the trade-offs between safety and mobility, and will explore the potential to progress both road safety and mobility by constructing and monitoring Performance Indicators. The specific indicators under consideration will aim to describe the extent to which the existing infrastructure meets the needs of older road user, by providing a safe and accessible road system. The analysis will focus on the safety issues encountered by older pedestrians and drivers in urban areas in Great Britain. As was discussed in section 1.1, older road users have a higher share of fatalities in urban areas and a lower share on motorways and rural roads. For this reason it was felt that urban areas were the appropriate environment on which to focus the work.

“Older road users” encompasses a number of sub-groups, including public transport users, pedestrians, cyclists, motorcyclists, car drivers and car passengers. The focus of this study will be car drivers and pedestrians. This is because journeys where the older road user is a car driver or pedestrian account for the highest proportion of journeys made by the over-65s, as is shown by figure 1, below.

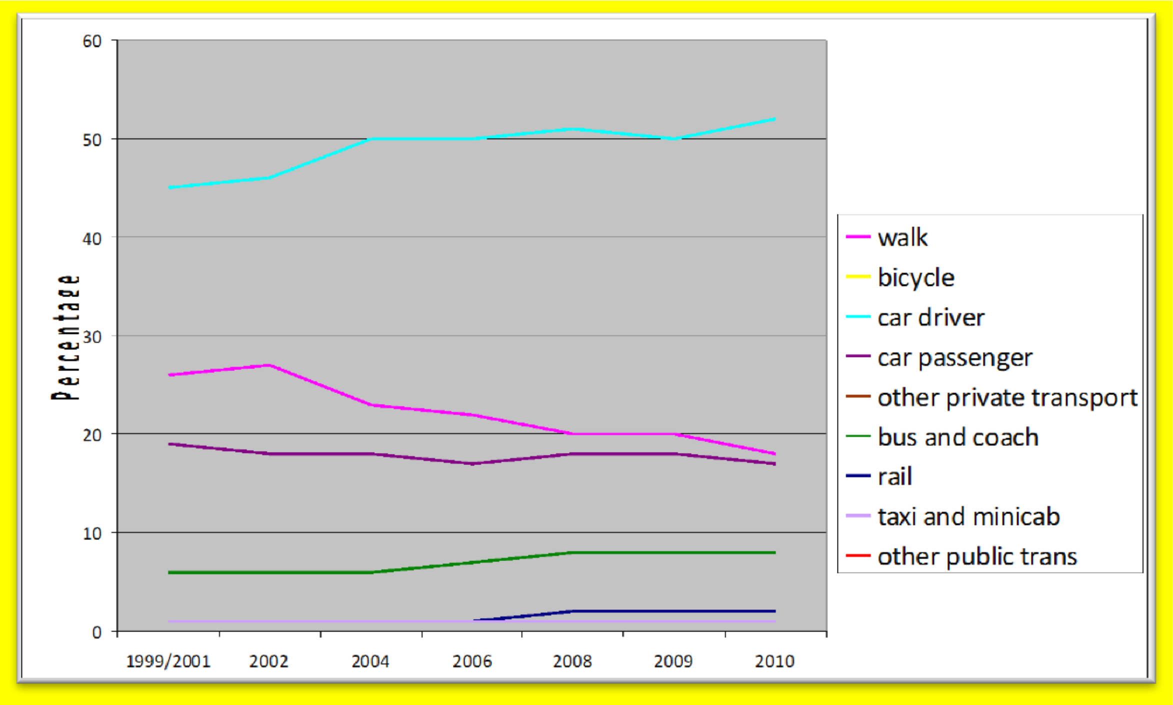

Fig 1; Trip Rates for older road users

Source; National Travel Survey 2009, DfT

Whilst there are significant issues relating to older public transport users, this category of older road user has been excluded from the analysis for a number of reasons;

- Earlier work (Brace et al, 2006) has indicated that many of the issues encountered by the elderly when using public transport relate to issues with the journey to and from the bus stop. At this point in their journey they are normally pedestrians, hence their needs can be considered along with this group.

- Other research indicates that many of the injuries that are sustained by bus passengers are a function of the design or operation of the vehicle, rather than resulting from aspects of urban infrastructure. For example, Halpern et al (2005) found that the majority of bus occupant injuries could have been prevented by modifications to the design of the vehicles' interior or by changing driving habits. Infrastructure modifications would not be expected to make a large contribution to reducing such injuries.
- Passengers, whether on buses or in other types of vehicle, are not "active road users". In other words, they are not directly interacting with the infrastructure and processing information in order to take decisions.
- Most fatalities involving bus occupants occur on rural roads (Albertson and Falkmer, 2004), whereas the focus of this research is urban areas.

For these reasons, it is not thought that Performance Indicators for infrastructure in urban areas would be particularly useful in addressing the needs of bus occupants, though factors such as location of bus stops and their proximity to features such as pedestrian crossings will be considered in relation to the needs of people walking to and from public transport interchanges. In the context of this work therefore, "Older road users" are defined as being older drivers and pedestrians.

Cycling currently accounts for very few journeys made by older road users in the UK. According to the Department for Transport (2009) cycling accounts for only 1% of trips for males aged over 60 and only 2% of trips for all ages, hence cyclists have also been omitted from the analysis.

The calculated indicators will be compared with casualty and fatality totals, in order to provide a more complete picture of road safety and its relationship to mobility than is possible using fatality and casualty figures alone.

The focus will be on indicators which measure infrastructure elements, rather than behavioural or legislative. The basis of the decision to focus on infrastructure, despite the known contribution to accidents of driver behaviour is set out in Chapter 2 below. Conclusions are then drawn about the effects on older road users' safety and mobility of past safety initiatives, and the potential priorities for future programmes. The main objectives are;

- To define in detail the key safety and mobility issues which affect older road users in urban areas.
- To explore the conflict that sometimes arises between the need to implement safety measures to protect vulnerable road users, and the desirability of promoting continued independent mobility for such groups.
- Based on the key issues defined, to calculate and validate a series of appropriate and relevant Performance Indicators for the safe mobility of older road users in urban areas in Great Britain.
- To evaluate the validity of using performance indicators in the context of safe mobility, and the relevance of the specific indicators proposed.
- To measure the success of past initiatives by reference to those key Performance Indicators (rather than in terms only of fatalities or casualties), and identify any significant differences between the conclusions suggested by the two different types of measure.
- To determine the extent to which the degree of success as measured using casualty outcomes differs from an assessment of success based on Performance Indicators.
- To make relevant policy recommendations on the basis of the research findings.
- To construct a framework for monitoring future performance using Performance Indicators.

It is hoped that the methodology which will be established and validated by this study could be used in the future as a complementary approach to the current strategy of framing targets in terms of casualty or accident totals. It will also provide an alternative way of assessing the effectiveness of past initiatives to improve road safety for the most vulnerable groups of road user.

CHAPTER 2: ROAD SAFETY, MOBILITY AND OLDER ROAD USERS

2.1 Introduction

This chapter has two distinct themes: Road Safety and Mobility. The aim of the first section is to cover some basic definitions about road safety; to look at what causes accidents and injuries, and at which counter-measures can be employed. The effectiveness of different approaches is discussed. The role of infrastructure in road safety is assessed in detail, and the effectiveness of well-designed and well-maintained infrastructure in preventing accidents and injuries is assessed. A critique of the effectiveness of different approaches to road safety is offered. The safety of older people in traffic is placed within the broader context of road safety, and the specific difficulties faced by older road users (both as drivers and pedestrians) are explored. Conclusions are drawn as to the appropriate infrastructure design to help to protect older road users from risk.

The second section examines the issue of mobility for older people, setting out its importance within the broader public health agenda and highlighting the complex interactions between peoples' environments and their well-being. Key terms are defined, and existing studies which aim to examine the way infrastructure influences the way people move around are assessed. The issue of potential conflicts between road safety policy and mobility is discussed. Conclusions are drawn about the role a well-designed traffic system can play in promoting mobility and well-being for older people, and about the methods by which these issues can be analysed.

Relevant literature was identified using existing knowledge, personal contacts and the “Web of Knowledge” database. From existing knowledge of the road safety field, key authors were identified, allowing authors who had cited the work of these researchers to be identified. For the mobility field, Mackett, Titheridge and Jones have all written extensively on the topic, again allowing others who had cited this work to be identified using “Web of Science”.

Additional research was identified via the Loughborough University catalogue, using relevant search terms including “road safety and ageing” and “ageing and mobility”. The “Web of Science” citation index was used as a guide to the importance of the material.

2.2 Road Safety Terms and Definitions

The main source of data on injury accidents in Great Britain is the Department for Transport’s “Stats 19” data. This is compiled from data collected at the scene of accidents, and includes fatal and injury accidents but not damage-only accidents.

Whilst official definitions of accidents and injury severity vary across different countries, in Great Britain, the statistics refer to personal injury accidents on public roads (including footways) which became known to the police. Figures for deaths refer to persons who sustained injuries which caused death less than 30 days after the accident. (www.dft.gov.uk)

A key source of compatible and comparable road safety data for Europe is the “CARE” database[2]. This is compiled from the national datasets of the individual

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[2] Community Road Accident Database of the European Commission, www.ec.europa.eu

member states, and also excludes damage-only accidents. Whilst definitions and data collection methods vary between countries, the CARE database does allow some Europe-wide analysis of accident and casualty data, and some limited cross-country comparisons.

In 2011, total fatalities in Great Britain were 1,901, a rise of 51 compared to 2010. This was the first rise in annual fatalities since 2003. (DfT, 2012)

According to Hakamies-Blomqvist (2003) there are no scientifically valid grounds for marking a specific point as the transition into older age. The changes that occur as part of the ageing process and their impact on driving ability will be explored in more detail in section 2.4, below. However, it must be recognised that individuals are affected by ageing in very different ways. According to the European Road Safety Observatory (www.erso.eu)

"using rigid age boundaries does not take into consideration the fact that ageing is a process that does not start at the same age for each and every individual, nor progresses at the same pace. There can be large differences in driving skills between people of the same age, as well as in their physical and mental abilities"

For the purposes of this research road users older than 65 years of age will be categorised as older road users. This is because of their relative increased susceptibility to injury compared to the average (Morris et al. 2003). It is also compatible with the age groupings used by commonly-used accident databases such as CARE, facilitating international comparisons of the problem. However, it is recognised that this categorisation is not ideal; between 65 and 74, the risk of involvement in a fatal accident is below that for both the 18 – 24 age group and the 25 – 29 age group. Only beyond the age of 75 does involvement in fatal accidents increase significantly, and even then it is considerably below that of the 18 – 24 group (Davidse, 2007). In addition, as life expectancy has increased, average remaining life expectancy at age 65 has increased, suggesting that a 65 year old in 2013 would enjoy better levels of health and fitness than a 65 year old in 1983.

2.3 Ageing and Traffic Risk

2.3.1 The scale of the problem

In Great Britain in 2010, adults aged over 65 accounted for 42% of all pedestrian fatalities, with 243 pedestrians over 60 being killed. Pedestrians and car occupants together accounted for the majority of fatalities amongst the over 65s; in 2007, 292 over 60s died as car occupants. (all figures from Dft, 2009) However, whilst the absolute number of older road users killed has reduced over the last 10 years, the proportion of total fatalities over 65 rose in Europe from 18.5% in 2004 to 19.2% in 2006 (erso.eu). The overall fatality rate is higher for those over 80 than for any other age group (DfT, 2011)

Compared to the overall population, older people are less likely to be killed on motorways and rural roads but are more likely to be involved in a fatal accident on an urban road (Leitner at al, 2008). It is likely that this can be explained by the relative lower mobility of older people, who are more likely than other age groups to be pedestrians. Older road users are also more likely to have crashes at complex intersections and junctions, such as those found in busy urban areas (Hakamies-Blomqvist 2003).

Older drivers also have an increased risk of accident involvement per kilometre driven. According to data from the Netherlands, the fatality rate for car drivers is more than five times higher for the 75 years and older than for the average for all ages. (ERSO.2006)

There are a number of reasons for focussing on the safety of older road users as opposed to any other group of road user. These include;

- Their likely increasing importance as a group. With an ageing population, meeting the design needs of older road users will become increasingly important in maintaining the reduction in fatalities seen in recent years.
- Their relative vulnerability compared to other road user groups. For those who rely on public transport, undertaking part of the journey by foot is usually unavoidable. For those who are still physically and mentally capable of driving themselves, infrastructure which is shown to be “safe” by conventional research can be the most problematic (Morris et al. 2003)
- The need to ensure that for those who can no longer drive (or elect not to) viable safe alternative transport options exist.

Many studies predict the increase in the numbers of older people, combined with their likely increased mobility will lead to large increases in fatalities involving casualties over 65. According to ETSC (2008);

“In the EU27 one road death out of five is aged 65 or over. In 2050 one road death out of three is likely to be an older person”.

According to Hakamies Blomqvist et al (2003) the challenges which relate to older drivers are becoming more prevalent. This is as a consequence of a number of trends, including the likely increase in the numbers of older women drivers, increases in the average annual distance travelled by older drivers, and an increase in the numbers of very elderly people who continue to drive. They state that;

“Older drivers are involved in significantly more fatal and serious injury crashes per kilometre…. And it is anticipated that this problem will increase as the proportion of older drivers in the population increases in the years ahead”

Lyman et al. (2002) say that

“among older drivers, police reported crash involvements are expected to increase by 178% and fatal involvements may increase by 155% by 2030. Drivers aged 65 and older will account for more than half of the total increase in fatal crashes and about 40% of the expected increase in all crash involvements; they are expected to account for as much as 25% of total driver fatalities in 2030, compared with 14% presently.”

The driver licensing system makes increases in the number of drivers over 65 easier to predict, and thus the estimation of increased accidents and casualties possible. The effect of an ageing population on pedestrian accidents and fatalities is less certain. Whilst increased licence-holding amongst the over 65s may result in a decrease in the importance of walking as a mode (and thus in falls in accident and casualty numbers), in Japan, which has the most rapidly ageing population in the world pedestrian fatalities are extremely high: 74% of pedestrian fatalities are aged over 60, and car users have the lowest share of fatalities amongst the over 60s (Kasuga, 2011). Oxley et al (1997) predict that increases in the numbers of older people in the population will naturally lead to increases in the number of older pedestrian accidents.

2.3.2 The ageing process and performance in traffic

There are a number of ways in which the ageing process may hinder performance in traffic. These are discussed in the following sections, beginning with a general discussion of the ways in which ageing can affect one’s ability to negotiate traffic safely, or can affect one’s risk of sustaining a serious or fatal injury. The specific safety issues encountered by older drivers and pedestrians will then be discussed.

2.3.3 Physical frailty

The magnitude of the effect that an ageing population with higher levels of mobility will have on fatalities may be unknown. However, it is known that older road users are more at risk of sustaining a fatal injury than the average road user, and much more so than the safest age group. According to Page (2007) elderly patients have a higher risk of fracture, especially to ribs and sternum, and in the case of Injuries resulting from road crashes, they have a hospital mortality rate double that of younger patients.

According to Fildes and Corben (2000)

“while older drivers have relatively few crashes, they are much more likely to be severely injured or killed given crash involvement”

Davidse (2008) concludes that the higher fatality rate of older drivers results from a slightly higher level of crash involvement and a much higher degree of physical vulnerability. Davidse goes on to state that older drivers are twice as likely to be injured as they are to be the cause of injuries to other road users. This is the opposite of the situation with regard to younger drivers, who are more frequently the cause of injuries to others.

2.3.4 Functional difficulties

In addition to their greater physical vulnerability, making them more susceptible to injury, deteriorations in certain elements of performance are associated with older road users experiencing difficulties in traffic. According to Brace et al. (2006) relevant functional difficulties which impair older road users’ ability to negotiate traffic include;

- Stiff joints and weak muscles making it difficult to turn to look, when crossing the road, or to apply force to the brakes or to manoeuvre a vehicle
- Deterioration in eye sight and hearing, loss of peripheral vision and medical problems such as glaucoma and cataracts
- Dulling of reflexes and reduced attention span, leading to increased reaction times and difficulty processing information

Age-related disorders include Alzheimer's disease and other dementia-type illnesses. Commonly occurring symptoms include;

- Memory loss
- Problems with language
- Disorientation
- Poor or decreased judgement
- Loss of initiative

All of which have potential implications for the ease with which sufferers can safely negotiate traffic (whether as drivers or as pedestrians). According to Fildes et al. (2000)

"Safe and efficient driving requires the adequate functioning of numerous abilities and loss of efficiency in any function can reduce driving performance and increase risk on the road. Unfortunately, as age increases, many abilities decline and health conditions become more common"

However, there are significant differences between the “younger” old drivers, for example, those aged 65 to 75 and the very elderly, such as those over 85. Cerrela (1985) found that only beyond the age of 85 do older drivers’ accident rates begin to match those of drivers under 25.

The ageing process leads to a number of changes in information processing capability. Sanders et al (2002) list the following key changes;

- A slowing of sensory-motor performance
- Increased disruption of working memory by a shift of attention during the time the material is being held there
- Difficulty in searching for material in long-term memory
- Difficulty in dealing with incompatibility

All of these have implications for how older users cope in complex traffic situations, especially in cases where there are;

- Large amounts of information (for example, high number of possible route choices, road signs or number of lane choices possible).
- Poor quality of information (for example, signage only visible when close to junctions, visual intrusion from buildings or vegetation, poor quality surface markings)
- Time pressure (for example short distance within which to make lane choices, no opportunity for individual vehicle drivers to select speed)

Fildes et al. (2000) states that complex traffic conditions lead to difficulty in making appropriate decisions for older drivers, because of the amount of information they must process and act on, and the time constraints placed on them.

Brace et al. (2006) looked at those human factors which are significantly correlated with driving performance. Sixty subjects took part in the study, and all were interviewed, provided details about their driving experience and accident records. Following this, their driving performance was measured by observing the number of errors made whilst driving a test route. One significant conclusion of the study was that older subjects take longer to perceive and respond to potentially hazardous situations. In addition, they adopted a smaller safety margin, largely as a result of this longer response time.

2.3.5 Medication

According to Holland (2001)

***"There is reliable evidence that certain prescribed drugs do increase the risk of road traffic accidents, especially for elderly drivers"*.**

Tranquilisers are cited as being particularly problematic for older drivers. The potential effect on driving performance may be greater for older than for younger drivers because of changes in the body's metabolism of drugs, existing reductions in cognitive ability, and a lower sensitivity to the effect of the drugs on performance. At older ages, as the number of chronic conditions and disabilities increases, so does the use of such medication (Millar 1998). According to Davidse (2007) nearly half of older adults suffer from more than one illness. This leads to an increase in the use of medication, and an increase in the risk of harmful interactions between different types of medication taken for different conditions (Hines and Murphy, 2007). These interactions are not always well understood due to the difficulty of separating the effect on performance in traffic of the condition from that of the medication. Interactions can involve both prescribed and over-the-counter medicines.

2.3.6 Errors

According to Davidse (2007), older drivers made a markedly high incidence of incorrect actions, especially at:

- Junctions regulated by traffic lights, where they ignored red lights more often (failed to notice), although driving through on yellow was observed less frequently;
- Right before left priority (this was a German study) where older drivers disregarded priority more often;
- Road-level railway crossings, where they failed to reduce speed adequately.

However, older drivers are less frequently involved in accidents where behavioural errors, alcohol impairment or lane-changing are involved (Davidse, 2007).

2.4 Older Pedestrians

Older pedestrians will, of course, be subject to the same physical manifestations of the ageing process discussed in section 2.4. However, these physical changes have different implications for the safety of pedestrians.

Review of the existing literature suggests two prime areas of concern regarding older pedestrians;

1) Road crossing behaviour
2) Walk speed

Older pedestrians' road crossing behaviour might render them more vulnerable to crashes because of declines in their physical, sensory, perceptual or cognitive abilities. According to Oxley et al. (1997) age-related perceptual and cognitive deficits may play a substantial role in many of the crashes involving older pedestrians. They state that;

“Reduced physical capabilities result in less mobility, and a reduced ability to move out of the way of approaching cars. Furthermore, their traffic judgements may be quite different to those of younger people because of perceptual, sensory and cognitive deficits”

As a consequence, it is important that infrastructure design should reflect these differences. However, Oxley et al suggest that facilities are built to the performance standards of younger adults. Whilst signalised crossing provision is “desirable” for older road users, as they are less able to perceive and respond to fast moving vehicles, it is much more problematic for older pedestrians to make lengthy detours to use them. In addition, their declining cognitive abilities make older pedestrians more likely than younger ones to become confused by complex junction layouts. As a result, they are overrepresented in intersection crashes (particularly those involving turning vehicles). They are also more likely to be involved in far-side (as opposed to near-side) collisions. This may be due to low walk speed (the far-side lane is clear of traffic when crossing begins, but is no longer clear when the far-side is reached) or to older pedestrians experiencing difficulties in simultaneously processing information about near-side and far-side traffic (Oxley et al)

Zegeer et al. (1993) found that they are also over-represented in crashes involving wide street crossings. Where there is a higher number of lanes to be crossed, risk also increases (Zegeer, and Bushell 2011).

The combined effects of low walk speed, difficulty processing near-side and far-side traffic simultaneously, wide street crossings and greater lane numbers may be why other studies including that of Oxley et al. (2004) have found that the use of median strips improves safety for older pedestrians.

It is not only the traffic conditions and road crossing that can cause safety issues for older pedestrians. Additionally, Oxley et al. (2004) point out that poor footpath condition, poorly designed kerbs, over-hanging foliage and poor signage all cause potential problems for older pedestrians.

Other site characteristics which appear to affect pedestrian safety include;

- High traffic volumes
- Greater numbers of pedestrians crossing
- The ration of traffic flow on the minor road compared to the major road
- Number of lanes to be crossed
- Presence of bus stops within 300m of the crossing

(Zegeer and Bushell, 2011)

According to Musselwhite and Haddad (2010). older pedestrians are much less likely than younger pedestrians to be involved in unsafe or reckless pedestrian behaviour. Older adults are more vigilant in looking for (and using) safe crossing locations. Despite this, they are more likely to be killed.

This can be attributed to 3 principle factors

- Pedestrian crossing intervals are inadequate for older pedestrians
- Turning traffic running during the pedestrian crossing phase
- Roadways are designed for speeds which are too high to safely accommodate either older pedestrians or older motorists

According to Retting et al. (2003) engineering modifications for pedestrian safety can be classified into 3 broad categories:

- Separation of pedestrians from vehicles: Whilst separation of pedestrian and vehicle flows may reduce the exposure of pedestrians to traffic risk, it may have other effects on people's ability to get around, and can introduce undesirable side-effects such as the community severance. This will be discussed in more detail in the context of mobility and older road users.
- Measures to increase the visibility and conspicuity of pedestrians: In many pedestrian crashes the driver reportedly does not see the pedestrian before the accident, therefore measures may be needed to increase the visibility and conspicuity of pedestrians.
- Reductions in vehicle speeds: Higher vehicle speeds are strongly associated with a greater likelihood of crashes involving pedestrians as well as more serious pedestrian injuries

The following sections look at existing work which aims to explain what causes road accidents, what relevance existing work has for older users, and how infrastructure modifications might influence accident involvement for older road users.

2.5 Infrastructure and road safety

Many attempts to outline general theories of accident causation focus on the interactions between the road environment, the road user and the vehicle. The "Haddon Matrix", as shown in figure 2, below is one such conceptual model, which can be used for the systematic exploration of road safety countermeasures. The matrix shows a pre-event, event, and post-event phase, and human, vehicle, and road environment factors. The matrix allows identification at each stage in the process of potential interventions to reduce injuries.

Fig 2; The Haddon Matrix

Source: Transport Safety Research Centre, Loughborough University.

A number of factors can affect driver performance, including alcohol consumption, drug-taking (whether illicit or prescription), fatigue and ill-health. Other driver-related factors include risk-taking behaviour and driver error. Vehicle factors include defects (though work by Sabey and Taylor (1980) suggests vehicle defects are not a major cause of accidents), and safety features. Safety features can be active or passive. Passive safety features operate in the “crash” phase of an accident and are those that afford protection to the occupants in the event of a collision. These include; air bags, seat belts, and energy-absorbing crumple zones. One increasingly high-profile rating of passive safety for consumers is the EuroNCAP testing programme, which was established in 1997 and which performs a variety of crash tests in order to provide consumers with information about the safety performance of different makes and models of car (http://www.euroncap.com). Active safety systems operate in the pre-crash phase in order to reduce the likelihood of accidents occurring. These include Electronic Stability Control systems and anti-lock braking. In the post-crash phase elements such as e-Call, a device that enables vehicles to send data directly to the emergency services following a crash might offer further potential for casualty savings. Improved trauma care is also thought to offer some possibilities; In a review of 1970-1996 data from a number of OECD countries between 5% and 25% of the reductions in road crash fatalities may have been due to improvements in medical care and technology. (Noland anandd Quddus, (2004))

Sabey and Taylor (1980), who looked at 2130 accidents, and categorised each according to whether the road environment, driver or vehicle was primarily (or partly) to blame for the crash. Their research indicated that driver error was a factor in the majority of accidents.

In terms of human and road environment factors, Sabey and Taylor estimated that these were responsible (either singly or in combination) for 95% of accidents, with road environment factors usually being associated with a road user factor. In other words, faults with the road environment were usually also accompanied by road user errors.

Sabey and Taylor identified four types of environmental factors which lead to accidents, these are;

- Adverse road design (for example, poor junction layout)
- Adverse road environment (for example, poor weather, slippery surface)
- Inadequate furniture (for example, poor road signs or markings)
- Obstruction (for example, road works)

They conclude that whilst ultimately major advances in road safety would require modifications to road user behaviour, brought about either through legislation, education or training, in the shorter term, modifications to infrastructure would be likely to provide more immediate and cost-effective reductions in accidents.

They assessed the contribution to road accidents of the road-user, the vehicle and the road environment, and concluded that the potential for accident and injury prevention that each element afforded was as shown in Table 3.

Table 3; Potential for accident and injury reduction.

Option	**Potential percentage saving**
Road user and road usage	33%
Vehicle safety measures	25%
Low cost road environment remedies	20%

Source; (Sabey and Taylor 1980)

They conclude that *"influencing the road user is the most difficult safety measure to effect, but when it can be achieved it can be the most dramatic…. In the short term lowering of risks can be best achieved by application of low cost road engineering measures and some legislation."*

The following sections discuss features of infrastructure which may affect the safety of road users and ways of assessing infrastructure safety. The role infrastructure design can play in mitigating against older road users' risk in traffic is discussed.

2.6 Infrastructure design for improved safety

The role of infrastructure in contributing to, or helping to prevent accidents and injuries is twofold; firstly, complex infrastructure can lead to an increased possibility of road user error. Secondly, poorly designed infrastructure can contribute to the severity of outcomes once an accident occurs. The focus of this work is the interaction between the road user and the road environment. Road user error is known to be a significant causal factor in road accidents, hence this section describes the ways in which good infrastructure design can help to minimise road user error.

2.6.1 "Sustainably safe" infrastructure

The implementation of the "sustainably safe" approach in the Netherlands has also led to an increasing focus in that country on the importance of good infrastructure.

“Sustainable Safety” acknowledges that human error plays a “vital role” in road crashes (Wegman et al. (2005)) but works towards preventing those errors using road planning, design and the improvement of existing roads.

According to Wegman et al,

“A sustainably safe traffic system has an infrastructure that is adapted to the capabilities and limitations of humans through proper road design”

Sustainable Safety infrastructure design focuses on three principles;

- Functionality
- Homogeneity
- Predictability

Functionality means that actual use of infrastructure matches intended use. Each road can fulfil only one function; through road, distributor road, access road. A distributor road may not, therefore, provide direct access to houses or businesses.

Homogeneity is intended to avoid vehicles with different characteristics related to speed, driving direction and mass from sharing infrastructure, and where this is not possible, to force motorised traffic to drive slowly.

Predictability should ensure that road users are familiar with the behaviour required on different road types, and what they can expect from other road users.

One limitation of this approach is that it may not always be practically possible for roads to fulfil only one function. In cases where main through-routes pass through shopping or residential streets, the implications for network capacity of limiting motorised traffic to 20mph could be significant.

The “sustainable safety” approach to infrastructure design does not cater well for roads which perform an important function for more than one road user type. This problem was addressed by the work of Jones (2010) who developed the “Link and Place” approach, where Links are important for through movement of traffic (including public transport, goods vehicles and local traffic) and Places are important for people shopping, sitting down, parking and loading. Each road can thus be allocated a ranking according to how important each of these functions is. Roads which are important for through movement of traffic can be planned accordingly with parking restrictions and curbs on pedestrian crossing opportunities (for example). Streets which are important destinations where people will shop or enjoy other leisure activities have lower speed limits and greater provision of seating.

In cases where a location is an important Link *and* Place, Jones argues that the approach should be one of balance and integration of the two functions, rather than a focus on traffic throughput, which he believes is what has happened previously.

2.6.2 Infrastructure and vehicle speeds

Infrastructure design can be used to influence specific aspects of road-user behaviour, for example, in the context of speed, where changing the feedback the driver receives from the road environment can change his or her perception of the appropriate speed. The contribution of speed to both the occurrence and severity of accidents is a phenomenon that has been widely discussed in the literature. According to West (1998)

"The role of speed in accidents and in seriousness of injury is incontrovertible"

Higher speeds reduce the time available to a driver in which to observe potential hazards developing, limit the reaction time available, and are likely to increase the severity of accident consequences. This may be of particular importance to older drivers, whose increased reaction times and potential difficulties in processing information are discussed in greater detail in section 2.7, below.

Table 4, below, shows the DfT's estimates for the extent of driving more than 5mph in excess of the limit in urban areas.

Table 4; Estimates of excess speed in urban areas

	Motorcycles	**Cars**	**Light goods**	**Buses/coaches**
% >35mph in 30mph limit	24	22	23	8
% >45mph in 40mph limit	19	10	11	3

Source; Transport Statistics Great Britain, 2005

Excessive vehicle speed in urban areas has particular implications for pedestrians, as a result of greater vehicle stopping distances with higher speed, and higher risk of fatal injury when a collision occurs (Zegeer and Bushell (2011)). According to the DfT[2] (2006)

"if a pedestrian is hit at:

• 20mph there is about a 1 in 40 (2.5 %) chance of being killed
or 97% chance of survival….

• at 40mph there is about a 9 in 10 (90%) chance of being killed or
10% chance of survival,"

The consequences of higher speeds are particularly significant for older pedestrians, who are at greater risk of sustaining a fatal injury than the average road user, and much more so than the safest age group. According to Page (2007) elderly patients have a higher risk of fracture, especially to ribs and sternum, and in the case of injuries resulting from road crashes, they have a hospital mortality rate double that of younger patients.

Dumbaugh (2008) identified a number of infrastructure features which are correlated with higher speeds, and are also associated with increases in fatal crashes. These included lane width, number of lanes and lack of on-street parking. On-street parking increases the accident risk for child pedestrians by "hiding" them from drivers, and for cyclists, as a result of vehicle occupants opening the vehicles' doors in their path. However, it appeared to provide what Dumbaugh describes as "friction" which has the effect of slowing traffic and thus helping to protect adult pedestrians.

Dumbaugh concludes that some design features introduced for road safety – such as wide lanes, and obstacle-free zones at the side of carriageways – have a negative impact on road safety by giving drivers the wrong message about what constitutes a safe and appropriate speed.

2.6.3 Task difficulty, mental workload and infrastructure design

Task difficulty measures the incompatibility between the workload on the driver and the driver's capabilities (Davidse, 2007). The main elements of task difficulty are illustrated in figure 3, below.

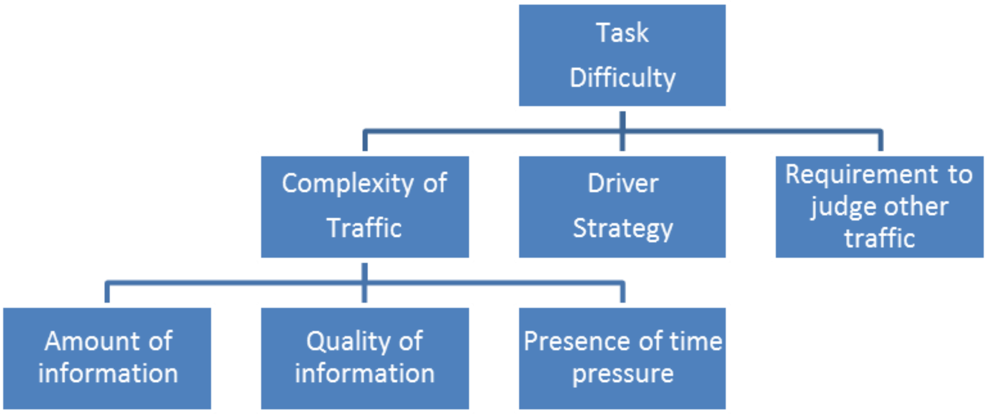

Fig 3; Elements of Task Difficulty

Source: Davidse, 2007

As can be seen, task difficulty arises out of a combination of environmental features, other road users' behaviour, characteristics of the vehicle and its speed and position on the road.

According to Fastenmeier and Gstalter (2007) the match between the car driver's capabilities and the demands of the driving task are important, because this is what determines the outcome in terms of more or less safe driving behaviour.

According to Green (2001) there are 4 commonly cited categories of measurements to assess the demands of driving. They include:

(1) Primary task performance (e.g., standard deviation of lane position),
(2) Secondary task performance (e.g., response time to a light inside the vehicle),
(3) Physiological measures
(e.g., heart rate variability), and
(4) Subjective techniques (e.g., workload ratings).

Primary task measures can be problematic, as (assuming task demands do not exceed capability) performance on different tasks could be identical, whilst one task could still be more complex. In addition, it is difficult to compare the task demands of tasks that are not similar.

The logic underpinning ***secondary task performance*** as a way of measuring task difficulty is that any spare resources not directed at the primary task can be directed towards the secondary task. As the primary task makes greater demands for resources, fewer will be available for the secondary task, and as a consequence, performance on that task will suffer. In order for such tests to be effective it is necessary for both tasks to tap the same resources. However, that being the case, it is then inevitable that performance on the two tasks will be linked, and it can be difficult to determine whether it is the difficulty inherent in the primary or the secondary task that is being measured.

Physiological measures of task difficulty presume that information processing requires central nervous system activity, and that this activity will be reflected in physiological elements such as heart rate variability or pulmonary response. Such measures offer advantages in that they can be taken continuously without interfering with the performance of the primary task. However, the equipment required to do this may be complex and bulky.

According to Fuller (2005) ***subjective measures*** of complexity can be undertaken in two ways; using an *engineering measure*, such as number of traffic signs, number of junctions, number of traffic movements permitted, or by using as *psychological measure*, such as success performing a secondary task. However, measuring by using secondary task performance does not necessarily show the complexity of the traffic as much as the driver's adaptation to it.

There is no universally accepted definition of mental workload, but at its simplest level, workload can be defined as being the demands placed on the person (De Waard and Brookhuis, 1997). However, it should not be thought of as being entirely external, as is implied by this definition: Workload is also determined by factors unique to the individual who is engaged in a task. For example, their familiarity with the task, any strategies they may have developed to assist with it, but also, other variable factors such as their mood at the time and their mental state (fatigued, impaired etc). For this reason, De Waard distinguishes between *"Demand",* which is determined by the goal that has to be attained, and "*Load* or *workload"* which describes the effect the demand has on the operator in terms of information processing. Using this distinction, it becomes possible to see how the same demands will not necessarily result in the same workload for all individuals.

In the case of Complexity of Traffic, the following variables could be considered as possible indicators;

- **Amount of information;** number of possible route choices, number of road signs, number of lane choices possible, lane choices available per route choice, presence of at-grade pedestrian facilities, presence of signals.
- **Quality of information;** distance from which signage is visible, presence or otherwise of visual intrusion from buildings or vegetation, quality of surface markings.
- **Presence of time pressure;** distance within which lane choices must be made (with reference to speed limit), degree to which individual vehicle drivers can select speed (rather than merging with flow, hence having it dictated by other vehicles' movements)

For driver strategy examples include; the possibility to lower speed, to change trajectory, or to change route. The requirement to judge conflicting vehicle movements is determined by the presence of conflicting vehicle flows uncontrolled by signals.

There are a number of theories which are useful in any assessment of mental workload. One of these is capacity. Capacity can be defined as *“the maximum or upper limit of processing capability”* (Wickens, 1992)

According to Elvik (2006);

- The more units of information per unit of time a road user must attend to the higher becomes the probability that an error will be made.
- The more cognitive capacity approaches its limits the higher the accident rate.

Both of these “laws” of accident causation are affected by infrastructure design, and the amount and quality of information provided to road users. As section 2.3 demonstrated, the changes which occur naturally as part of the ageing process have an effect on the processing of information and on individuals’ cognitive capacity. As a result, complex traffic and infrastructure which results in a high mental workload has a bigger impact on older drivers than on the average. Modifying infrastructure which imposes a high workload on drivers is thus one of the ways in which infrastructure could be designed to accommodate the specific needs of older road users . The following sections discuss ways in which infrastructure can be assessed, in order to determine the degree to which it meets the needs of users.

2.6.4 Infrastructure management tools for road safety

According to Elvik (2010) there are a number of safety management tools which enable roads authorities to assess infrastructure safety. These include;

1. Road safety audits, described as “a systematic assessment of plans for new road schemes, intended to ensure that new roads have the lowest attainable accident potential for all kinds of road users.”

2. Road safety inspections, defined as “road safety audits applied to a road that has already been constructed and open to traffic for some time.” The aim of road safety inspections is to identify features which may cause a problem, but which have not yet become apparent through the occurrence of accidents, or to identify new problems which have been caused introduced by changes to the infrastructure or how it is used.

3. Accident modelling: Accident modelling generally uses advanced regression techniques to identify factors which explain the variations in accident rates across different parts of the network.

4. Road protection scoring; this is a way of assessing how “forgiving” a road is. The methodology involves recording road features that are relevant to safety along a road, and assigning a score that reflects the risk posed.

5. Identification and analysis of hazardous road locations; this is sometimes referred to as “accident hotspot analysis” and involves the in-depth analysis of clusters of accidents.

6. Impact assessment of investments and road safety measures: This is the process by which the expected effect on accidents of remedial road safety measures is estimated.

7. Monitoring of road user behaviour: As has been stated, road user behaviour is known to be one of the key factors in determining accident causation. As a result, monitoring is thought to be useful in determining appropriate counter-measures. Commonly-monitored factors include speed, use of protective systems, impaired driving (Elvik (2010))

8. Conflict studies and naturalistic driving: Recent advances in software and video analysis techniques have allowed more detailed study of conflict (situations where collisions would occur if road-users do not adjust their speed or trajectory) and of how road-users behave in conflict situations.

9. In-depth analyses of accidents: In-depth accident studies supplement accident national accident datasets, which do not always have the necessary level of detail for robust scientific analysis of accidents.

The following sections discuss the suggested methods of identifying infrastructure which might be suitable for modification to promote safety (i.e. 1 – 4) in order to identify a suitable methodology for assessing the degree to which the infrastructure in the case study city caters for the needs of older road users. A number of other studies which look at the safety of infrastructure are also presented.

Road Safety Audit can be thought of as a standardised procedure to improve the design of new roads. It is intended to be preventative in nature, highlighting potential issues before infrastructure is available to users, rather than reacting to accidents once they happen. One method of evaluating the impact of Road Safety Audits is to compare the accident rates on audited roads to those on roads which have not been subject to audit.

SWOV (2009) discuss one example of a study which aimed to do this, finding that whilst some studies have suggested Audits can provide a small return, this cannot be proved for all schemes. They conclude;

"In general, however the costs of an audit and the resulting modifications to a road scheme tend to be quite small. Thus even accident reductions that are too small to be statistically detectable may provide societal benefits that are greater than the added cost"

In the specific context under consideration here, there is no new infrastructure to be considered, hence Road Safety Audits of the type described are of limited relevance. However, it should be borne in mind that any proposed major modifications to the assessed infrastructure would be subject to auditing. The Parliamentary Advisory Council for Transport Safety (PACTS) has recently suggested that infrastructure should be subject to a "health check" which examines its suitability for older users. (PACTS, 2012) Should this be adopted, consideration for the needs of older road users could become an integral part of the road safety audit process.

Road Safety Inspections are Audits which are performed on existing road infrastructure. This may be done in a thematic manner, in order to look for specific safety factors. Fildes et al. (2000) undertook Road Safety Inspections, specifically to address the issue of infrastructure design for older road users. The methodology involved first highlighting locations where clusters of accidents involving older drivers could be identified. A procedure was then developed to investigate the role of road features in those crashes. In total 12 sites were selected, at which 78 older driver crashes had occurred. Almost all of the sites (11 out of 12) were at intersections, all of them at-grade. A check-list of features for the inspection was developed using existing audit practices, and was refined further through reference to relevant literature.

Using this methodology, a number of factors which increased difficulty for older drivers was identified. These included; complex roundabout design where wrong lane-choices were difficult to correct, problems with safe gap selection, due to the need to simultaneously check for signals, signage and on-coming traffic, junctions where merging was made difficult for older drivers because of issues with peripheral vision and restricted head/neck movement.

The authors acknowledge a major limitation in using accident data to select sites for inspection: Firstly, it may be important to know whether the older road user was at fault in the accident, or was simply a casualty of it. Secondly, there may be other sites with similar issues for older drivers at which no accident problem has been identified, either because of “chance”, because of the role of older people’s exposure to traffic risk at those sites, or because of the possibility for road users to adopt coping strategies when faced with difficulties at other locations. Nevertheless, the study established the possibility of using inspections of infrastructure as a means to improve safety for older road users.

Accident modelling generally uses advanced regression techniques to identify factors which explain the variations in accident rates across different parts of the network. This information can then be used to select suitable sites for remedial engineering works. One advantage of modelling the occurrence of accidents, rather than using only outcomes data about the location of accidents is that the effect of "Regression to the Mean" can be accounted for. Regression to the mean can be explained thus; because of the random nature of accidents, the mean frequency of accident occurrence is not known. When it is directly estimated using accident occurrence, further accidents are likely to occur at a rate closer to the true (but unknown) mean. This means that sites selected for remedial work on the basis of an apparently high accident frequency are likely to experience a lower rate when further measures are taken, even if no remedial work is undertaken. Statistical models can use a wider range of information to identify suitable sites for treatment, and provide a method by which the effect of regression to the mean can be estimated and accounted for.

One method widely applied to road accident modelling is Bayesian Analysis. This was the approach used by Heydecker and Wu (2001), who proposed four different criteria for site-selection, based on Bayesian analysis. The results of the analysis showed that different approaches yield different results in terms of which sites should be the priority for remedial action.

Measuring the safety performance of road infrastructure is a surprisingly new concept. One high-profile project which aims to do this is “EuroRAP”. “EuroRAP” is a sister program to EuroNCAP, described in section 2.4. The formal objectives of EuroRAP are to:

- reduce death and serious injury on European roads rapidly through a programme of systematic testing of risk that identifies major safety shortcomings which can be addressed by practical road improvement measures;
- ensure assessment of risk lies at the heart of strategic decisions on route improvements, crash protection and standards of route management; and
- to forge partnerships between those responsible for a safe roads system - motoring organisations, vehicle manufacturers and road authorities.

According to John Dawson of EuroRAP;

“Until EuroRAP there were no internationally recognised standards for governments, consumers or engineers to measure the safety of the roads we use every day. Roads were assumed to be safe if they met the engineering standards of the time when they were built…. There are thousands of road sections across Europe where road-users are routinely killed and maimed for want of simple, affordable safety

features… These programmes have some of the highest returns available anywhere in the European economy”

(EuroRAP Chariman’s Message, 2006)

EuroRAP assesses road infrastructure using three measures;

- Risk mapping
- Performance tracking
- Star rating

Risk mapping uses accident and injury data to map those roads at which users are at highest risk. Roads with similar levels of traffic flow can be compared, for example. Performance tracking looks at how risk changes through time, identifying high risk routes where rates are improving, and helping to identify those measures which are most effective.

The star rating differs from the other measures, as unlike risk mapping and performance tracking it does not use outcomes-based measures such as accidents or fatalities as the basis for the calculation.

The star rating describes how well roads protect the user from death or injury when an accident happens. The assessment evaluates the safety that is 'built in' to the road design. This is done through an audit of the infrastructure which identifies safety features and hazards in the road environment. This is thought to be particularly useful where accidents are rare and thus statistical analysis of outcomes measures is not possible. The potential advantages of not using outcomes-based measures for road safety policy were discussed in section 1.3.

One limitation of road protection scoring is that the derived measure should be independent of other factors (such as user behaviour and vehicle safety features). However, as has been stated, interactions between the road user and the environment can influence user behaviour. One example of this might be drivers selecting higher travel speeds on roads where they “feel safe”.

According to Elvik (1997) a number of studies from different parts of the world have reported large reductions in the number of accidents when safety measures are introduced at accident hotspots. However, in order to accurately evaluate the effectiveness of such treatments, it is necessary to account for the effect of several confounding factors. These include regression to the mean, which has already been discussed, but should also include changes in traffic volumes, changes in general accident trends and accident migration (whereby accidents may increase at nearby untreated sites). Elvik concluded that the results of before and after studies of road accident hotspot treatment depend strongly on which of the possibly confounding factors are controlled for. Moreover, he concludes that

> “the more confounding factors that a study controlled for, the smaller were the effects attributed to blackspot treatment. Studies simultaneously controlling for general trends, regression to the mean and accident migration did not find any statistically reliable effects of .. treatment on the number of accidents”

This might suggest that hotspot analysis as a means of identifying suitable sites for infrastructure modification may have some limitations.

Thematic road safety inspection has many advantages as a method for collecting suitable data for the calculation of safety performance indicators for older road users in urban areas. These include;

- It can be applied to existing as well as new infrastructure.
- Unlike modelling, hot-spot analysis and risk mapping it is independent of accident and injury rates.
- It does not require complex or expensive data collection.
- It can incorporate as many or as few factors as are relevant to the issue under consideration.

The appropriate factors a thematic inspection for older road users' safety should cover can be determined on the basis of the factors already discussed which describe how the ageing process causes difficulties in traffic.

2.7 Designing for Older Road Users' Safety

There are a number of issues which should be given special consideration when implementing road safety measures with the older road user (ORU) in mind.

Infrastructure which is generally considered to be less risky for the “average” road user may be more problematic for older road users. For example, roundabouts are known to be generally safer for motorised vehicles than other junction types with conflicting vehicle movements, regardless of whether or not those junctions are controlled by some form of traffic management. However, there is some evidence that their use poses additional problems for older drivers by increasing the mental workload and the complexity of decision-making required (Schieber, 2004, Federal Highway Administration, 2000)

With regard to these changes, the following are suggested as design criteria for information processing tasks for the elderly (Sanders et al. 2002)

- Displayed signals should be louder, brighter and stronger
- Controls and displays should minimise irrelevant details that could act as noise
- Time should be allowed between the execution of a response and the signal for the next response
- More time should be allowed to practice and initially learn material

Factors such as reduced peripheral vision, lengthened reaction times and poor visual acuity have been shown to result in a higher level of workload than that experienced by other drivers. According to Dewar et al (1997) older users can experience a marked loss in sign legibility distance with reduced lighting, which is exacerbated by the introduction of glare (such as car headlights). According to Benekohal, et al. (1994) other difficulties older users are likely to encounter include;

- Difficulties with reading signs
- Difficulties following pavement markings
- Difficulties responding to traffic signals

As a consequence it is suggested that

- road signage should be large, graphic and as clear as practicable
- Signs should be placed to enable them to be seen early
- Longer amber times in signal settings would allow older drivers longer to see and respond to the signals before a potential conflict situation arises.
- Older drivers are more likely to make mistakes if they have to yield to other drivers, hence signal settings which do not additionally require traffic running on green to yield (for example, when turning right whilst opposing straight on traffic is running) are preferred

Table 5, below summarises the main features which the examined literature suggests would aid older improve users' safety.

Table 5; Design features for older road users' safety

Safety Feature	**Group Benefiting**	**Rationale**	**Reference**
Clear, graphic signage	Drivers and pedestrians	Older road users experience marked loss in sign legibility.	Dewar et al (1997)(Fildes, Corben et al. 2000)
Time allowed between execution and next signal	Drivers	Reduces mental workload	Sanders et al (2002)
Reduction in vehicle speeds	Drivers and pedestrians	Increases the time older drivers and pedestrians have in which to perceive and respond to cues.	Retting et al (2003)
Provision of pedestrian-only phases	Pedestrians	Traffic running during the pedestrian crossing phase increases risk for older pedestrians.	Musselwhite and Hadad (2010)

Although human error plays a significant role in accident causation, infrastructure modification has been shown to be a factor which can help to reduce the incidence of error, and to help reduce the severity of the consequences when errors are made. The ways in which the ageing process makes certain infrastructure more problematic for older road users have been explored. A number of features of urban infrastructure have been shown to be problematic for older road users. These include;

1. Speed, which reduces the time available for both drivers and pedestrians to make judgements about the proximity and speed of other road users, and which increases the potential severity of consequences when an accident occurs
2. Traffic complexity, which adds to mental workload and increases task difficulty for older drivers and pedestrians, leading to increased likelihood of error
3. Roadway width, which increases vehicle speed and also increases risk for older pedestrians
4. Complex intersections

In addition to addressing those issues, other factors which have been shown to improve safety for older road users include;

- Clearer signage

- Median strips
- Unobstructed pavements

Older Road Users are not a homogenous group, and their needs and limitations vary according not just to age, but more importantly with their general levels of health. However, they are more at risk of being involved in a fatal accident than the average road user, especially as pedestrians and car drivers. They are expected to become an increasingly important group, due to the effect of an ageing society and changes in factors such as the number of older people holding driving licenses and their expectations about the level of mobility they should enjoy.

Not all of the factors identified as being problematic for older users can be directly linked to accident involvement; one explanation for this may be the compensating behaviours adopted by older drivers. One example of this is avoiding routes along which problem infrastructure is encountered.

Many older drivers develop coping strategies to deal with their declining abilities, such as limiting their driving to roads they know and allowing more space between themselves and other cars. According to DfT (2001)

“Older people who believe they are performing less well modify their behaviour in ways that, on the face of it, ought to reduce accident risk. For example, many older drivers reduce night driving”.

The effect of compensating behaviour may be to reduce older road users' exposure to risk at the problem locations, which may in turn reduce their accident involvement. The effect of barriers to safe mobility on older users' exposure to traffic risk is explored further in Chapter 8. Performance Indicators may be a particularly useful way of monitoring the effectiveness of measures aimed at older road users, as this approach enables safety and mobility to be considered together, whereas outcome-based measures (number of casualties or crashes) consider safety in isolation.

Thematic infrastructure audit has been identified as an appropriate way of assessing the extent to which older road users' safety is catered for, as this is a method which can be applied to existing infrastructure, is independent of accident and casualty rates, and is relatively inexpensive compared to other methodologies.

The previous section has outlined some of the basic definitions relevant to the issue of road safety and older road users, looked at traditional approaches to the academic study of road safety, and how it has developed over time, and placed the road safety of older people within the broader context of road safety generally. The specific difficulties that older road users face in traffic have been explored and linked to previous policy measures, which may or may not be appropriate for addressing the needs of older road users. The following section looks at the issue of mobility for older road users in urban areas, setting out its importance within the broader public health agenda and highlighting the complex interactions between peoples' environments and their well-being. It draws together the policy objectives of protecting older road users from traffic risk whilst at the same time promoting continued independent mobility. The issue of potential conflicts between road safety policy and mobility is discussed. Conclusions are drawn about the role a well-designed traffic system can play in promoting mobility and well-being for older people, and about the methods by which these issues can be analysed.

2.8 Mobility Terms and Definitions

In much existing literature, the terms mobility, accessibility and usability are often used interchangeably. The following sections provide definitions of each of these terms, discuss the differences in their meanings, and look at existing work which aims to measure the extent to which existing infrastructure impacts on the mobility of users, the accessibility of essential services and the usability of the network for older pedestrians and drivers.

According to Metz (2000), mobility is a term which is used to convey several different meanings. For example, it can be synonymous with “travel”. On the other hand, it can be much broader, referring to the fact that the potential to make a trip may exist, regardless of whether or not that trip goes ahead. In the context of older people, where the ability to get out and about has been shown to be linked to a number of health and well-being indicators, a definition of mobility which incorporates the potential to make trips may be particularly relevant. Metz argues that;

“mobility is not at present an operational concept capable of quantification. Rather, what is measured is travel behaviour, which may then be discussed in terms of the implications for the mobility of those concerned.”

Metz suggests that it is necessary to articulate the key concepts of mobility before any measurement of the phenomenon is possible. He suggests the following as the key elements of mobility;

1. *Travel to achieve access to desired people and places.*
2. *Psychological benefits of movement—of “getting out and about”.*
3. *Exercise benefits.*
4. *Involvement in the local community*
5. *Potential travel*

In the case of older people, it may be that the benefits of actually making the journey are as important as the utility derived from whatever activity takes place at the end-destination. This is because those more nebulous benefits (such as exercise, community involvement and psychological benefits) help to maintain mental and physical health for older people, a point which is expanded upon further in section 2.2.

Accessibility is a concept which is closely linked to mobility: Whereas mobility describes the ability or possibility of individuals to make specific trips, accessibility refers to the ease with which particular locations, services or activities can be reached.

According to the Social Exclusion Unit (Mackett and Titheridge, 2004), accessibility is concerned with whether key services can be reached at reasonable cost, in reasonable time, with reasonable ease. It is useful to think of mobility as being connected with the ability (or otherwise) of individuals or groups of user to make the journeys they wish to make, whereas accessibility is more concerned with the ease with which particular services or activities can be reached. In other words, one describes phenomenon from the point of view of individuals or groups of people, whereas the other describes buildings, infrastructure or institutions.

Usability is a broader and more subjective concept, incorporating people's perceptions of the environment. According to Wennberg et al. (2010)

"Usability is the extent to which human needs, based on individual or group preferences can be fulfilled in terms of activity performance in an environment. …. Thus usability is subjective, referring to a person's perception of a certain environment"

Wennberg et al also points out that usability is a highly dynamic concept; a dropped kerb, provided to make road crossing easier for those in wheelchairs or with limited lower limb mobility may immediately become unusable if blocked by parked vehicles, for example. They point out that journeys are often made up of a complex chain of separate journey phases, each of which must be usable. Hence if the bus is accessible to those with limited mobility, but crossing the road to the bus stop is impossible for the mobility–limited passenger, then the bus is not usable, even though the vehicle itself is accessible.

All of these concepts have implications for the quality of life of older road users, though the ease with which they can be observed and monitored will differ. The following sections examine existing work which looks at the measurement of mobility, accessibility and usability. The advantages and limitations of the techniques adopted are assessed, and conclusions are drawn as to which, if any, might be appropriate for the specific case of older road users in urban areas.

2.9 Ageing and mobility

Supporting the mobility of the elderly is not only important for practical reasons (for example, to buy food and attend medical appointments) it has also been shown to be important in maintaining health.

"Measures aiming at better safety can often serve other transport political goals such as mobility or equity. For example, design features making the car easier to use for older drivers facilitate the driving task, which is likely to increase safety but they may also have a positive effect on mobility… and finally on equity by helping a sub-population at risk of social exclusion to keep themselves mobile and active" (Hakamies-Blomqvist et al.2003)

However, some issues that may impact on the ability of older people to stay mobile can be masked by broad casualty figures. For example, subways and overpasses may reduce pedestrian representation in casualty figures but can lead to severance of communities and reduced quality of life, especially for the most vulnerable & mobility-limited. Figure 4, below illustrates this point. Whilst pedestrian casualties are reduced dramatically by the presence of the guard rail, pedestrian activity is severely curbed. This may have implications for the long term viability of small, local businesses and in time may result in a reduction in the provision of local services and increasing isolation for those without access to a car.

Fig 4; Median-strip guard rail to reduce pedestrian casualties.

Further deteriorations in physical condition with advanced ageing can lead families, the medical profession and even the media to question their continuing right to private motorised transport. The BBC (2003) quotes a senior police officer as saying *"older drivers should consider hanging up their keys if they're having trouble keeping up with the pace of life on today's roads*…"(BBC, 2003). Brace et al. (2006) also found evidence that pressure from family members, health practitioners and police forced older drivers to consider alternative modes of transport, even when the drivers themselves had initially felt confident to continue. This perpetuates an apparently common notion that rather than researching ways to support safe mobility for the elderly, policy should be geared towards limiting the circumstances under which they can drive, for example through compulsory re-testing from the age of 70 (The Times, September 3rd 2007). This may be why there is much legislation governing the accessibility of some types of public transport facility but practically no guidelines about designing the physical features of the road infrastructure itself to meet the needs of older road users. For example, Part V of the Disability Discrimination Act (DETR, 1995) covers accessibility of vehicles such as buses, part III refers to facilities including railway stations, but nothing similar for road infrastructure is included in the legislation.

However, older road users who switch from driving to walking increase their risk of becoming a traffic fatality. According to Dumbaugh (2008), pedestrians over 65 are twice as likely as the population as a whole to be killed. Those who switch from driving to using public transport may experience difficulty in planning and making the journey, and must almost certainly in any case, make part of the journey on foot in order to access stops and once they reach their destination, as public transport does not always run exactly where needed.

Changes in casualty rates for older road users must be weighed against the popularity of certain activities; most people would not consider it to be desirable if a measure targeted at pedestrian safety discouraged walking (or made it difficult for older road users with physical impairments), and any resultant fall in risk exposure explained all or most of any subsequent fall in casualties.

As has been stated, maintaining “safe mobility” for older people is important, as it has shown to be strongly linked to mental and physical health. (Marottoli et al. 1997)

According to Maratolli et al (1997)

“driving cessation was one of the strongest predictors of an increase in depression among older people”

According to Glass, de Leon et al (1999)

“Social and productive activities are as effective as fitness activities in lowering the risk of death. Enhanced social activities may help to increase the quality and length of life”

For this reason it is important that safety and mobility for older road users are considered together, rather than safety (as measured by casualty counts) being assessed in isolation.

2.10. Infrastructure and mobility

Barriers to older road users’ mobility can be physical, psychological or environmental. In terms of physical barriers to mobility, some of the factors already identified as having an impact on older road users’ safety can also affect their mobility. These include;

- Functional limitations such as eye-disorders and disease
- Decline in motor functions such as muscular strength and joint flexibility
- Dementia

(Davidse, 2008)

They can affect mobility either by placing tangible physical constraints on users (for example, by restricting the distance they can walk, and thus preventing them from accessing bus stops) or by introducing additional psychological barriers (for example, by reducing their confidence and thus their willingness to travel). Psychological barriers to mobility are factors which lead older users to doubt their ability to make the journey. These include fears about safety, concerns about crime or just doubts about their own ability to safety negotiate the journey.

Environmental barriers are those with direct relevance to infrastructure design. Clarke and Niewenhuisen (2009) identified a number of environmental barriers. These included;

- Discontinuous or uneven surfaces
- Noise
- Inadequate lighting
- Heavy traffic

According to Dumbaugh (2008), the current approach to facilitating older road users' mobility is not adequate. He states that;

"Solutions should strive to eliminate the core barriers that persons with differing abilities face, preferably with integrated solutions that enable everyone's needs to be accommodated within a single, inclusive design"

He believes that failure to do this leads to increasing isolation of older road users, especially those without access to a car.

2.11 Infrastructure management for mobility, accessibility and usability

Previous studies have developed a variety of indicators to measure the extent to which people are able to travel to the services and activities that are important to them. These measures are often looked at in the context of addressing social exclusion issues, in order to improve access to jobs, health care and education (Titheridge, Mackett et al.(2001)). As a result of this, they do not always specifically address the needs of the elderly, or they consider them only in conjunction with accessibility, mobility and usability for the disabled. This fails to take account of the differences in priorities with respect to the activities and services which the two groups need to access, and differences in their mobility needs.

Since mobility and usability are more difficult concepts to measure as a result of the highly dynamic or subjective elements they imply, much research has focussed on measuring accessibility.

However, according to Metz, there would be advantages to measuring mobility: Attempting to measure mobility would, he believes, allow the measurement of benefits associated with individual movement which extend beyond those normally taken into account in existing models and planning tools. He suggests that this would be particularly worthwhile for investigating the loss of mobility with increasing age and for assessing the impact of measures aimed at enhancing the mobility of older people.

The following section introduces previous studies for assessing mobility, accessibility and usability, discusses the relevance of the methodology used, and draws conclusions about its suitability for the proposed study.

i) Mapping (Koernicke 2007), (Jones, Titheridge et al. 2006)

Koernicke (2007) developed the Accessibility Constraints Map (ACM) as a way of monitoring the areas within the Sutherland Shire (New South Wales, Australia) where residents were most likely to encounter greater difficulty and lesser access to key social needs such as health services, shopping, employment and education. The ACM looks specifically at people who rely mainly on walking and public transport as their main mode of transport.

The methodology was based on a number of key accessibility factors, chosen on the basis of the availability of data, the ease with which it could be measured and updated, the cost of collecting or accessing the data, the transferability of the measure to other councils, and the contribution of the factor to a reasonable appreciation of the accessibility constraints faced by residents. The factors chosen were;

- Distance to bus stop
- Topography/gradient
- Bus and rail service frequency
- Distance to higher and lower order centres

- Centre Hierarchy
- Presence of paved footpath

An accessibility constraint value was derived for each factor, for each parcel of land in the Sutherland Shire, ranging from 10 (reflecting a high level of access or influence on access) to 0 (being a low level of access or influence on access). These scores were based on data sources associated with travel demand management and travel behaviour.

A survey was undertaken, requiring residents to choose between the importance of one accessibility factor over another. The scores were then weighted in order to reflect the communities' opinions on which had the biggest influence on their travel decisions. The weighting values were then multiplied by the accessibility factors to produce an accessibility index, which was then mapped onto each parcel of land on the Geographical Information System (GIS).

The results suggested that level of service for public transport had a higher level of importance, whilst distance to bus stop, gradient and distance to centre, and footpath provision all had similar levels of importance. It was also found that accessibility can vary even at a very local scale where factors such as provision of footpaths and distance to bus stops change within a short distance.

For a local authority looking to identify the areas where significant accessibility improvements may be possible, this methodology has a number of advantages.

These include its reliance on existing data, simple methodology and the ease with which results can be interpreted.

However it also has a number of limitations; for example, measuring the distance to the bus stop does not provide any information about the nature of that journey: Issues such as safety concerns, traffic intrusion and pavement condition, which could significantly affect the propensity of residents make that journey are excluded from the analysis. Similarly, being close to a bus stop may not be as good for the accessibility of the service as one would think, if in order to use the bus stop, pedestrians have to cross many lanes of fast moving traffic. In addition, the ACM focuses purely on walking and public transport use. A more broad measure of accessibility might also consider the needs of those who do have access to a car, but who nevertheless have mobility issues. These might be caused by, for example, traffic conditions, road layout or parking problems, which may be of relevance to older drivers.

Jones et al. (2006) measured pedestrian access to local bus and rail stations, incorporating information to describe traveller perceptions. Whilst the specific focus of this research may be relatively narrow, some of the findings are equally relevant to analysis of access to other services and activities, such as shopping, health centres and so on. The rationale for the work was the lack of attention paid by transport models and academic literature to the walk component of public transport journeys. This work was also driven by concerns about social exclusion, and the ability of disadvantaged groups including older people to access public transport. Other groups included in the focus groups and incorporated into the analysis included young people (16 – 21), disabled people, people travelling with young children, unemployed people and people working unsociable hours.

Analysis of existing literature identified a number of factors which influence walk access. These are;

- Maximum walking distances
- General pavement problems and hazards
- Road crossings
- Design of bus stops
- Fear of crime

Following focus groups, four further factors were incorporated into the analysis;

- Local terrain (e.g. hills)
- Lack of provision of seating and shelter at bus stops
- Difficulty in crossing the road
- Low levels of street lighting

Surveys were then undertaken to find out the extent to which different groups find different walking environments more or less attractive. From this, weighting factors could be derived, according to the extent to which different groups found the identified factors to be a barrier to walk access.

Comprehensive street audits were then undertaken which collected data on;

- Location and type of crossing points
- Guard rail and dropped kerbs
- Lighting (location and type of lamps, and luminosity)
- Location and characteristics of bus stops

Local authorities also supplied additional data about traffic flow, road accidents and reported crime. This data was then combined into a local access catchment map, showing subjective weighted walk times to various public transport facilities for different user types (including older people). These results were then presented at focus groups, in order to get feedback on the results and findings.

The specific focus of the work on access to public transport means that the methodology is geared very much to enhancing travel demand models by better understanding of the "walk" part of public transport journeys. In addition, whist older road users were one group targeted by the research other groups with mobility were also incorporated. Whilst there may be some overlap between the problems experienced by older people, the disabled and those travelling with young children, the work also looked at the experiences of the unemployed and shift workers, who one would imagine face rather different issues. For this reason, the methodology is not directly transferable to a study of the mobility of older road users. Some factors which might present a significant barrier to older road users, such as pavement condition and footway width were not considered in detail by Jones et al. Nevertheless, collecting data via a process which combines a street audit with existing data on traffic conditions and accidents (for example), and mapping the results, provides a methodology which is relatively simple to implement and interpret, even if its sophistication depends on the number of variables which are incorporated. Weighting the results by feedback from members of the specific road user groups under consideration should help to ensure that any assumptions made are realistic, and that results accurately describe the experiences of users in the road environment.

ii) Before and after studies

Using before and after studies is a relatively common way for local authorities to assess the effect of changes in road infrastructure. For example, they are widely used to monitor the effectiveness in terms of casualty and speed reductions of automatic (camera) enforcement of speed limits. However, in scientific literature on mobility they are relatively rare (Wennberg et al. 2010). This may be because of a lack of communication between researchers and the relevant bodies who would be interested in supporting such studies, or may be a reflection of the practical difficulties involved.

Wennberg et al. undertook a before and after study which examined the effects of improvements in outdoor environments in Sweden on older people’s perceptions of the environment and on their mobility. The study methodology involved focus groups, questionnaires and participant observation of older people. The questionnaires were repeated before and after implementation of a program of removal of barriers, in accordance with Swedish governmental accessibility directives. The type of barriers involved included uneven surfaces, drainage grooves, high kerbs and poor lighting. For the participant observation, participants walked a self-chosen route with an observer, with any usability problem which hindered the participant during the walk being noted.

Surprisingly, the results indicated that whilst participants were more satisfied with the outdoor environment after implementation, there was little change in their mobility or perception of safety. One suggested explanation for this is that the removal of smaller barriers such as high kerbs was not immediately noticeable. In addition, since there was a time-lag of two years between the before and after studies, participants would have aged 2 years during the course of the study. For some participants, this in itself would have led to a reduction in mobility, which could have cancelled out some or all of the benefits of barrier removal. Also, in the case of complex journeys, a failure in one link of the chain (for example, if difficulties in accessing shop entrances are not addressed) will limit the usability of the whole journey. This may have meant that whilst removal of the barriers fixed some small links in the chain, others remained, limiting the effectiveness of the measures in promoting mobility.

Before and after studies is a useful way of assessing the effect of barriers to mobility. However, without dedicated partners in local authority to undertake remedial work such as that described here, they are not a practicable approach for this study. In addition, the timescales required are not practicable, and do lead to additional problems in terms of the mobility and health levels of participants not remaining constant over the entire period under consideration.

iii) Output-based measures

Output measures are widely used by local and national government (Titheridge et al. 2007), and include things like; number of fully accessible bus services or proportion of footways identified as being in poor condition.

Titheridge and Solomon (2007) assessed the relevance to the specific case of older road users of a number of indicators suggested by the Department for Transport (DfT) as being suitable for use in accessibility planning. They state that whilst accessibility has been deemed to be central to planning decisions, very little progress has been made in devising policies which seriously address discrepancies in accessibility and mobility. Thus the rationale for accessibility planning is to tackle inequalities in accessibility, by targeting specific groups or geographical areas which are particularly affected.

Titheridge and Solomon combined data from the National Travel Survey (NTS) with results from a questionnaire-based survey and focus group discussions, in order to assess the extent to which the output-based measures adopted by the DfT were relevant to the travel behaviour and needs of older people.

The results suggested that the adopted DfT indicators are not suitable for older people. Whilst the DfT indicators look at access to specific destinations such as hospitals and shopping centres, this research suggests journey times and destination possibilities are not important determinants of mobility and accessibility.

In addition, these measures tend to concentrate on specific elements of the transport network and say nothing about how individual elements link together, or how easily a journey can be undertaken.

The largest barriers, as observed by older people themselves are micro-level details such as pavement conditions, static obstacles such as overgrown hedges and moving ones such as bicycles, inadequate crossing facilities, and lack of resting places when walking.

This suggests that an important step in promoting the mobility of older people would be the development of indicators which were able to describe the incidence of these micro-level barriers in the environment, since it is the specific indicators chosen by the DfT (rather than the concept of output-based measures) which lack relevance. This suggests that suitably focused output-based measures (or indicators) could be a useful way of measuring and monitoring older people's mobility.

2.12 Designing for older road users' mobility

A number of factors which act as barriers to, or facilitators of mobility for older road users have been identified. These include;

- Pavement quality
- Lighting
- Footpath obstruction
- Noise levels

- Traffic conditions

These factors will be incorporated into the performance indicators for pedestrian mobility.

2.13 Discussion

A key limitation of much of the existing work is that it fails to make a strong enough distinction between mobility, accessibility and usability. This may mean that difficulties with specific locations can be over-looked: Provided infrastructure may make a particular location accessible (for example, by providing a kerb alongside a bus stop which allows for level access to the vehicle) whilst at the same time not ensuring that it is usable for older people (if for example the same kerb makes it impossible for mobility-limited older passengers to cross the road to board the bus)

In many existing studies of accessibility, the disutility of walking as a mode, and the additional “costs” that it imposes are the starting points for the work. However, for older people, travel time may not be an important factor in making travel decisions. As has been stated, in the case of older people, maintaining mobility has been shown to be a factor in staying mentally and physically well for longer. Rather than being an additional cost, walking may in fact generate additional benefits, which are much harder to measure. These are the benefits referred to by Metz, which form the basis of his argument that it is important to look for better ways of measuring and assessing mobility.

Much existing work has grown out of concerns about social exclusion and the influence transport provision can have on exclusion. For this reason, there are two issues with adapting current work to look specifically at the needs of older road users: Firstly, much existing work prioritises access to activities and services which are not of specific relevance to older road users. For example, the DfT's Core National Accessibility Indicators (DfT, 2009, from (Titheridge, Mackett et al.)) include; number and percentage of children aged 5 – 10 years within 15 and 30 minutes of primary school; number and percentage of people in receipt of Jobseekers' allowance within 20 and 40 minutes of a location with more than 500 jobs. It is clear that there are other indicators which would be more important in the context of older people. Whilst one would expect these to include the Health and Supermarket indicators, the work of Titheridge and Soloman suggests that all destination-based indicators have limited relevance to the measurement of safe mobility for older people. Indicators of key importance to older people need to look at a much more micro-level. Additionally, social exclusion resulting from transport issues is generally assumed to be a more significant problem for those without access to a car. As a result, there is a broad body of work which looks at non-car journeys, but very little which looks at mobility issues for those who DO have access to a car. In the case of older people, mobility can still be a problem, especially where the *usability* of the system for those with, for example, shorter reaction times or poorer peripheral vision, may lead to issues of road safety or driver confidence.

King, 2000 says;

"Road use by older people has a number of elements; road quality, lighting, presence and quality of footpaths, standards for signage, traffic signals, complexity of intersections…. The road environment can be changed to make it easier for drivers to drive safely, and hence to continue driving longer, and for older pedestrians to walk safely…"

The mobility issues which face older drivers must also be addressed if a complete picture of mobility for older road users is to be addressed.

The incorporation of cost of travel into some existing models is also problematic; many older people in the UK are entitled to free bus passes, and for many others, journey cost may simply not be a high priority factor when making travel decisions. “Older people” are a socially diverse group, and whilst there will be some for whom cost of travel is an issue, there are many others for whom it is not. It is therefore not always appropriate to give a high weighting to costs.

According to Titheridge and Solomon (2007)
“a number of studies question the premise that accessibility as defined… in terms of access to destinations and time taken to arrive at them is the main concern of older persons….Travel to achieve access to desired people and places is only one element of this concept. The others are the psychological benefits of “getting out and about”, the exercise benefits, involvement in the local community and the feeling of the possibility of making trips”

A number of key characteristics of mobility measures have been identified. These include;

- The necessity of looking specifically at the needs of older road users, rather than looking more broadly at all socially excluded groups (for example, including the unemployed) or all mobility-limited groups (including the disabled)

- The ability to incorporate mobility for car drivers as well as pedestrians
- The importance of micro-level mobility factors such as pavement condition, obstacles etc, as opposed to destination-based measures such as proximity of services
- The importance of looking at mobility and usability, not just at accessibility, as services which are generally accessible may nevertheless be unusable for mobility-limited older people
- The ability to incorporate some of the more nebulous and intangible aspects of mobility, such as feeling part of the community.

In terms of the methodology by which this may be done, mapping mobility and/usability constraints using a combination of street audit, questionnaire and focus groups is a promising methodology. Whilst the studies assessed here were not targeted specifically at older road users, nor at mobility and usability, additional variables (such as presence of fixed or moveable obstacles) could easily be incorporated. This would make it more relevant to the aims and objectives of this particular study, but could also result in a more sophisticated model, capable of describing in more detail the problems faced by older road users.

Before and after studies are not thought to present a practicable methodology for this work. Similarly, output-based measures may be a good way of assessing the accessibility of activities and services, but are not well-suited to looking at mobility and usability, since, as has been explained, infrastructure can be accessible whilst at the same time being unusable, and presenting a barrier to mobility for older road users.

For this reason, the proposed methodology for assessing the mobility of older road users in urban areas will use a street audit approach to identify those elements of the infrastructure which previous work has shown hinder the ability and willingness of older road users to make journeys. The methodology will look at both pedestrians and car-drivers, as existing studies do not appear to focus sufficient attention on the needs of drivers. As Titheridge and Soloman point out, whilst many older people do not currently have access to their own transport, the proportion of the over-60s who do is expected to rise dramatically; 71% of women and 90% of men aged 50 – 59 hold a driving license, compared to 27% of women and 69% of men over 70. As a result, mobility for older road users cannot be seen purely in terms of walk access and public transport use, and the extent to which road infrastructure facilitates mobility for drivers must be incorporated.

2.14 Reconciling safety and mobility

The role of urban design and land-use planning in providing safe and accessible infrastructure for older road users has not, in the past been fully integrated with road safety policy. According to Ewing and Dumbaugh 2009) much conventional transport planning begins from the premise of identifying bottle-necks in the infrastructure and looking for ways of alleviating them. Once this need is identified, safety is addressed by designing improvements with higher design speeds in mind, on the basis that higher design speeds will lead to better safety performance.

This approach can be traced back in large part to the 1963 Buchannan Report, “Traffic in Towns” (Buchanan 1963). Its central conclusion was that traffic movement should be segregated from social and leisure activities and pedestrian movement. However, according to Hamilton-Baillie (2008b), widespread implementation of measures to separate motorised and non-motorised traffic has led to unanticipated negative consequences:

> *“The need for underpasses, bridges, traffic signals, barriers and controls, implicit in achieving segregation, has reduced accessibility for non-motorised traffic. Isolation, inequalities and a fragmented and degraded public realm were outcomes not anticipated by Buchanan”*

The overall effects are difficult to quantify, and as a result, less is known about the intangible aspects of urban road design (for example, the inter-connections between the environment and health, the informal use of public spaces, walking) than is known about the tangible ones (motorised traffic volumes, road accident casualties). This may be a partial explanation for the design focus on throughput of motorised traffic, rather than the quality and attractiveness of urban space.

In addition, to presenting physical barriers to the movement of pedestrians and cyclists, separation of infrastructure imposes more nebulous barriers connected to people’s perceptions of the environment. According to Buchanan the engineering required for efficient movement of large volumes of motorised traffic reduces the visual attractiveness of the urban landscape. He describes the average UK streetscape as being;

"dominated by standardising features associated with conventional traffic engineering. White lines, yellow lines, zig zags and garish cross-hatching…traffic signals, road signs and steel pedestrian guard rails"

Stating that the outcome of this is often

"isolating small residual spaces for pedestrians from each other and from the traffic"

According to Ewing and Dumbaugh (2009) *"the empirical evidence on traffic safety strongly suggests that safety and mobility may be conflicting goals, at least in urban areas."*

It could be argued therefore that policy-makers have deliberately prioritised pedestrian safety and driver mobility (as demonstrated by separation of motorised and non-motorised traffic and higher design speeds) over pedestrian mobility (as demonstrated by allocating road space to pedestrians and leisure activity). Possible explanations for this include -

1) The case for designing for throughput of motorised traffic, as stated in the Buchanan report, being more coherently and persuasively made than the case for designing for the mobility of non-motorised traffic.

2) The relative ease with which variables connected to vehicle traffic can be collected and verified compared to variables connected to vulnerable road users and/or mobility.
3) The emotive aspects of road death, making safety a more "newsworthy" policy objective than the more intangible and nebulous benefits associated with mobility.
4) The economic imperative to reduce congestion, keep traffic moving and avoid the well-documented costs of traffic fatalities and injuries. These costs vary according to the precise calculation method adopted, but are reckoned to be in the region of £1.6 million for each fatality (Spackman et al. (2011).

On the other hand, the possible negative consequences of prioritising casualty reduction and vehicle throughput include;

- Premature deaths resulting from air quality issues generated by vehicle emissions. According to the Committee on the Medical Effects of Air Pollutants (2010) these amount to nearly 29,000 deaths in the UK, or a loss of life expectancy from birth of approximately 6 months.
- Decreases in the use of "benign" modes such as walking and cycling.

The notion that separation of pedestrians from traffic is the best or only way to promote safety is not universally accepted. Other approaches which aim to provide more of an equal balance between safety and mobility, and the needs of pedestrians and motorists may not necessarily lead to less safe conditions.

“Shared Space” is an idea which has been promoted as an alternative to segregation.

According to Kaparias at al (2012)

“*Shared space is an approach to improving streets and places where both pedestrians and vehicles are present, with layouts related more to the pedestrian scale and with features encouraging drivers to assume priority having been reduced or removed. It creates a more pedestrian-friendly environment than conventional street layouts, which are based on greater segregation between pedestrians and vehicles, while at the same time introducing uncertainty… leading to lower vehicle speeds and improved safety”*

In the UK, examples of “Shared Space” schemes can be found in Kensington (illustrated in fig 5, below) and Coventry (fig 6).

Fig 5; Shared Space, Kensington, London

Source: I Bike London

Fig 6; Shared Space, Coventry

The idea behind Shared Space is to better integrate different types of traffic, without the need to extensive segregation, engineering measures or signage, allowing users to form their own strategies for appropriate behaviour, based on perceptions of risk. According to Hamilton-Baillie (2008a), this results in a situation where traffic is integrated into a public space without loss of safety, accessibility or mobility.

Ewing and Dumbaugh (2009) believe that,

“contrary to accepted theory, at least in dense urban areas, less-“forgiving” design treatments—such as narrow lanes, traffic-calming measures, and street trees close to the roadway—appear to enhance a roadway’s safety performance when compared to more conventional roadway designs. The reason for this apparent anomaly may be that less-forgiving designs provide drivers with clear information “

They conclude that a better understanding is required of the interactions between design, travel behaviour, safety and mobility.

2.15 Conclusions

This chapter has looked at existing literature which examines the related issues of safety and mobility for older drivers and older pedestrians, drawing conclusions about the key issues, appropriate methodologies for assessment, and the policy trade-offs that have been made in designing urban road infrastructure solutions.

A number of factors have been identified which promote or hinder the safety of older road users in urban areas. Different methodologies for assessing the degree to which urban infrastructure meets the safety needs of older road users have been assessed, with a thematic inspection of infrastructure selected as the appropriate method for the aims and objectives of this study. The methodology will be elaborated in detail in Chapter 3, but will incorporate a subjective assessment of driver workload using an engineering-based measure. For pedestrians the thematic inspection will highlight known risk factors for older pedestrians, many of which relate to road crossing.

A number of factors which promote or hinder the mobility of older road users in urban areas have also been identified, with infrastructure audit also found to be the most suitable methodology for the purposes of this study.

At first glance, safety and mobility and the needs of motorised and non-motorised traffic do indeed appear to be competing ends, at least in urban areas where the complex needs of different users must be met. The traditional approach to mobility – that of prioritising throughput of motorised traffic, with safety catered for by grade separation of different types of traffic – has been critiqued. Alternative solutions have been presented, and their potential to balance competing needs in a more optimal way has been discussed.

The following chapter describes Performance Indicators, setting out the theoretical arguments for their use, the features they should possess and their potential to aid analysis of the safety and mobility issues encountered by older road users in urban areas.

CHAPTER 3: PERFORMANCE INDICATORS

3.1 Introduction

This chapter will look at how Performance Indicators can be used to describe the prevalence of urban infrastructure which does not cater well for safety and/or mobility for older people. The key theoretical requirements of Performance Indicators are presented, and different potential approaches to their construction are critically assessed.

There are two main limitations with existing accident and casualty data. Firstly, it is widely acknowledged that a proportion of accidents does not become known to the police, and thus some accidents are excluded from the official data. There are a number of potential reasons for this, including;

- Those involved in the accident did not realise there is a legal obligation to inform the police.
- Those involved wish to avoid contact with the police, because they were known to the police, were not insured, or were committing other offences such as driving while under the influence of alcohol.
- Less obvious or less severe injuries sustained in the crash only manifest themselves later.

Two types of under-reporting are possible; either the police remain unaware that the accident has occurred, and/or the casualty severity is incorrectly recorded. Less severe accidents are thought to be more commonly under-reported, but even a small number of fatalities may not become known to the police.

According to the DfT [3] in 2009 there were around 39,000 admission to hospitals in England resulting from road traffic accidents recorded, compared with 21,000 serious injuries reported in police data. As police and hospital data is not directly comparable, a number of studies have attempted matching police accident data with hospital admissions data in order to attempt to quantify levels of under-reporting (Ward et al. 2006) (James, 1991) (Teanby, 1992).

As well as varying by accident severity, under-reporting is also thought to vary by road user class. Ward et al. (2006) found that pedal cyclists and pedestrians had the lowest levels of under-reporting, and car occupants the highest.

According to Ward et al. (2006)

“The serious group of casualties could be up to twice as large as indicated by the STATS19 serious category…. Not all of the shortfall in the STATS19 serious group of casualties is due to under-reporting because in the slight category are casualties which should be in the serious category and have been misclassified or misrecorded. These could add up to another 25% to the serious category.”

There appears also to be an age effect, whereby casualties aged 20 – 24 years were least likely to be known to the police.

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[3] http://www.dft.gov.uk/pgr/statistics/datatablespublications/accidents/casualtiesgbar/rrcgb2009

According to the DfT (2006)

"there is general recognition and acceptance that the STATS19 record is an underestimation of the actual number of road traffic accident casualties."

3.2 Safety Performance Indicators

Although the idea of Road Safety Performance Indicators is a relatively new one, the use of Safety Performance Indicators in other sectors has a much longer history. The Health and Safety Executive produces guidelines on monitoring and improving performance, and cites a number of reasons why monitoring measures of injury are an imperfect way to assess safety performance. These include;

- Whether a particular event results in an injury is often a matter of chance.
- Injury rates often do not reflect the potential severity of an event, merely the consequence.
- A low injury rate can lead to complacency.
- A low injury rate results in few data points being available.
- There must have been a failure, ie injury or ill health, in order to get a data point.
- Injury statistics reflect outcomes not causes. (HSE, 2001)

These guidelines have a clear relevance to road safety, where all of the above points could equally well be applied to traffic collisions; the outcome of a road accident is affected by the physical characteristics of the road users involved, with elderly casualties more likely to sustain serious injuries due to their relative frailty (Morris et al. 2003).

Dahlgren et al. (2005) suggest a number of characteristics that effective Performance Indicators should demonstrate. These include;

- *To identify an objective, auditable and non-disputable set of parameters;*
- *To provide insights, when used as a set, regarding what is important;*
- *To provide information that is understandable to stakeholders;*
- *To provide an additional basis for assessment and to take corrective actions;*
- *To provide an additional basis for investigations by regulators;*
- *To enable comparisons to be made.*
- *To encourage licensees to monitor performance using specific indicators;*
- *To promote the licensees' own improvement of processes.*

Whilst the context of these characteristics is the Nuclear Industry, some of this guidance is also relevant in the context of road infrastructure, where Performance Indicators could identify an additional set of objective parameters, provide insights as to what is important, provide information to stakeholders and provide a basis for assessment, investigation, comparison and improvements in road safety and mobility.

In an industrial context, Performance Indicators can be chosen from near-miss data such as low-level incidents or from precursors which might, in combination, give rise to a major incident. The current “state of the art” of road accident and incident data collection would rule out this approach: Whilst data concerning fatalities arising from crashes is believed to be fairly accurate the same is not true of slightly or seriously injured casualties, let alone damage-only accidents or near misses.

With more widespread implementation of event data recorders in vehicles, analysis of such incidents may become a practicable proposition, but that is not the case at present. It is therefore necessary to identify other *measurable* elements of the safety performance of the traffic system.

One important point to note about Performance Indicators is that the actual values of the indicators are not necessarily intended to be direct measures of safety. Safety performance can be inferred from the results achieved, for example by comparing year-on-year changes in the value of the indicator, or by comparing one country or region against another. However, the numerical value of any individual indicator may be of no significance if treated in an isolated manner, but can be made significant when considered in the context of the performance of other indicators (www.hse.gov.uk)

In the context of road safety, indicators could be considered especially useful on a local level, where they can be used to compare similar regions or areas, to monitor the effects on the traffic system of new or upgraded infrastructure, to validate policy *before* the effects have translated into changes in accident or casualty rates, and to incorporate a wider range of policy objectives into monitoring and evaluation activities.

3.3 Road Safety Performance Indicators

According to Hermans et al. (2008) the concept of Road Safety Performance Indicators has gained popularity in recent years. This may be as a result of the work of projects such as SafetyNet (Hakkert, Gitelman, 2007) and SUNflower (Wegman et al. 2008)

According to Nardo et al (2005) an indicator can be defined as

“a quantitative or qualitative measure that is deduced from a series of observed facts to reveal the relative positions“

The European Transport Safety Council (2001) identified a number of reasons for using Performance Indicators rather than outcomes measures as a means to monitor road safety.

These included:

- Crash outcomes can be highly dependent on chance, with even small variations in the elements of the crash (speed, weather conditions, angle of impact, age of casualties for example) altering the severity of the outcome.

- Reporting of accidents and injuries is often incomplete
- Crash counts do not always provide adequate information about the underlying processes that lead to accidents and injuries
- Falling fatalities may mean that low numbers of cases present a problem when attempting to analyse a very specific issue, for example, fatalities involving pedestrians over 65 years old.

Hakkert and Gitelman (2007) represented the theoretical basis for Performance Indicators as shown in figure 7, below

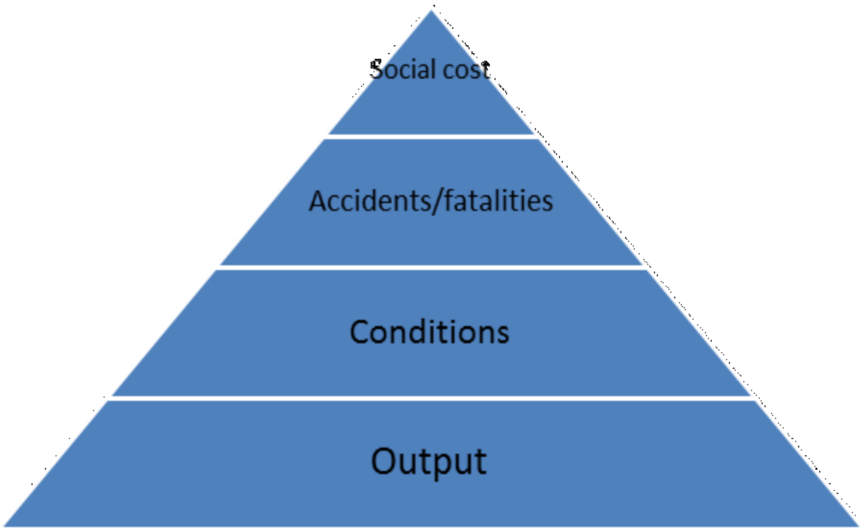


Fig 7; Safety Performance Indicator theory

Figure 7 shows how the social cost is the final outcome of the operation of the traffic system. In the ETSC model, this represents the cost of accidents and injuries (for example, lost output, the cost of treating casualties, the attendance at the scene of the emergency services, and the knock-on effect of resultant traffic disruption.) In this model it can also be considered to include the costs of treating the consequences of lack of independent mobility for older people. Accidents and fatalities are the “Intermediate outcomes” in the ETSC model, which here would also include increases in depression, and in other physical conditions which were shown in Chapter 2 to be linked to lack of independent mobility for older people. The operational conditions of the next level of the triangle are the element that performance indicators attempt to measure. These result from the outputs of policy – in the case of infrastructure, this could mean the decision to separate motorised and non-motorised traffic in order to maximise traffic throughput or minimise pedestrian accidents.

Indicators can be used for several objectives, such as monitoring performance, identifying trends, predicting problems, assessing policy impact, prioritizing remedial measures, benchmarking and so on. In the work presented here, the objective of using indicators is to incorporate a wider range of information into monitoring the effect of road safety policies than could be achieved only by using outcomes measures such as accidents or fatalities. In this way, the impact of road safety policies on people’s mobility can also be assessed, and the trade-offs between safety and mobility for different groups of road user can be made more explicit.

The European Transport Safety Council highlighted seven areas for which it was felt Performance Indicators for road safety should be calculated. These areas were;

- Alcohol and drugs
- Speeds
- Protective systems
- Daytime running lights

- Vehicles (passive safety)
- Roads
- Trauma management

These are the topic areas selected for discussion and calculation of SPIs for the SafetyNet project (Hakkert et al 2007) and were also used by Hermans et al. (2008).

However, as has been pointed out by Hakkert and Gitelman (2007), these different areas operate at different levels of the traffic system; Protective systems, daytime running lights, passive safety and trauma management describe the incidence of counter-measures to either reduce accidents (in the case of daytime running lights) or to lower the severity of consequences (in the case of protective systems, passive safety and trauma management). Alcohol and drugs is concerned with human behaviour as a causal factor in accidents. Speed can also be thought of as a human factor. However, as has been explained in Chapter 2, the design of infrastructure can also be a factor in determining vehicle speeds. Selection of the appropriate level of the road safety system for which to calculate performance indicators may be dictated by data availability (or the ease with which it could be acquired). For example, whilst data on the use of daytime running lights may be relatively easy to collect using roadside surveys, data on the proportion of drivers who are driving whilst impaired cannot be collected this way and must therefore be inferred from other data. Where data for Performance Indicator calculation must be inferred from accident data, it will be subject to all of the previously-discussed limitations of this data.

This work focuses on Performance Indicators related to infrastructure, which include speed limits as one input. The reasons for considering speed as an infrastructure features (as opposed to a human factor) are set out in chapter 2.

Further to selecting the appropriate features of the road safety system on which to focus for Performance Indicator calculation, there are a number of other important considerations to bear in mind. The European Transport Safety Council suggested the following additional requirements of performance indicators:

- Firstly, a causal relationship between crashes and the indicator under consideration must be established.
- Performance Indicators should relate directly to policy; if a region is performing badly with respect to a particular indicator, there must be easily identifiable measures that can be taken to reduce the hazard in the system and improve performance. So, for example, whilst weather conditions may have a causal relationship with crashes, a Performance Indicator for weather conditions for which easily identifiable counter-measures could not be designed would not meet the requirements.

One difficulty with establishing a link between the indicator under consideration and crashes is the role of Exposure to Risk. As was explained in section 2.15 cases where the infrastructure is particularly problematic for older users, some users will choose to avoid it, either by not making the journey at all, or by changing some journey characteristic such as mode choice, route choice, or time of trip. The effect of this will be to reduce the exposure to risk of certain groups of user at certain locations: Pedestrian casualties may be very low in some areas, but this may reflect the fact that pedestrians do not use the infrastructure unless they have no alternative. Thus low accident rates may be an indication of barriers to mobility as much as facilitators of safety. This will be discussed further in Chapter 9, where proxy measures of exposure will be explored, but is worth bearing in mind when considering what the nature of the relationship between performance indicators and outcomes-based measures such as number of accidents or number of casualties should be.

For the purposes of calculating the Performance Indicators, the links established by existing work between features of urban infrastructure such as junction complexity, number of lanes of traffic pedestrians have to cross, traffic speeds and the safety of older road users will be assumed to be correct. In chapter 9 accident statistics will be examined in conjunction with proxy measures of road safety, in order to draw conclusions about the nature of the relationship between crash counts, exposure data and Performance Indicators.

3.4 Performance Indicators for mobility

Whilst they are not often explicitly referred to as “Performance Indicators”, these types of measures are arguably more common in studies concerned with mobility and accessibility than they are in road safety literature. A likely explanation for this is the relative ready availability of crash and casualty data for road safety research, for which there is no comparable outcomes-based data for use in mobility studies.

Examples of typically-used mobility and accessibility indicators include;

- Indices which measure levels of car-ownership.
- Indices which count the number of older people within a threshold travel cost (measured either in time, distance or financially) of an amenity or service.
- Indices which measure access times to transport infrastructure such as public transport interchange

Some measures of accessibility and mobility have already been discussed in Chapter 2, which noted that, firstly, accessibility is more commonly measured than mobility, possibly as a result of the increased difficulty of defining and measuring mobility (Metz, 2000); secondly, measures of accessibility and mobility often incorporate several mobility-limited groups together (for example, those without access to a car, those with disabilities) rather than being specifically geared to older people (Mackett et al, 2012); and finally, mobility indicators often ignore those with access to a car, limiting their relevance to older road users who do have access to a car, even though they may still be mobility disadvantaged.

3.5 Composite Performance Indicators

The possibility of presenting indicators at several levels of detail is a useful feature of performance indicators. By manipulating the level of detail at which the indicator is presented, results can be geared to different users such as local government officials, practitioners and the scientific community. In the case of politicians, "headline" figures can be presented, which combine many layers of detail in order to provide a single over-arching measure. When data are combined in this way, the resulting measure is known as a “Composite Indicator”.

For practitioners, a set of less aggregated performance indicators, helping to highlight the areas most in need of remedial action would be the most useful. This means that, for example, locations can be ranked for their overall performance, in order to determine priorities for remedial work. For the scientific community, indicators at the lowest levels of composition and highest level of detail would facilitate research into the causes and consequences of the phenomenon identified.

In addition to summarising complex information in a more accessible form, another advantage of composite indicators is that these single measures can incorporate information from several different domains where necessary. One example of this is the Human Development Index (Anand and Sen, 1994), which rather than measuring development using only indicators of wealth such as GDP, incorporates other information such as life expectancy, adult literacy and purchasing power.

There are advantages and disadvantages to constructing composite indicators. These are discussed by (Nardo et al. 2005), who cite the following advantages;

- Can summarise complex issues
- Can be easier to interpret than looking for a trend in many separate indicators
- Can facilitate benchmarking
- Can assess the progress over time in complex issues

- Can reduce the size of a set of indicators, or include more information within an existing limit
- Can place performance and progress at the centre of policy
- Can facilitate communication with the general public and promote accountability

Against these, the following disadvantages are suggested;

- May send misleading messages if poorly constructed or misinterpreted
- May invite simplistic conclusions
- May be misused, for example, to support a desired policy
- The selection of indicators and weights could be subject to political interference
- May disguise failings and increase the difficulty of identifying proper remedial action
- May lead to poor policies if dimensions that are difficult to measure are ignored.

It could also be argued that composite indicators “waste” data, by condensing lots of information and thus disguising much of the detail,

Composite indicators are frequently used to rank the overall road safety performance of countries, as well as for other areas such as well-being, industrial competitiveness and sustainable development (Nardo et al. 2005) However, one crucial issue to consider when doing this is the weightings that must be given to individual factors.

For example, in the case of pedestrian mobility, should the effect of obstructions to the pavement be given the same importance as the effect of having to make a long detour to cross the road? Is one more important than the other, and if so, by how much?

Applying weightings to the identified factors can be done in a number of ways, for example, reflecting policy priorities (attaching higher weights to those factors which policy-makers deem to be important), or they could reflect the estimated influence of different factors on outcomes. For example, by attaching higher weights to factors which are thought to have the biggest impact on fatalities or on people's ability to make journeys.

A number of different methods have been suggested for attaching weights to individual indicators in order to create composite indicators. Hermans et al (2008) suggest several methods, including –

- **Factor analysis**, which reduces the dimensions of the problem under consideration to a smaller number of factors which together explain 100% of the variance.
- **Analytic hierarchy process**, which translates the problem into a hierarchy consisting of an overall goal (improving road safety or older people's mobility for example) and a number of criteria contributing to the goal, and a number of alternative approaches, of which the best must be selected. One possible way of applying this approach to the question of safe mobility for older road users would be to ask older road users themselves about the criteria which

contributes most towards achieving the goal, and the approaches which they believe are best. However, there are two obvious limitations to this approach; the possibility of obtaining inconsistent weightings, and the subjective nature of the weights obtained.

- **Budget allocation**, as the name implies, involves asking “experts” to allocate a given budget over a number of indicators in such a way that spending more on one element suggests a higher importance is attached to it. Weights are then calculated from the budget allocation such that the share of budget allocated to an indicator gives its weight. As with analytic hierarchy process, this approach may be subject to inconsistent and subjective weightings. In addition, the budget allocation may represent not the importance of the indicator to safety (or mobility) but the political pressure generated by a factor, or the perceived effectiveness of investment in that area.

- **Data envelopment analysis** compares the performance of a country (or region) to the performance of others in the set, choosing the optimal weights in order that no other weighting yields a higher indicator value. This approach is about *relative* performance, hence is of limited relevance to this particular study which does not aim to compare the performance of different countries or regions.

- **Equal weightings** as the name suggests applies the same weight to each indicator. The main advantage of this is simplicity, whereas the main disadvantage is that no insights are gained as to the relative importance of different indicators. However, Hermans et al conclude that this approach works best when indicators may be highly correlated.

3.6 Conclusions

Performance Indicators have a track-record of use in other fields, and have previously been used in road safety by the European Transport Safety Council. Some methodological questions remain, the most significant being;

1) The issue of whether to apply weights to individual indicators (and if so, how)
2) Establishing the precise nature of the relationship between an indicator and road safety
3) The determination of the appropriate level of aggregation of information.

In terms of indicators for mobility, the main limitations of existing indicators include;

1) The focus on accessibility, rather than mobility, possibly as a consequence of the highly personal and dynamic nature of mobility, making measurement more problematic
2) The inclusion of older road users along with other mobility-disadvantaged groups, despite their different characteristics and needs.
3) The lack of mobility indicators for those *with* access to a car.

The approach adopted in this study is to apply equal weightings to all factors when producing composite indicators. The main reasons behind this decision being;

- The difficulty of obtaining consistent weightings.
- Many of the suggested processes for weighting combine data in an arbitrary way, using the judgement of individuals rather than a single, repeatable scientific process.
- The scope of this study does not allow for comparisons between countries or over time, hence weightings are more problematic and of more limited use.
- Some degree of correlation between the indicators is likely, given that factors like number of lane choices, high speed limit and designated pedestrian crossings are more likely to be found together in locations with high traffic flow. On the other hand, locations with lower traffic flows and lower speed limits are also less likely to have dedicated crossings and wide carriageways for example.

The results obtained in the study will be presented at three levels of detail. In the first section, the values obtained for the simple indicators are presented and analysed. In the second section, composite indicators for each of the four domains (driver safety, pedestrian safety, driver mobility, pedestrian mobility) are presented and analysed. In the final section, the trade-offs between safety and mobility and between drivers and pedestrians are explored, with conclusions drawn about the policy implications of this conflict.

Presenting the performance indicators at these different levels of detail facilitates an understanding of which specific issues contribute to the overall scores and thus helps to identify the key issues that must be addressed in order to improve performance.

CHAPTER 4: METHODOLOGY

4.1 Introduction

The following chapter sets out the methodology that this study adopts in order to meet the study objectives. The rationale is explained, and the data collection activities which will be necessary are outlined.

Review of the existing literature has established some of the limitations of using only accident and injury counts as a means of monitoring road safety. These limitations relate to; the potential of certain physical features of the road environment implemented for road safety to inhibit the activities of vulnerable road users such as elderly pedestrians; the difficulties older road users can experience when confronted with features such as roundabouts, which are safer for the average motorist, but which present difficulties for older drivers and pedestrians; and the lack of detailed exposure data, which is essential when assessing safety using accident and injury data.

A review has also been undertaken of literature which looks at issues of accessibility of services, mobility of older road users, and the usability of provided infrastructure. This has made it possible to identify the key factors which affect mobility. The problems of measuring the accessibility of infrastructure and the mobility of older road users have been discussed, and the advantages and disadvantages of the methodologies adopted by previous studies have been explored. This has made it possible to identify the most appropriate methodology for assessing safe mobility for older road users.

Table 6, below, shows how the proposed performance indicator measures are linked to the conclusions of the literature review. Previous work looking at mobility for older road users has focused on pedestrians and public transport users. One of the key findings from the literature reviewed in chapter 2 was that driving is likely to be an increasingly important mode of transport for older people. As has been explained, increasing proportions of those over 65 are expected to be licence holders in the future. Older women, who traditionally had lower levels of licence-holding are thought to be more likely in the future to drive and have access to a car (O’Neill, 2000). As was stated by Titheridge and Soloman (2007) and discussed in Chapter 2, measures of safe mobility for older road users cannot assume that this is an issue related solely to walk and public transport access. The mobility needs of older drivers should also be discussed. For this reason, separate safety and mobility indicators will be derived for both drivers and pedestrians. This will also enable the compromises that may need to be made between drivers (who might wish to see throughput of motorised traffic prioritised) and pedestrians (who might prefer to see slower vehicle speeds or more frequent crossing points) to be analysed.

Table 6; Links between literature conclusions and performance indicator measures

Conclusion from literature	Reference	Name of relevant measure
Certain types of infrastructure are known to present a risk to older road users as a result of their failure to account for the specific difficulties which result from aspects of the ageing process.	Section 2.5	Safety performance Indicator
Certain micro-level features of road environments inhibit the motivation to and ability of older road users to remain mobile, and limit the usability of the infrastructure.	Section 2.9	Mobility performance Indicator

As figure 1 demonstrates, journeys where the older road user is a car driver or pedestrian account for the majority of journeys made by the over-65s. Indicators for safe mobility for cyclists are not proposed, due to the lack of cycle journeys currently made by older people. This limits the data available for older cyclists' accidents, and also for journeys made by bicycle and makes robust analysis and meaningful conclusions difficult.

Vehicle passengers are also excluded from the analysis, for a number of reasons;

- Earlier work (Brace et al, 2006) has indicated that many of the safety issues encountered by the elderly when using public transport relate to issues with the journey to the bus stop. At this point in their journey they are normally pedestrians, hence their needs can be considered along with this group.

- Other research indicates that many of the injuries that are sustained by bus passengers are a function of the design or operation of the vehicle, rather than resulting from aspects of urban infrastructure. For example, Halpern et al (2005) found that the majority of bus occupant injuries could have been prevented by modifications to the design of the vehicles' interior or by changing driving habits. Infrastructure modifications would not be expected to make a large contribution to reducing such injuries.
- Most fatalities involving bus occupants occur on rural roads (Albertson and Falkmer, 2004), whereas the focus of this research is urban areas.
- Vehicle passengers are not considered to be "active" road users, in that they are not interacting with the infrastructure in the way that a pedestrian or car driver does.

There are six separate but linked elements to the methodology;

- A review of existing literature, the results of which are set out in the previous chapters.
- Collection of user data via focus groups and travel diaries.
- Audit of infrastructure in the case study city.
- Calculation of Performance Indicators for safe mobility for older road users in urban areas.
- Validation of calculated performance indicators using user data and secondary data sources
- Comparison study of qualitative data, calculated performance indicator and outcomes-based measures.

- Recommendations

The following chapter describes the links between the suggested methodology and safety and mobility issues. The key indicators of safe mobility are identified and their relevance to the research questions and their links to previous work are assessed. Their potential for use in conjunction with more traditional measures of safety and accessibility, to further understanding of the problems faced by older road users in urban areas is explored.

4.2 The case study city

The city of Coventry, in the West Midlands (UK) is used for the case study. It is approximately the 13th biggest city in the United Kingdom (www.ukcities.co.uk), and with a population of approximately 300,000 it is comparable in size to, amongst others, Wakefield, Cardiff, Nottingham, Leicester and Sunderland. Its relatively central location and lack of particular distinctive geographical physical features make it a useful case study example, from which results could be generalised to a number of other cities. The road network comprises an inner ring road with major arterial routes radiating out, and an outer ring road/by-pass on the city's periphery. This again makes it a good model for a number of other cities including Nottingham, Leicester and Derby. Coventry received its city status in 1345, making it one of the UK's "oldest" cities. Despite this, much of the city's infrastructure was designed and built with the motorcar in mind, thanks to extensive damage during the Second World War, and the subsequent planned reconstruction and redevelopment. As a result of this, there is a great deal of planned separation of pedestrians and motorised traffic in the central areas.

Coventry was chosen for the case study for a number of reasons, including; its usefulness as a model for other cities; its convenient central location; the opportunity to compare purpose-built pedestrian infrastructure with other approaches such as “Shared Space”; and the ability to draw on personal knowledge of the city.

The decision to use only one case study city rather than using more than one and then comparing results was made on the basis that:

- The case study objective of designing, applying and evaluating a methodology could be met by using only one case study city.
- Any comparisons that would inform the analysis could be carried out by comparing different parts of the city.
- The framework which the study develops could be applied equally well to any other city, hence the use of only one case study city during the development of the methodology does not affect the degree to which the work could be generalised to other cities or to other areas within the case study city.

4.2 Collection of user data

Collection of user data serves two objectives; to understand the services and facilities that older users wish to access, and to assess the impact on their travel patterns of barriers to safe mobility.

In order to meet these two objectives, the methodology will have two separate but linked elements: A group discussion in the form of focus groups; and a travel diary type approach. Table 7, below summarises the objectives of the two methodological elements.

Table 7; Objectives of the questionnaire activity

Objective	Element
To validate the calculated performance indicators for older road users	The focus group and travel diaries will enable comparison of the impact of barriers (as measured by the performance indicator) with the impact of the barriers as described by older users.
To provide a proxy measure of exposure to risk	The travel diaries will provide detailed data on the trips older users made, which alternatives to the journey were considered (for example, different route, different time of day, different mode) and the reasons they were discounted. Any differences in older users' exposure at high/low barrier sites can then be explored and "suppressed demand" estimated.

Gaining an understanding of the services and activities that older people particularly need to access, as well as those that they feel serve important social functions forms the basis of the analysis of infrastructure which follows, by;

1. Informing the selection of locations at which to undertake audits by helping to identify areas which have the facilities and services that older people wish to use
2. Informing the selection of variables to be recorded, by identifying (in conjunction with the literature study) the barriers to and facilitators of safe mobility.

The methodology involves a series of focus groups designed to obtain user data about the generalities of how the infrastructure described and assessed is used by older people, and how they feel about their safety and mobility at these locations.

Participants will be presented with a set of posters illustrating examples of infrastructure and locations around the case study city. They will be encouraged to examine the posters, and from what they see on them, coupled with their own experiences of using the infrastructure in question, to comment on any noteworthy features. This approach was adopted because it had been used successfully by other researchers interested in user interactions with road infrastructure and their effect on mobility (Jones et al, 2006).

The difficulty of collecting exposure data for specific groups of vulnerable road user such as older road users and pedestrians has been discussed in Chapter 2. Since it has already been suggested by other literature presented that older drivers avoid situations where they feel less competent, it is possible that analysis of accident rates alone will provide an incomplete picture of the problematic infrastructure: Where alternatives routes exist, older drivers may simply avoid the locations where they feel most at risk, potentially reducing the absolute numbers of accidents because of lower risk exposure, but meaning that the difficulties older drivers have at these locations are not highlighted. The same process may also happen with older pedestrians; where infrastructure is problematic, they avoid it. Accident and casualty numbers may fall as a result, but without it being possible to analyse what has happened to accident and casualty *rates*.

The second objective served by the user data is to collect information on older road users' experiences of traveling through and to particular locations. This will help to validate the calculated performance indicators by ensuring that the locations which are identified are the ones which older road users feel present problems, and will also enable a proxy measure of exposure to risk to be calculated.

The focus group data will be supplemented with more detailed travel diary data (also collected during the focus group events). This will attempt to look in far greater depth at the journeys older road users make, the reasoning behind decisions regarding route and mode choice, the time at which journeys are made, and also to explore occasions when a conscious decision NOT to make a journey was taken. The aim of this is to collected detailed data about the micro-level factors which influence older road users' travel decisions in order to;

- Collect the necessary data to explore whether or not the locations have been rated correctly and verify that the results of the analysis of infrastructure reflect the experiences of the older road users themselves (validation of performance indicators). In other words, to ensure that older road users would indeed be likely find the locations identified as having high barriers to mobility more problematic than those with low barriers, and to quantify the impact on older people's mobility of the barriers identified.
- To act as a proxy measure of exposure to risk, by establishing whether any of the barriers are sufficient to cause older road users to avoid the specific locations in question, or to avoid making the journey at all. This will enable relative accident rates to be estimated for the identified locations.

Suppressed demand means that a link or place serves activities and services which previous focus groups and existing literature would suggest older road users would wish to access, but which they use to a lesser extent than they would like, because of problems with mobility, usability or accessibility. Travel diaries were adopted as the methodology for this, as it was felt they would make it possible to collect the more detailed data required, and to focus on the travel decisions made by older users and the reasons behind those decisions.

Using the focus group data, and travel diary data, conclusions will be drawn about the extent of “suppressed demand” in the areas identified as having high incidence of barriers to mobility.

In addition to providing a validation of the results from the street audit and mapping exercise, this information will be fed into a model incorporating secondary data such as accident and casualty data.

4.4 Audit of infrastructure in case study city.

Data collection concentrates on key infrastructure features within the urban area of Coventry. In order to facilitate the data collection, the City has been divided into a number of zones using information collected from the focus groups. Zone boundaries were drawn on the basis of the Links and Places they incorporate and provide access to, where Links are key vehicular routes around the city which are of importance to drivers, and Places are destinations which contain the services and facilities older people need to access, such as shops, banks, libraries and surgeries.

These will be of most importance to pedestrians. As well as offering the facilities and services which were identified by the focus groups as being important, zones were also selected for the different social and economic factors they exhibit, in order to assess whether this has an effect on the safety and mobility of older users.

The zones are also designed to cover the city in a geographical sense (being located in different parts of the city) and are diverse in terms of the road environment itself, the type of traffic carried, and the type of area the road passes through. Some are busier roads with a more diverse range of traffic, whereas some are quieter local roads.

Dividing the city into zones resulted in a manageable scale for data collection, whereas auditing every Link and Place in the city would not have been possible within the scope of the study. It also facilitated comparisons between different parts of the city. This is important, as Performance Indicators present a measure of relative, not absolute performance, so the ability to compare different scores is of crucial importance.

A thematic audit of infrastructure was undertaken within each of the zones to identify and map the instances of features which are a barrier to safe mobility. Thematic audit of infrastructure was identified by the literature as being a suitable methodology for assessment of both safety and mobility. It has the advantage of being independent of accident data (thus not requiring detailed exposure data), and of being applicable to existing infrastructure. For these reasons it was felt to be the appropriate method for this study.

Each location was visited several times over a period of several weeks. Infrastructure audit sheets were completed, recording the necessary data to derive the performance indicators for each of the four domains.

The audit of Links will collect the necessary data to assess the safety of older drivers. Review of the previous literature has suggested which factors present a barrier to the safety of older drivers. The audit will focus on identifying instances of road infrastructure which does not cater well for the needs of older drivers, as a result of these features being present. These are likely to be infrastructure and junctions where the mental and visual workload imposed on older drivers by the design is high, and the scope for drivers to adopt a coping strategy is low. An audit will be undertaken of the major intersections and links in order to determine the mental and physical workload imposed.

This will necessitate analysis of (in the case of the Safety performance measure);

- Travel time between junctions
- Instances of information over-load (units of information per unit of travel time, number of signs approaching junctions, number of items on signs)
- Number of decisions (or interactions with the infrastructure) that must be made per unit of travel time
- Number of factors disturbing traffic flow (bus stops, pedestrians for example)
- Junction characteristics such as provision of turning lanes, presence of traffic signals, number of lane choices
- Obscured/illegible signage.
- Angle of intersection at junctions, movements from stop, number of directions of on-coming traffic.

In order to derive the mobility performance indicators for drivers, the following factors will be audited;

- Speed limit
- Distance between signalised pedestrian crossing points
- Presence of pedestrian-only phases in signals
- Presence of measures to curb vehicle speeds (such as speed cushions, cameras)
- Number of banned turns
- Presence of parking restrictions

Review of the previous literature has identified the physical features which present a barrier to the safe mobility of older pedestrians. The audit of Places will focus on identifying instances of those features. For the purposes of deriving the safety performance indicator (pedestrians) measure, the following have been included;

- Physical separation of motorised and non-motorised traffic
- Signalised crossings, and the presence of pedestrian-only phases in other traffic signals
- Any barriers to visibility
- The presence or otherwise of a median strip
- Traffic conditions, for example, speed limit, presence of large or fast-moving vehicles such as emergency vehicles, goods vehicles or buses
- Parked cars

In order to derive the mobility performance indicator for pedestrians, the following features will be audited;

- Deviation of pedestrian route from desire line
- Poorly signed/discontinuous pedestrian routes
- Crossing facilities; distance between safe crossing points, proximity of crossings to other essential facilities such as bus stops, shops etc.
- Average wait times to cross the road
- Pavement surfacing; condition (well/poorly maintained, use of tactile surfaces, whether or not surfaces are even)
- Shared pedestrian/cycling facilities
- Pavement obstructions, both moveable and fixed; for example, poor/illegal parking and vegetation.
- Motorised traffic; density, noise levels, fumes or other sources of intrusion
- Ease of access to public transport (for example, is access level, can return journeys be made with equal ease?)

Infrastructure will be audited for the incidence of these factors, along with other factors identified through the focus groups, to provide an indication of the safe mobility for older road users in each of the zones.

4.5 Calculation of Performance Indicators for Safe Mobility for Older Road Users in Urban Areas

Two sets of linked but separate performance indicator measures will be calculated, one for safety and one for mobility. This will facilitate analysis of the trade-offs between the need to protect vulnerable road users such as the elderly from road risk, and the desirability of promoting continued independent mobility for this group. As has been stated, developing a better understanding of this potential conflict is one of the key aims of the work. Table 8 below, shows how the conclusions from the literature review relate to the different aspects of safety and mobility that the derived performance indicators will be designed to measure.

Table 8; Relationship between literature study conclusions and PIs

Conclusion from literature	Nature of Impact	Affected road users	Name of relevant measure
Certain features of urban infrastructure and traffic flow impose a high mental workload on users	Safety Impact	Drivers	Safety Performance Indicator (drivers)
Certain features of urban junctions impose a high mental workload on users	Safety Impact	Drivers	Safety Performance Indicator (drivers)
Certain features of urban infrastructure impose a high physical workload on drivers (for example, by requiring strenuous head/neck movements for observation)	Safety Impact	Drivers	Safety Performance Indicator (drivers)
Certain features of urban infrastructure increase the complexity of road crossing	Safety Impact	Pedestrians	Safety Performance Indicator (pedestrians)
Certain features of urban infrastructure increase the risk associated with road crossing	Safety Impact	Pedestrians	Safety Performance Indicator (pedestrians)
Certain features of urban infrastructure restrict vehicle speeds	Mobility Impact	Drivers	Mobility performance Indicator (drivers)
Certain features of urban infrastructure restrict vehicle movements	Mobility Impact	Drivers	Mobility performance Indicator (drivers)
Certain features of urban infrastructure restrict pedestrian movements	Mobility Impact	Pedestrians	Mobility performance Indicator (pedestrians)
Features of urban infrastructure increase the time needed to cross the road	Mobility Impact	Pedestrians	Mobility performance Indicator (pedestrians)
Certain features of urban infrastructure impose a high physical workload on older pedestrians (for example, by requiring road crossing by use of bridge or subway)	Mobility Impact	Pedestrians	Mobility performance Indicator (pedestrians)
Micro-level features of road environments inhibit the activity of older pedestrians	Mobility Impact	Pedestrians	Mobility performance Indicator (pedestrians)
Features of urban infrastructure may inhibit older pedestrians' access public transport facilities.	Mobility Impact	Pedestrians	Mobility performance Indicator (pedestrians)

The calculated performance indicators will be of two types; “simple indicators”, representing only a single issue or dimension, and “Composite Indicators” where the information collected is combined into a single measure. These two different types of indicators are anticipated to have different potential uses, with the simple indicators being aimed at the research community, and composite indicators being aimed at practitioners and policy-makers. Table 9, below, describes the composite indicators for each separate indicator type in turn, whilst Figures 7 to 22 provide a scheme for the development of the individual composite performance indicators, which are described in turn in the sections which follow.

Table 10; relationship between composite and simple indicators

Composite indicator name	Indicator type	Simple indicators incorporated
Mental workload Penalty	Safety Performance Indicator (drivers)	Decision Frequency Decision Complexity Decision Speed Traffic Complexity
Junction workload penalty	Safety Performance Indicator (drivers)	Signalised yes/no Speed limit at junction Signs within 500m of junction Total items of information on signs Number of lane choices Obscured, degraded or illegible signage
Physical workload penalty	Safety performance Indicator (drivers)	Movements from stop, number of directions of on-coming traffic, angle of on-coming traffic

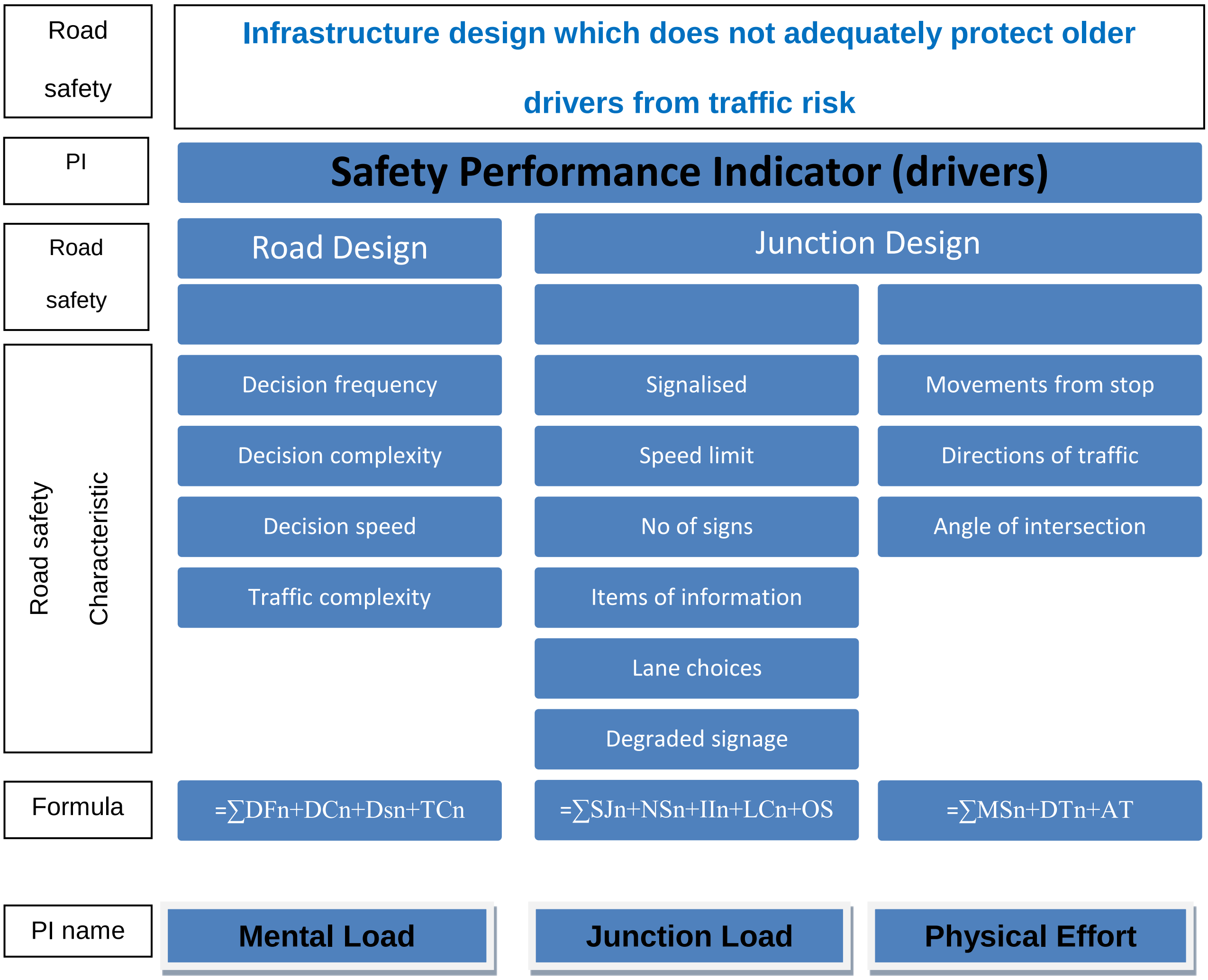
Composite indicator name	Indicator type	Simple indicators incorporated
Crossing difficulty	Safety Performance Indicator (pedestrians)	Physical Separation of infrastructure Dedicated crossings Pedestrian-only lights phase Barriers to visibility Median Strip Number of traffic lanes
Crossing risk	Safety Performance Indicator (pedestrians)	Speed limit HGV, Bus or BLU route, Parked cars
Time penalty	Mobility Performance Indicator (drivers)	Speed limit Approximate distance between safe crossings Pedestrian-only light phase Measures to curb speed (cushions, cameras etc)
Utility penalty	Mobility Performance Indicator (drivers)	Percentage of junctions with banned turns Percentage of routes which are urban clearways Percentage of routes with bus or cycle only space
Distance penalty	Mobility Performance Indicator (pedestrians)	Deviation of pedestrian route from desire line Number of poorly signed routes Percentage of poorly located crossings
Time penalty	Mobility Performance Indicator (pedestrians)	Average wait time for change of signalised crossings Average wait time for gap in non-signalised crossings
Effort penalty	Mobility Performance Indicator(pedestrians)	Average number of steps Average ramp length

Composite indicator name	Indicator type	Simple indicators incorporated
Utility penalty	Mobility Performance Indicator (pedestrians)	Percentage of locations with poor pavement condition Percentage of locations with shared cycle/pedestrian provision Percentage of locations with footpath obstructions Percentage of locations with traffic intrusion
Public transport access	Mobility Performance Indicator (pedestrians)	Percentage of locations where access is not level Percentage of locations where return journeys cannot be made with equal ease

4.5.1 Safety Performance Indicators for older drivers

Figure 7, below shows the schema for the Safety Performance Indicators for older drivers. As can be seen, the performance indicator focuses on the design of the road infrastructure itself and the design of the junctions, producing three unweighted composite indicators; mental load, junction load and physical effort. The data requirements and analysis techniques are discussed further in the sections which follow.

The presented formulae were developed as part of the study: Whilst previous studies have derived Road Safety Performance Indicators for infrastructure (Hakkert and Gitelman, 2007), these were intended to measure performance on a national level, hence focused on the trunk road network. The indicator described by Hakkert and Gitelman measured the degree to which the provided infrastructure met the demands on the network as measured in terms of traffic flows. This is very different from the focus of this study, which is urban roads and the needs of users as individuals with different performance standards. As a result it was necessary to derive completely new indicators, with the presented formulae representing the outcome of findings from the literature review, incorporating feedback from Dr M. Vis of the Institute for Road Safety Research (SWOV) in the Netherlands (personal communication, May 2012).



Road safety	**Infrastructure design which does not adequately protect older drivers from traffic risk**		
PI	**Safety Performance Indicator (drivers)**		
Road safety	Road Design	Junction Design	
Road safety Characteristic	Decision frequency	Signalised	Movements from stop
	Decision complexity	Speed limit	Directions of traffic
	Decision speed	No of signs	Angle of intersection
	Traffic complexity	Items of information	
		Lane choices	
		Degraded signage	
Formula	$=\sum DFn+DCn+Dsn+TCn$	$=\sum SJn+NSn+IIn+LCn+OS$	$=\sum MSn+DTn+AT$
PI name	**Mental Load**	**Junction Load**	**Physical Effort**

Figure 7; Schema for safety performance indicator (drivers) development

The following flow charts elaborate the methodology for each Safety Performance Indicator (drivers) in turn.

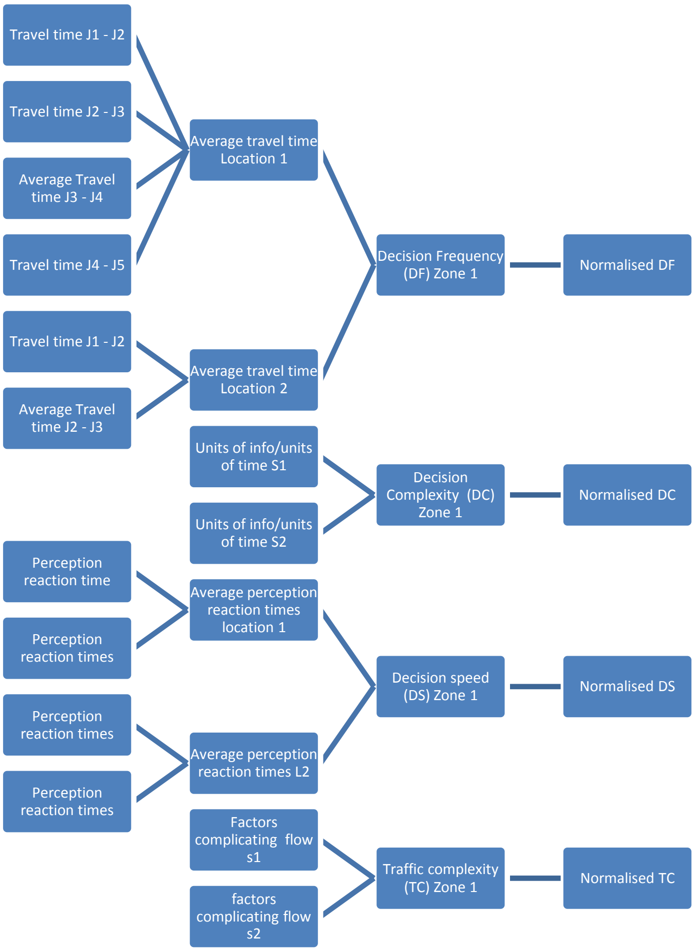


Fig 8; Methodology for Mental workload indicator

Mental Workload Penalty describes the degree to which the assessed infrastructure imposes a high mental workload on the driver. This is calculated by recording the travel time between junctions (“Decision frequency”), the average units of information to be processed per unit of travel time (“Decision complexity”), the number of decisions to be made per units of travel time (“decision speed”) and the number of complicating factors such as disturbances to traffic flow (“Traffic complexity”).

All of these variables are given equal weight for reasons which are set out in Chapter 7.

The collected data is normalised using the formula;

$X_n = a+(x-A)/(B-A)$

Where;

X = any value in the dataset

A = the smallest value recorded

B = the largest value recorded

a = the smallest value in the normalised range

b = the largest value in the normalised range.

The un-weighted composite indicator is then derived using the formula;

Mental Workload Penalty = $\sum \quad DFn + DCn + DSn + TCn$

Where -

DF = Decision Frequency (seconds)

DC = Decision Complexity (no of items)

DS = Decision Speed (no of interactions with infrastructure/second)

TC = Traffic Complexity (no of items)

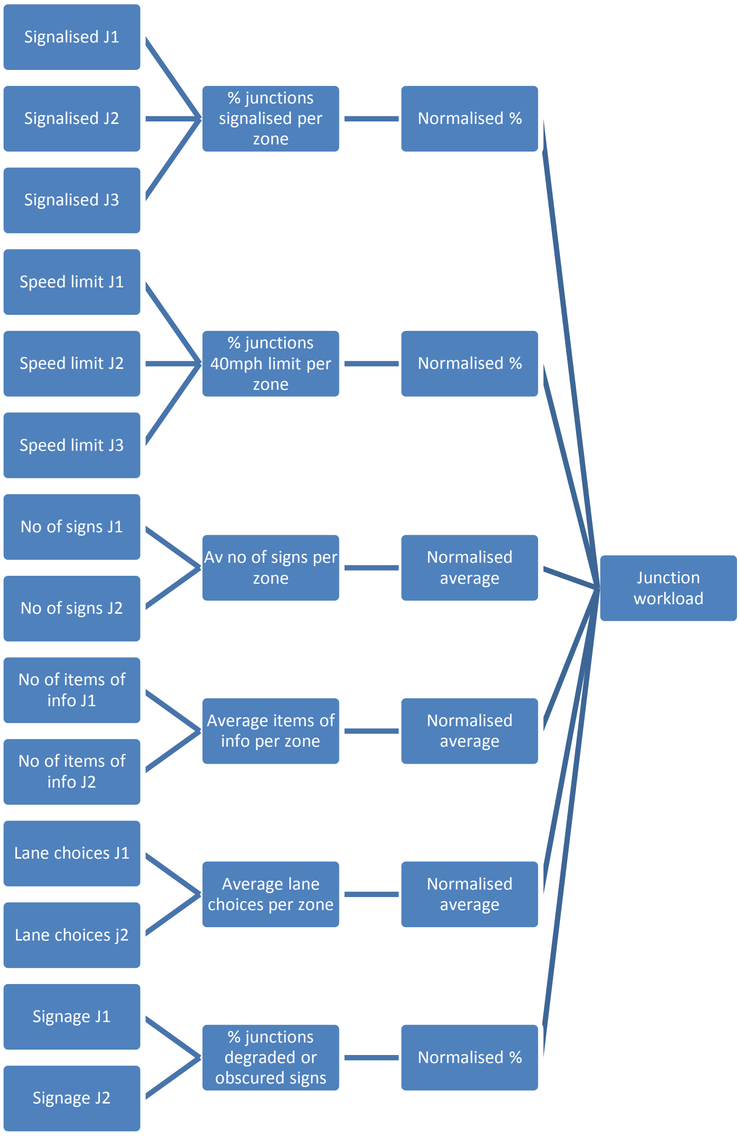


Fig 9; Methodology for Junction workload indicator

Junction workload penalty assesses the complexity of the junctions, in order to identify what proportion of junctions within a zone impose a high workload on the driver. As can be seen from figure 9, the contributing factors relate to the number of elements of information the driver must attend to, the time available in which to do so, and any complicating factors such as poor quality signage and traffic signals.

The collected data is normalised as per the formula already set out. The un-weighted composite indicator is then derived using the formula;

Junction Workload Penalty = $\sum \quad SJn + NSn + IIn + LCn + OS$

Where-

SJ = Percentage of signalised junctions

NS = Average number of signs

II = average number of items of information

LC = average lane choices

OS = Percentage of junctions with degraded or obscured signs

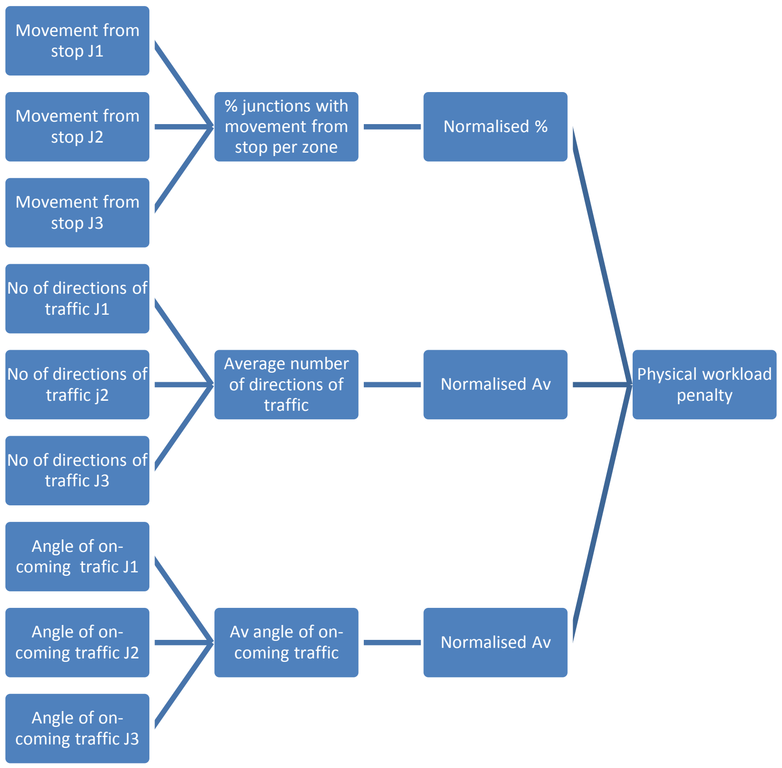


Fig 10; Methodology for Physical workload indicator

Physical workload penalty describes the degree to which the assessed infrastructure fails to take account of the physical limitations faced by some older drivers, such as restricted head and neck movements. It is calculated by recording the number of junctions at which drivers are required to simultaneously judge traffic from more than one direction, or where drivers must yield to traffic which is approaching from a direction other than straight ahead or 90 degrees left or right. Included in this, for example, would be the majority of junctions on the Ring Road, where drivers must merge between vehicles approaching from almost directly behind.

The collected data is normalised as per the formula already set out. The un-weighted composite indicator is then derived using the formula;

Physical Workload Penalty = $\sum \quad MSn + DTn + AT$

Where-

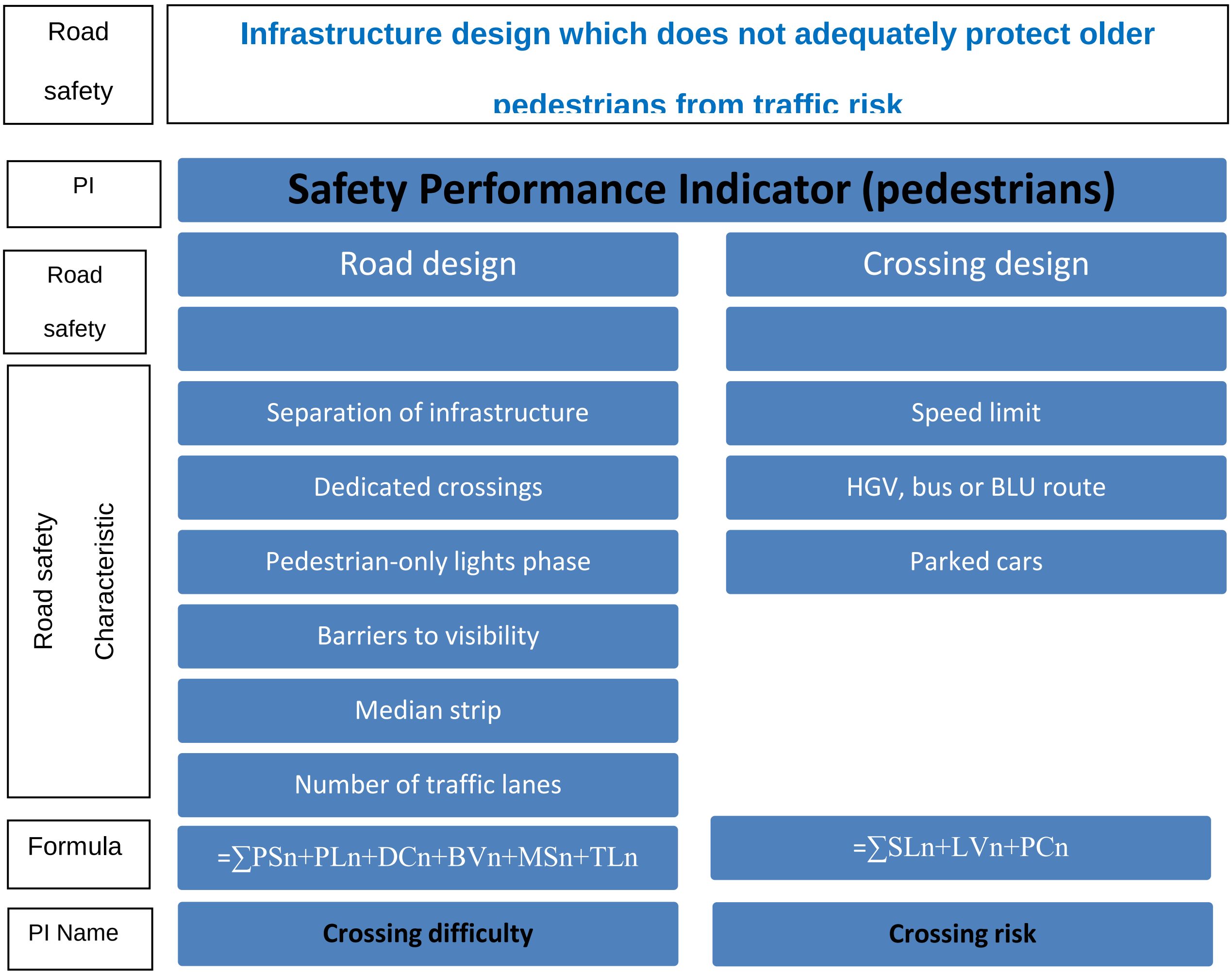
MS = Percentage of junctions at which movement from stop is required

DT = Average number of directions of approaching traffic

AT = average angle of on-coming traffic

4.6.2 Safety Performance Indicators for older pedestrians

Fig 11, below shows the schema for the Safety Performance Indicators for older pedestrians. As can be seen, the measures focus on the design of the road environment and the design of the crossing provision.



Road safety	Infrastructure design which does not adequately protect older pedestrians from traffic risk	
PI	Safety Performance Indicator (pedestrians)	
Road safety	Road design	Crossing design
Road safety Characteristic	Separation of infrastructure	Speed limit
	Dedicated crossings	HGV, bus or BLU route
	Pedestrian-only lights phase	Parked cars
	Barriers to visibility	
	Median strip	
	Number of traffic lanes	
Formula	$=\sum PSn+PLn+DCn+BVn+MSn+TLn$	$=\sum SLn+LVn+PCn$
PI Name	**Crossing difficulty**	**Crossing risk**

Fig 11; Schema for development of safety performance indicators (pedestrians)

The main safety risk to pedestrians comes from crossing the road. Hence the indicators for pedestrian safety are related to different aspects of road crossing difficulty.

Figures 13 to 22 set out the methodology which is used for the performance indicator calculations, which are described in detail in the following sections.

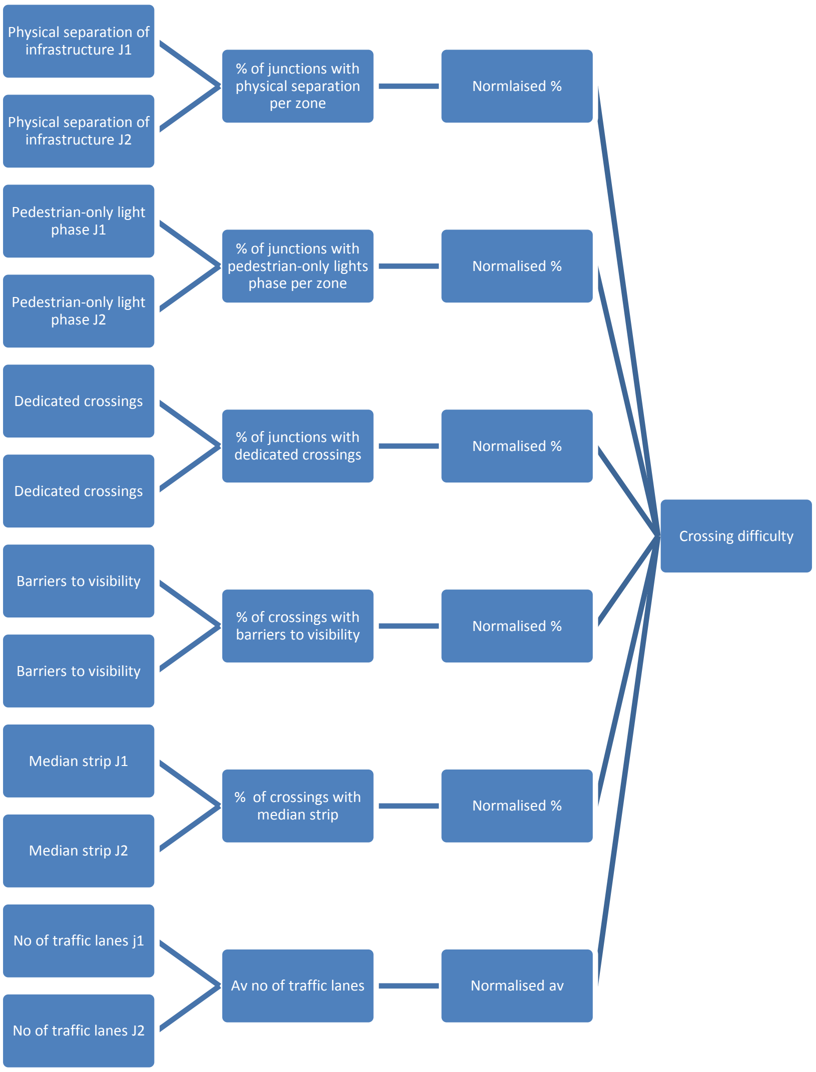


Fig 12; methodology for Crossing Difficulty indicator

Crossing Difficulty records the presence or otherwise of grade separation of pedestrians and motorised traffic, pedestrian-only phases in signals, the number of lanes of traffic to be crossed, and the presence or otherwise of median strip. These are all factors which the literature and focus groups have suggested increase the difficulty older pedestrians face when trying to cross the road. The collected data is normalised as per the formula already set out. The un-weighted composite indicator is then derived using the formula;

Crossing Difficulty = $\sum \quad PSn + PLn + DCn + BVn + MSn + TLn$

Where-

PS = Percentage of junctions with physical separation

PL = Percentage of junctions with pedestrian-only lights phase

DC= percentage of crossings with dedicated facilities

BV = percentage of crossings with barriers to visibility

MS= Percentage of crossings with median strip

TL = average number of traffic lanes

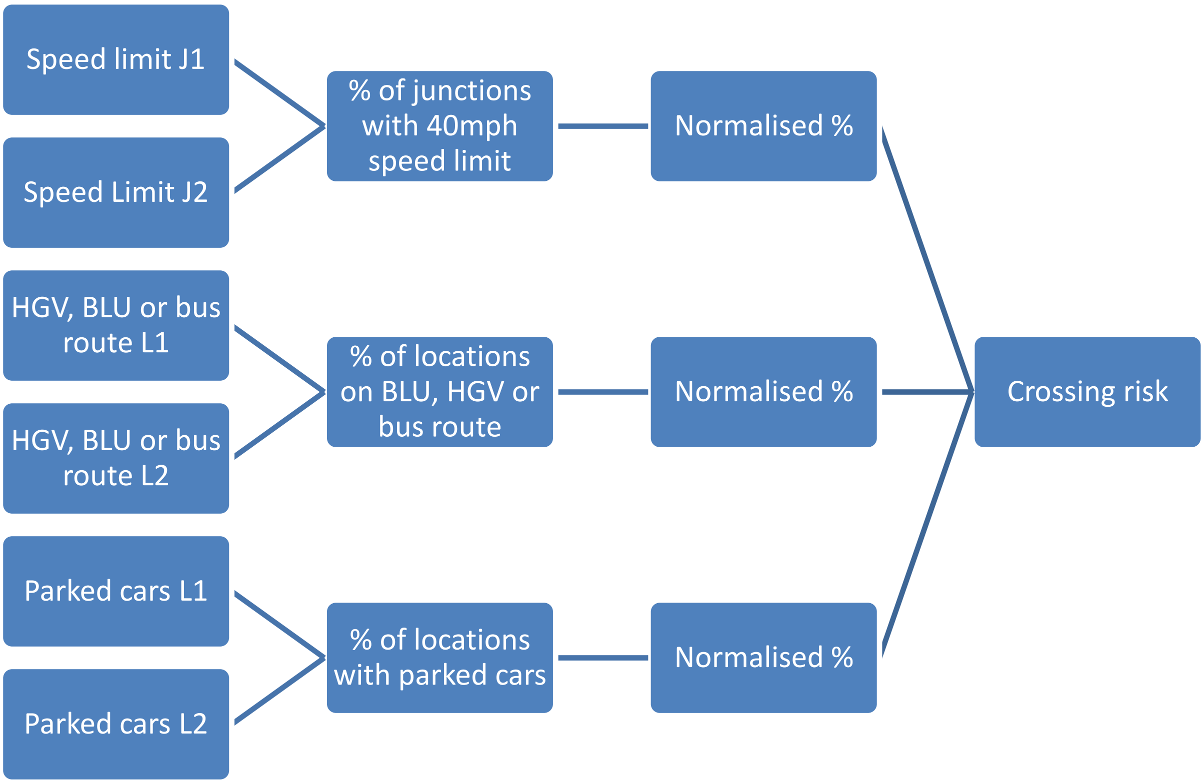


Fig 13; methodology for Crossing Risk indicator

Crossing Risk records the traffic speed, the presence or otherwise of parked cars, and the presence in the traffic flow of large or fast moving vehicles such as goods vehicles, buses or blue light users. These are all factors which existing data suggests increase the risk of older pedestrians suffering a serious or fatal injury when they are involved in a collision. The collected data is normalised as per the formula already set out. The un-weighted composite indicator is then derived using the formula;

Crossing Risk = $\sum \quad SLn + LVn + PCn$

Where-

SL= Percentage of junctions with a 40mph speed limit

LV = Percentage of locations on Blue light user, large goods vehicle or bus route

PC= percentage of locations with parked cars

4.5.3 Mobility performance indicators for drivers

Figure 14 summarises the schema for the proposed mobility indicators for drivers, and the variables used in the calculation. As can be seen, the measures focus on the travel speed and the degree to which freedom of movement for motorised traffic is facilitated. The following sections discuss the two indicators in more detail.

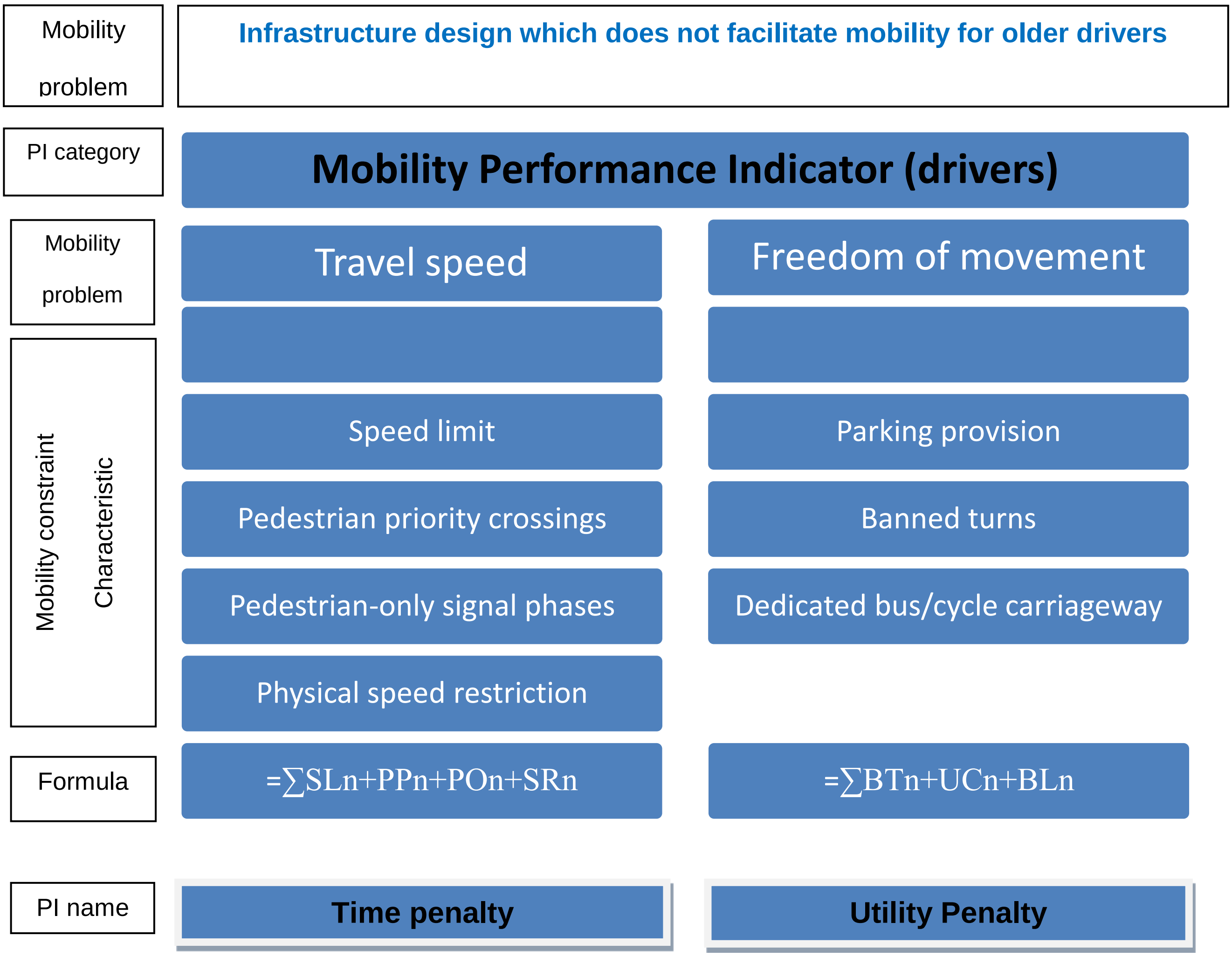


Figure 14; Schema for mobility performance indicator (drivers) development

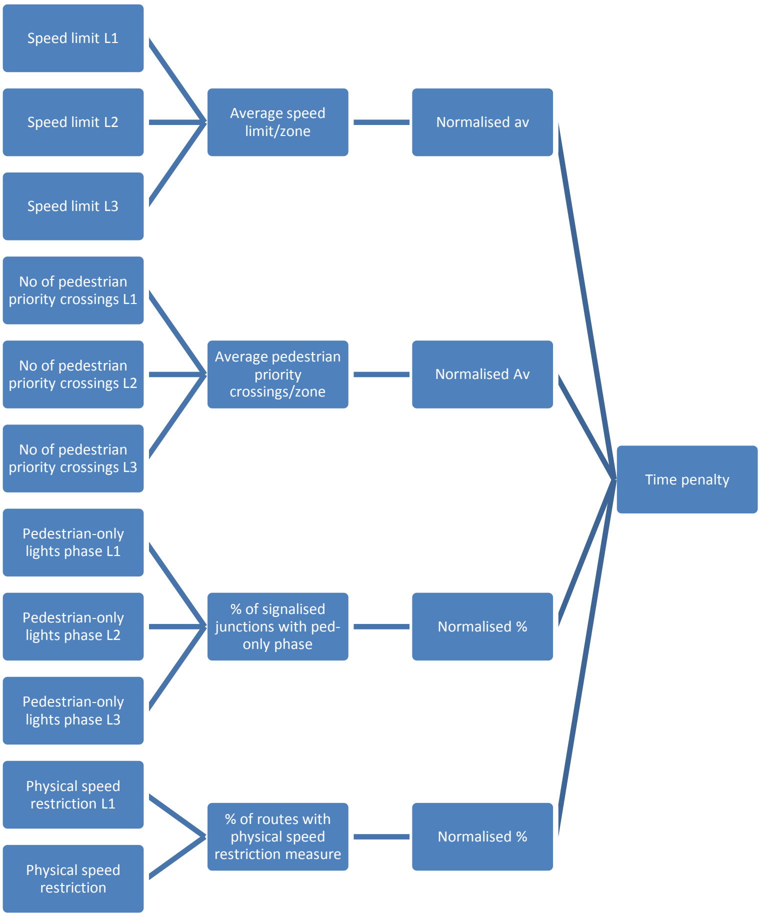


Fig 15; Methodology for Time penalty (drivers) indicator

Time Penalty provides an indication of the degree to which car journeys in the urban area are slowed down in order to facilitate pedestrian movement or pedestrian safety. Three variables are used: The speed limit, the percentage of dedicated pedestrian crossings within the study location, and any instances of features designed to slow vehicle traffic (for example, chicanes, speed cushions and other traffic calming, or camera enforcement of the speed limit). The collected data is normalised as per the formula already set out. The un-weighted composite indicator is then derived using the formula;

Time $\text{Penalty}_{\text{drivers}} = \sum \quad SLn + PPn + POn + SRn$

Where-

SL = Percentage of locations with 20mph or 30mph limit

PO= Percentage of signals with pedestrian-only phase

SR = Percentage of routes with physical speed restriction measures

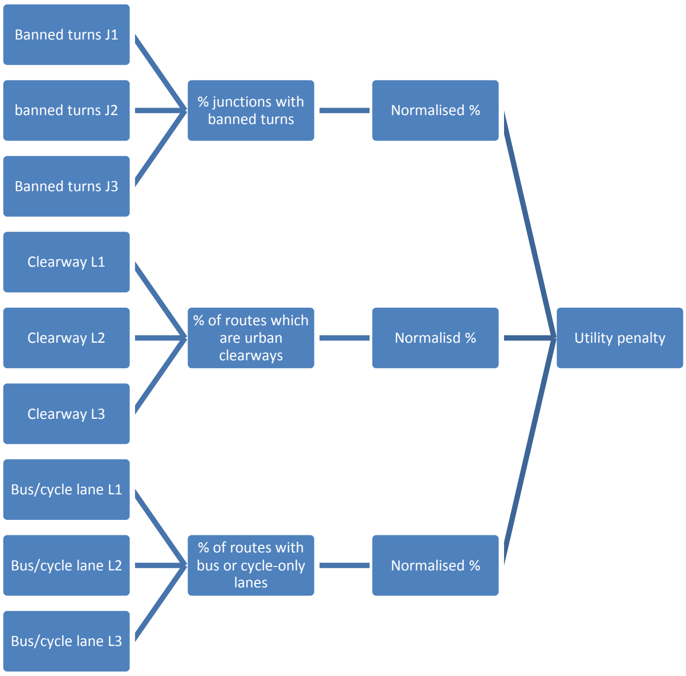


Fig 16; Methodology for Utility penalty (drivers) indicator

Utility Penalty describes the degree to which movement of motorised traffic is facilitated in the urban area. Features such as pedestrian-only infrastructure, banned turns and parking restrictions are recorded, in order to identify areas where vehicle movement is restricted. The collected data is normalised as per the formula already set out. The un-weighted composite indicator is then derived using the formula;

Utility $\text{Penalty}_{\text{drivers}} = \sum \quad BTn + UCn + BLn$

Where-

BT= Percentage of junctions with banned turns

UC = Percentage of routes which are urban clearways

BL= Percentage of routes with bus or cycle-only infrastructure

4.5.4 Mobility performance indicators for pedestrians

Figure 17, below shows the schema for the development of the mobility performance indicators for pedestrians. As can be seen, the indicators cover 5 dimensions; the increased distance necessitated by barriers to mobility, the increased time, increased effort, decreased enjoyment and lack of access to transport interchange. The following figures show the methodology for each indicator, and set out the formula for its calculation.

Mobility problem	Infrastructure design which does not facilitate mobility for older pedestrians				
PI	**Mobility Performance Indicator (pedestrians)**				
Mobility problem	Increased distance	Increased time	Increased effort	Decreased enjoyment	Lack of access to interchange
Mobility constraint Characteristic	Deviation of route from desire line	Road crossing wait time	Topography	Pavement condition	Pedestrian access
	Poorly signed routes		Grade separation	Footpath obstructions	Ease of return journeys
	Poorly located crossings			Intrusion (noise, fumes)	Level access
				Lighting levels	
				Attractiveness of environment	
Formula	$=\sum ADn+PRn+SCn$	$=\sum AWn+AGn$	$=\sum NSn+RLn$	$=\sum PCn+SIn+FOn+TIn$	$=\sum ALn+RJn$
PI name	Distance Penalty	Time Penalty	Effort Penalty	Utility Penalty	Public Transport

Figure 17; Schema for mobility performance indicator (pedestrians) development

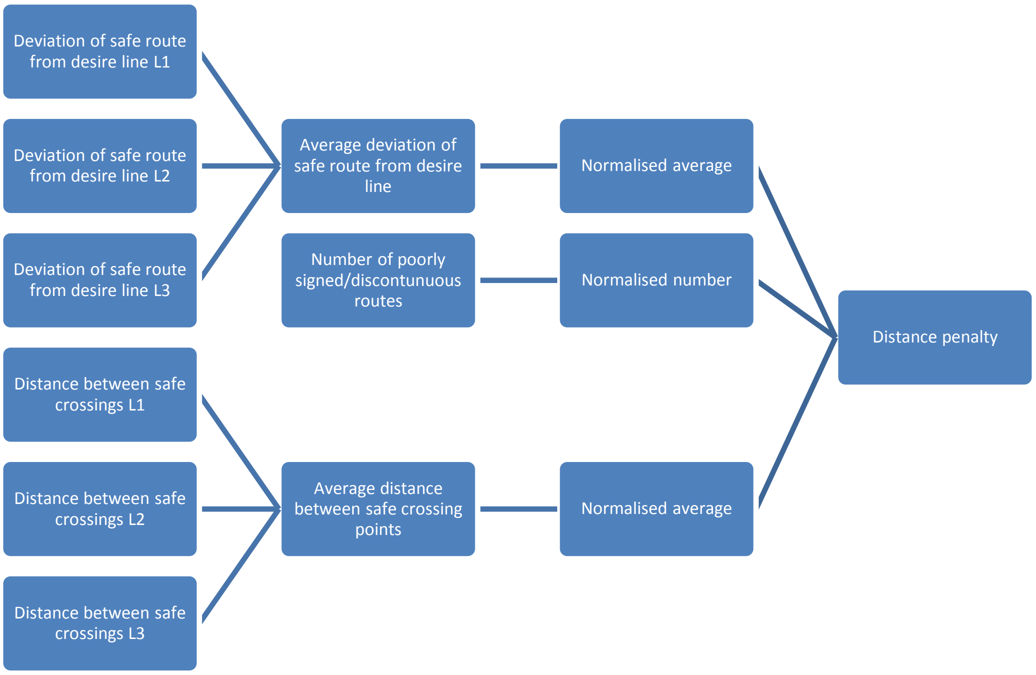


Fig 18; Methodology for Distance penalty (pedestrians) indicator

Distance Penalty is calculated by measuring the distance between a direct road crossing and the "safe" crossing point as determined by the location of crossing facilities such as signalised crossings or grade separated crossings. A distance penalty is calculated for all infrastructure with dedicated crossing provision, as it is assumed that where this has been provided, it has been deemed "unsafe" for pedestrians to attempt crossing elsewhere.

The locations at which distance penalties have been calculated is determined by reference to the services and facilities which exist at a location. For example, where a bus stop is on one side of the road and services such as shops are on the other, the distance penalty is measured from the bus stop to the shops. In the case of roundabouts with no grade separation of pedestrians, the distance penalty is the difference between directly crossing the roundabout, and walking along the arms to the signalised crossing. Distance penalties have also been calculated where there is clear divergence between the pedestrian desire line and the safe pedestrian route, as evidenced by patchy grass, mud or other damage to planting.

In the cases where there are many potential distance penalties at the same location (for example, at the Ring Road, where many facilities and services are located) a number of distance penalties are identified and calculated, with average penalties then being used. The collected data is normalised as per the formula already set out. The un-weighted composite indicator is then derived using the formula;

$$\text{Distance Penalty}_{\text{pedestrians}} = \sum \quad ADn + PRn + SCn$$

Where-

AD= Average deviation between pedestrian desire-line and safe route (metres)

PR = Average number of poorly-signed or discontinuous routes

SC= Average distance between safe crossing points (metres)

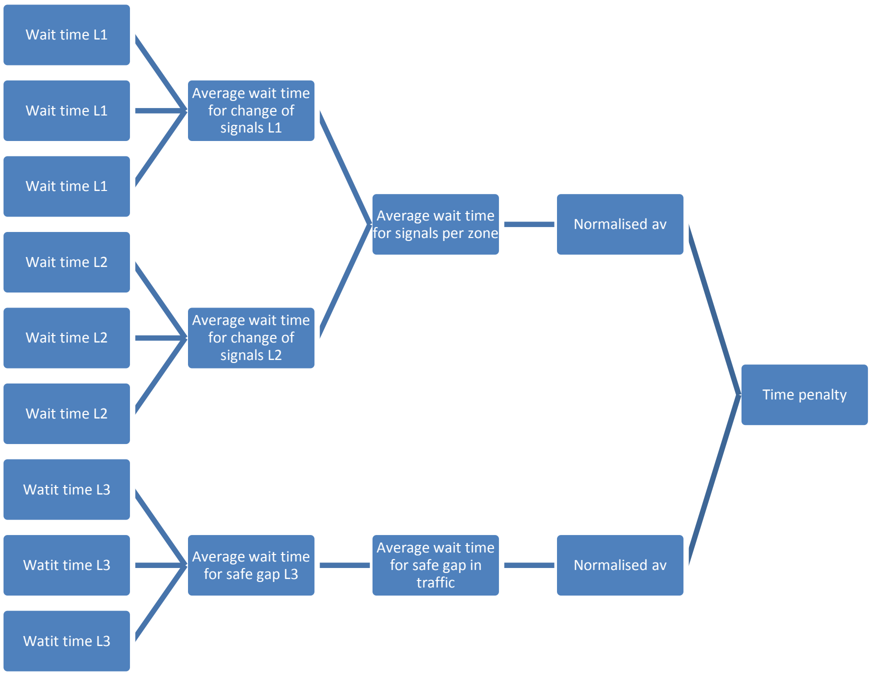


Fig 19; Methodology for Distance penalty (pedestrians) indicator

Time Penalty is calculated by timing the wait to cross the road, from placing the call (at signalised crossings) to the traffic stopping. For comparison, at locations with no grade separation, an average wait time to cross the road away from the dedicated crossing provision is also calculated. This will be used when assessing the trade-offs made between driver mobility and pedestrian mobility. Again, in locations such as the ring road where there are several signalised crossings and potentially several different measures, an average measure is taken. The collected data is normalised as per the formula already set out. The un-weighted composite indicator is then derived using the formula;

Time Penalty$_{\text{pedestrians}}$ = $\sum \quad AWn + AGn$

Where-

AW= Average wait time at signalised crossings (seconds)

LG = Average wait time at un-signalised crossings (seconds)

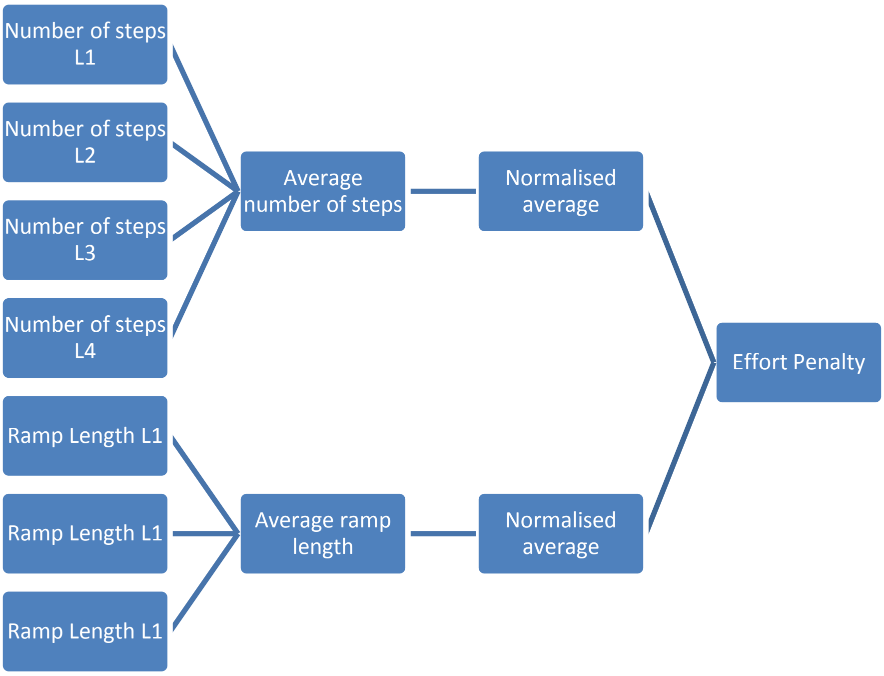


Fig 20; Methodology for Effort penalty (pedestrians) indicator

Effort Penalty is calculated for locations where there is grade separation of pedestrians and motorised traffic which means that the safe pedestrian route involves a change of level such as bridge or subway. The effort penalty is the number of steps which must be climbed in order to access a bridge or leave a subway, and the average length of the ramp. The collected data is normalised as per the formula already set out. The un-weighted composite indicator is then derived using the formula;

Effort Penalty = $\sum \quad NSn + RLn$

Where-

NS= Average number of steps

RL = Average ramp length (metres)

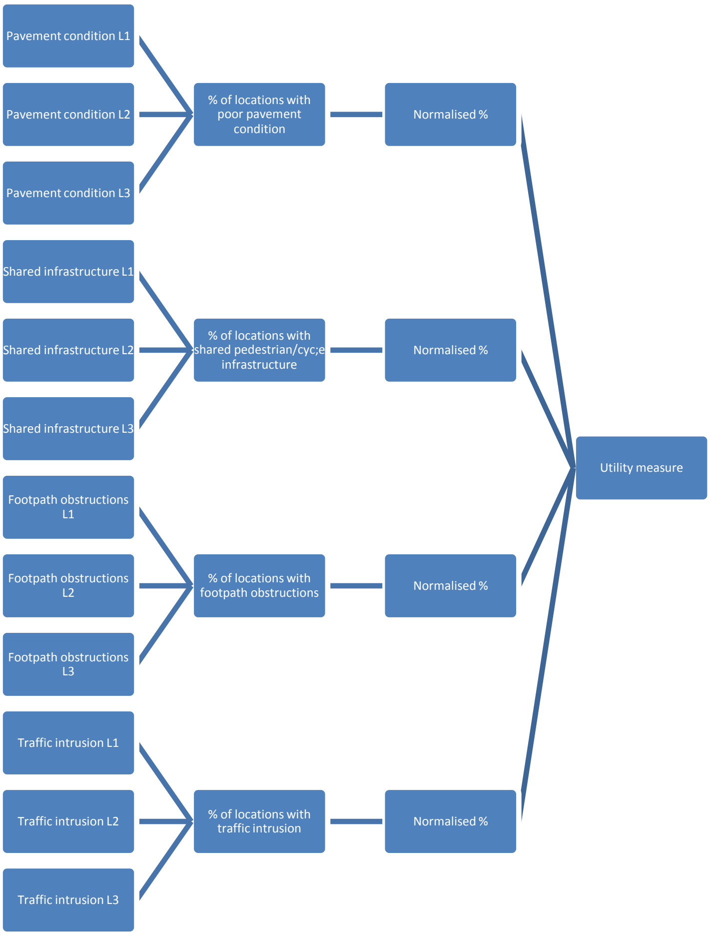


Fig 21; Methodology for Utility penalty (pedestrians) indicator

Utility Penalty is a subjective measure which records the presence of factors which the literature study and focus groups highlighted as having a negative impact on older users' perceptions of an area. The utility penalty is calculated by scoring each incidence of the following negative factors; Road noise, poor lighting, unattractive infrastructure (for example, intrusive signage, high guard rails), uneven paving, the presence of shared cycle and pedestrian facilities, and the incidence of pavement obstructions such as signage, parked vehicles, shop displays and bollards. The collected data is normalised as per the formula already set out. The un-weighted composite indicator is then derived using the formula;

$$\text{Utility Penalty}_{\text{pedestrians}} = \sum \quad PCn + SIn + FOn + TIn$$

Where-

PC= Percentage of locations with poor pavement condition

SI = Percentage of locations with shared pedestrian/cycle infrastructure

FO= percentage of locations with footpath obstructions

TI = Percentage of locations with traffic intrusion

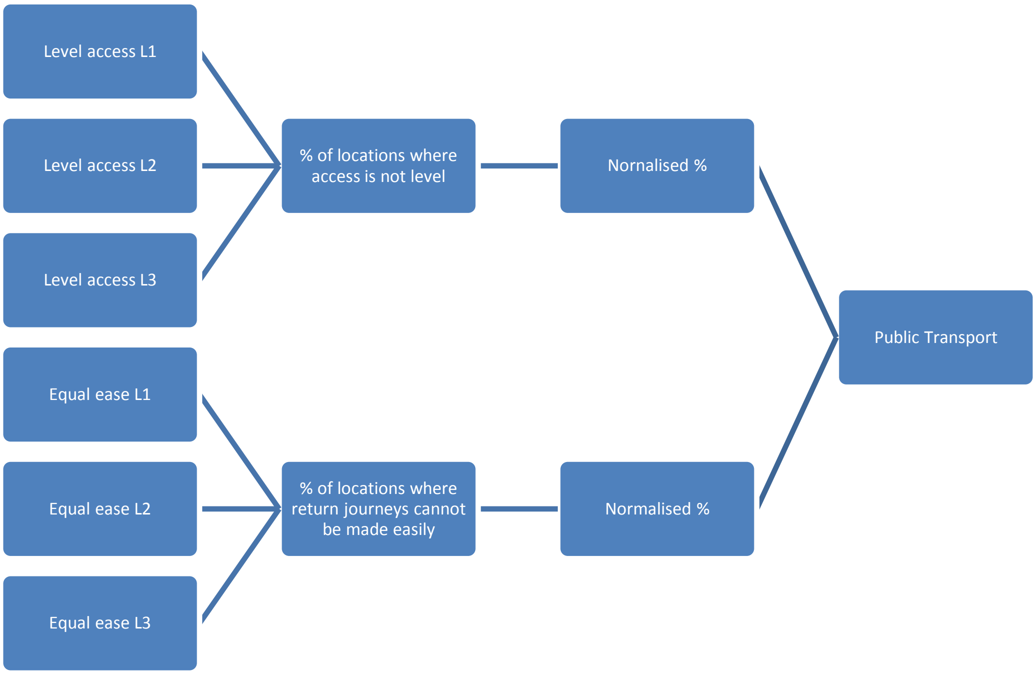


Fig 22; Methodology for Public transport penalty (pedestrians) indicator

Public Transport Access is a measure of how easily pedestrians can access the public transport services in their local area. As has been stated in section 1.4, many of the issues older people face in using public transport services relate to their journey to/from the bus stop. This measure aims to capture the extent to which the limitations of older road users have been taken into consideration in the location and design of public transport services, and the degree to which their needs *as pedestrians* walking to and from bus stops and train stations are met. The measure has two components: The first measures the incidence of locations where access to public transport is not on one level (for example because of high kerbs or steps), the other measures the incidence of locations where return journeys cannot be made with equal ease (for example, because the “to town” and “from town” stops are on opposite sides of major road junctions. The collected data is normalised as per the formula already set out. The un-weighted composite indicator is then derived using the formula;

Public Transport Access = $\sum \quad ALn + RJn$

Where-

AL= Percentage of locations where access is not level

RJ= Percentage of locations where return journeys cannot be made with equal ease.

4.6 Comparison study of qualitative data, calculated performance indicator and outcomes-based measures

The calculated performance indicators will be validated by comparison with the travel diary data, in order to attempt to draw some conclusions about how accurately they described the problems encountered by older road users, and reflect their experiences.

The validated performance indicators will then be compared with secondary data such as accident and casualty figures. The accident and casualty figures will be assessed in conjunction with the proxy exposure data collected via the focus groups and travel diaries.

Any differences between performance as measured using outcomes-based indicators (accident statistics) and performance as measured by performance indicators will be analysed in order to understand-

1) The policy trade-offs that have been made
2) The impact of those trade-offs on the safety and mobility of older road users
3) The potential contribution of performance indicator measures to determining future policies.

This will enable questions such:

- Have some road safety measures (for example roundabouts and dedicated crossing facilities) led to a reduction in safety and/or mobility for older road users?
- Do additional issues become apparent when performance indicators, rather than outcomes-based measures are monitored?

4.7 Recommendations

Remedial measures will be suggested for those locations which perform poorly on the performance indicator measures and/or show high levels of suppressed demand and/or high accident rates. These remedial measures will also be assessed against the policies which would have been suggested by analysis of the accident and casualty statistics alone. In cases where there is a discrepancy between the two, the implications for safety and mobility of the different approaches will be identified and discussed.

The potential offered by performance indicators in policy design will be explored and recommendations for appropriate performance indicators and necessary data collected will be made.

4.8 Conclusions

The aim of this research is to explore the conflict that may sometimes arise between progressing road safety and facilitating continued mobility for older road users in urban areas. The methodology outlined in this chapter will allow analysis of the extent to which constructing performance indicators and monitoring them in conjunction with casualty and accident totals can help to balance the promotion of road safety with the facilitation of continued mobility. The difficulties outlined in section 1.2 which arise from the lack of sufficiently detailed data regarding exposure to risk of older road users (both as pedestrians and drivers) are addressed here through the use of in-depth case studies allowing a proxy measure for exposure (“suppressed demand”) to be estimated at the locations deemed to have high incidence of barriers to mobility. This performance indicator, used in conjunction with accident and casualty measures, will enable conclusions to be drawn about the degree to which the mobility of older road users has been compromised by specific road safety interventions (for example, barriers and dedicated crossing points).

The indicators for safe mobility of drivers and safe mobility of pedestrians will describe the extent to which existing infrastructure meets the needs of older road users, by providing a safe and accessible road system, whilst the qualitative data will ensure that incorporation of the identified barriers to mobility are correctly weighted to reflect the needs and experiences of older road users themselves.

As well as providing recommendations for improving performance, the methodology described provides a way of measuring the success of past initiatives by reference to these performance indicators (rather than in terms only of fatalities or casualties), and thus of identifying areas where genuine improvements in the safety of older road users have been made.

CHAPTER 5: FEASIBILITY STUDIES

5.1 Introduction

This chapter sets out the results of the feasibility studies undertaken to determine the practicability of the proposed methodology. Aims and objectives of the feasibility studies are set out, the methodology is elaborated, some preliminary results are presented, and conclusions are drawn regarding the limitations of the studies and the future direction of the work.

Two separate feasibility studies were undertaken. The first pilot was a scoping study, designed to test the extent to which older road users experienced barriers to mobility in the urban area, the terms in which they articulated the difficulties, and their opinions on the degree to which the infrastructure they used helped to protect them from traffic risk. The second was a test of the proposed methodology for the assessment of infrastructure and the validation of this methodology using the travel diary study.

5.2. Aims and Objectives

The overall aim of the feasibility studies was to determine how suitable the proposed methodologies were for addressing the research questions, and to highlight any previously unanticipated difficulties. The objectives of the feasibility studies were;

- to test the methodologies proposed

- to gain some insight into the likely timescales
- to highlight any possible barriers
- to assess the usefulness and suitability of the proposed methodologies in achieving the objectives set out for the study.

Both feasibility studies focussed on the city of Coventry in the West Midlands (UK). This city was chosen for the reasons set out in the previous chapter, but had the added advantage of being a place where contacts in stakeholder organisations such as the City Council had expressed a willingness to provide data and feedback where appropriate.

These two studies are described in detail in the following sections.

5.3 Pilot Study A – Scoping Study

5.3.1 Methodology

The methodology for the scoping study consisted of three separate elements;

- Questionnaire activity
- Visual inspection of infrastructure
- Comparison of accident statistics

The purpose of the questionnaire activity was to find out from older road users themselves how they perceive their safety and mobility when using different types of road infrastructure. This serves a number of objectives;

- To confirm the findings of the literature study, highlighting the key difficulties older road users encounter.
- To help ensure that the analysis focuses on issues which are relevant to the users of the specific infrastructure assessed later in the work.
- To highlight areas of infrastructure where later data collection could be undertaken, by identifying areas where respondents felt there were particular, specific issues with the infrastructure, which could be captured by the later work.

The visual inspection of infrastructure was intended to ensure that such work was feasible, to identify any practical difficulties or barriers, and to provide information about likely timescale required for such work.

The purpose of the limited analysis of accident statistics which was incorporated into the scoping study was to test the hypothesis set out in section 1.2, namely that using outcomes measures (such as accident and casualty figures) does not necessarily give a complete picture of road safety, especially in the absence of detailed and reliable exposure data.

The separate elements of the scoping study feed into the pilot study which is described below.

5.3.2 Questionnaire Study

30 questionnaires were distributed using the Warwickshire Federation of Women's Institutes. As it was intended only as a scoping study it was felt that 30 would provide sufficient responses to test out the methodology, especially as the response rate was likely to be high given that the questionnaires were handed out in person and the group was relatively small. Distributing via the WI meant that the target age group was reached, and also that those receiving the questionnaire were relatively active, mobile older people. For the most mobility-limited older users it was anticipated that other issues besides infrastructure design would present bigger barriers to mobility (for example, underlying health conditions), hence distributing via local health care facilities such as GP practices was discounted. Whilst distributing via the WI resulted in more female than male responses this was not felt to be a problem given the statistics presented in Chapter 1 describing women's longer life expectancy and predicted increases in licence-holding amongst women over 65. 22 questionnaires were returned (Appendix A) the characteristics of the respondents being described in table 10, below;

Table 10; Characteristics of questionnaire respondents.

Gender	**Number**	**Percentage**
Male	8	36
Female	13	59
Not given	1	5
Age		
60 – 64 yrs	6	27
65 – 69 yrs	8	36
70 – 74 yrs	5	22
75 – 80 yrs	1	5
not given	2	10

Respondents were invited to identify two or more locations where they felt the road infrastructure placed them at risk, and to explain what specifically about the places they had identified caused them concern.

Figure 23 shows the locations of the most commonly identified problem infrastructure.

Slightly over half (12) of the respondents identified two locations, 9 respondents identified only 1 location, and 1 respondent identified 3, making a total of 37 suggestions. The characteristics of the identified locations are summarised in tables 12 and 13.

Figure 23; Locations identified through the questionnaire (numbers 1-6) and through later analysis of accident statistics (numbers 1, 2, 7,8)

Table 11; Characteristics of identified locations.

Location name	Map ref	Location description	No mention
A46, junction with A428	4	Multi-lane roundabout (Not signalised)	1
A444 Ricoh Arena junction	2	Multi-lane roundabout (signalised)	3
A45 Fletchampsted Highway	3	Multi-lane roundabout (unsignalised)	1
A46/A45 Toll Bar End	1	Multi-lane roundabout (signalised)	7
London Rd/Whitley roundabout	5	Multi-lane roundabout (signalised)	6
Binley Road jct Church Lane	6	Crossroads (signalised)	1
Binley Road A444 jct	6	Multi-lane roundabout (unsignalised)	5
A46/M40 Longbridge	n/a*	Multi-lane roundabout (signalised) Motorway junction	3
Catthorpe M6/M1 interchange	n/a*	Multi-lane roundabout (signalised) Motorway	1
Dunton Motorway Intersection A38/M6/M42	n/a*	Multi-lane roundabout (signalised) Motorway junction	1
Tomkinson Road Nuneaton	n/a*	Blind bend	2
Gypsy Lane Nuneaton	n/a*	Local distributor road	1
Could not be identified from description	n/a*		5

*indicates locations not shown on the map, as they fall too far outside the city.

Table 12; identified locations categorised by infrastructure type.

Junction type	Number	Percentage of locations
Multi-lane roundabout (Not signalised)	7	19%
Multi-lane roundabout (signalised)	21	57%
Other signalised junction	1	3%
Not junction	3	8%
Other (could not be identified)	5	13%

The results of this small-scale questionnaire study suggest that certain types of infrastructure design limit the scope for older drivers to employ modifying behaviour techniques. They can and do try to minimise their need to use the locations identified, suggesting that were sufficiently reliable, disaggregated exposure data available, safety issues at these locations might be more obvious. Where no alternative routes exist, coping-strategies such as increased following-distance and lower speed for example do not necessarily help, meaning that both safety and mobility problems are encountered by older road users at these locations.

Only 8% of the identified locations were not at a junction. Junctions are known to be particularly risky for older users, with research suggesting that most fatal accidents involving older drivers occur at junctions in daylight at low speed (Hakamies-Blomqvist, 1998), and with older pedestrians being over-represented in intersection crashes, especially those involving turning vehicles (Zegeer et al, 1993). There are a number of potential contributory factors including distraction, misunderstanding priority and observation errors. Junctions in urban areas should therefore be a particular focus of research activity.

Whilst junctions in general are a problem for older users, these figures show that multi-lane roundabouts, whether signalised or not, cause particular concern. Roundabouts are known to be safer in the main for motorised vehicles than other junction types but they are less safe for pedestrians and cyclists (Federal Highway Administration, 2000). This suggests that they also cause anxiety for older road users. One explanation for this is that the type of coping strategies that are adopted by older drivers, such as leaving longer following distances, larger gap selection at junctions (Schlag, 1993) cannot readily be applied to roundabouts. Complex judgements about the speed and distance of approaching vehicles must be made in relatively short time spans, and vehicle speed on busy roundabouts is dictated to some extent by the speed and flow of the traffic into which vehicles entering the roundabout must merge. The topography of some roundabouts may cause additional problems for anyone with the kind of mobility limitations described (such as stiff joints and weak muscles). For example, the London Road/Whitley roundabout (identified by 6 respondents) requires drivers travelling from East to West to observe and merge with traffic coming from directly behind (see figure 5).

Figure 24; London Rd/Whitley Roundabout.

As can be seen, traffic heading westbound from the A4028 London Rd must merge with traffic heading North/Northwest along the A444 as it leaves the roundabout towards Whitley Village. The necessity to select and manoeuvre into the correct lane and to observe traffic signals once on the roundabout may lead to confusion and an over-load of information. The provision of the right amount of information, in a clear and accessible format at an appropriate distance from the roundabout is clearly an issue. Table 13, below, details the reasons given by respondents for identifying particular locations.

Table 13; Reasons given for selection of particular locations

Reason	No of mentions	%
Confusing design	5	12
Inadequate information	13	30
Speed/volume of traffic	13	30
Poor sight-lines	7	16
Other	5	12

(N=43)

The Toll Bar End roundabout was highlighted by 7 respondents, making comments which included;

“marked very poorly”

“too many roads served by one island”

“lanes very difficult to follow especially heading to city centre. Speed/volume of traffic make it difficult to exit”

“Too many lanes and too many accesses so even traffic lights leave confusing options”

“Many large lorries…. Very intimidating for cars – visibility for oncoming traffic very restricted”

“If I can find another route to where I’m going, then I take it. Why put myself though all that stress?”

“When it is really busy, the lanes fill up with traffic waiting for the lights to change. You wait for a gap, pull on to the roundabout and then find there’s an enormous lorry blocking your lane and you’re right in someone’s way with nowhere to go”

"You're just going round where you're supposed to be, and suddenly you have to slam on the brakes because someone's exit is blocked and they've stopped right in the way of where you want to go"

Comments relating to the lane markings and to confusion on the part of users support the suggestion that the amount and type of information provided at junctions should be an important component of later audits. However, the number of tasks users must focus on (identifying the correct exit from several options, being aware of other traffic, observing signals) is clearly also a factor for older drives. Though signalised roundabouts were by far the biggest single location type identified by respondents as being problematic, many respondents felt that the introduction of signals (or their extension on already signalised junctions) would improve problem roundabouts. In most cases traffic lights were seen as a way of slowing traffic and reducing the flow, especially on the larger roundabouts where vehicles were able to build up speed significantly before exiting the roundabout, making it difficult for other vehicles to enter or for pedestrians to cross. Several respondents suggested that such large roundabouts were an inappropriate design, especially in an urban area where there are likely to be pedestrians and cyclists, and that alternative infrastructure such as crossroads or flyovers should be considered. In the case of cross roads, it is likely that maintaining sufficient throughput of vehicles could be a problem. Additionally safety could be compromised, as roundabouts are thought to be a safer design for the majority of drivers. However, since this research specifically examines the urban context it could be argued that the appropriateness of such large roundabouts in urban areas should be reconsidered, given the problems they also pose for other vulnerable road user groups. For this reason, any instances of large signalised roundabouts in the study area will be identified through the audits. In the case of the single most frequently mentioned location (A46/A45 Toll Bar End roundabout), a consultation regarding junction improvements was launched in 2009. The proposals include an underpass for Birmingham-Leicester traffic, which would significantly reduce traffic flow on the roundabout itself. Whilst this scheme was suspended following the change of administration after the election of May 2010, in November 2011, the Chancellor announced that the scheme would be reactivated (http://www.highways.gov.uk/roads/projects/5392.aspx) Because of the current uncertainty regarding this location, and its position on the edge of the urban area, it will not be included in the later infrastructure audits. However, it has been used here for the visual inspection of infrastructure as a useful location at which to test the principles involved.

As has been noted previously, much existing literature focuses on older people's mobility from the perspective of pedestrians and public transport users (see Chapter 2), whereas many older road users continue to drive. The responses of the participants indicate that the safety and mobility issues which are faced by older drivers are also significant, and should not be masked by a focus on the needs of more vulnerable older road users such as pedestrians. However, during the main collection of user data, more effort will be made to ensure participants consider safety and mobility issues from both a driver and a pedestrian perspective.

5.3.3 Visual Inspection

The Toll Bar End Roundabout is located to the Southeast of Coventry, forming part of an outer ring road that was planned during post-war reconstruction of the city but which has never been completed. It is formed by the meeting of the A46 Eastern Bypass, opened in 1989 and the A45, linking Coventry to Birmingham to the Northwest and London to the Southeast.

According to the Highways Agency, an executive arm of the UK Department for Transport with responsibility for the strategic road network, the roundabout is used by approximately 86,000 vehicles per day, which is significantly above its design capacity (Highways Agency, 2007). This not only leads to congestion, delays and frustration, but can add to the problems experienced by users attempting to negotiate the roundabout by adding to the complexity of the traffic situation.

Figures 25 - 28 show views of the approach to the roundabout travelling London-bound along the A45 (Northwest to Southeast

Fig 25; View of Northwest approach to Toll Bar End, approximate distance from the roundabout of 300 yards.

As can be seen from the picture, there are only two lanes to the approach at this point, and six separate signs are visible in the picture. Assuming a speed of 50 – 60 mph, (the legal limit is 60mph at this point) it can be appreciated that drivers must process the information provided on each of these signs (and those on the road surface itself) in a relatively short space of time.

Fig 26; Northwest approach, approximate distance of 200 yards from roundabout.

At 200 yards from the roundabout, the carriageway has widened to three lanes. In addition there is the junction immediately behind the second sign, where a minor road joins from the left hand side.

Fig 27; Final Approach to junction.

Figure 27 shows the final approach to the junction. By this point the carriageway has widened to five lanes, one of which can be used for either traffic heading towards London or for traffic heading towards Leicester.

Fig 28; Toll Bar End roundabout

Figure 28 illustrates the relatively short distance between the signals on the roundabout itself, which can lead to lanes being blocked by waiting traffic. The large goods vehicle in the centre of the picture would prevent right-turning traffic from entering the roundabout in the correct lane on two arms; the B4110, visible on the left of the picture, and the A45, from which the picture is taken.

The main problems encountered by older drivers at this location can be summarised as;

- The need to select the correct lane from a choice of up to five lanes on some approaches, whist processing a large amount of information from roadside signs and instructions on the carriageway itself.
- The difficulty of manoeuvring round the roundabout whilst also observing the signals on the roundabout, the movement of other traffic (which may stop

suddenly, because of blocked exits or traffic signals) and pedestrians, for whom there are signalised crossing points on most arms.

- The difficulty of correcting a wrong lane choice, due to the volume of traffic and the general complexity of flows on the roundabout.
- The presence of very large vehicles, which cannot by their nature manoeuvre solely in one lane.

It is possible that the factors identified would make this infrastructure problematic for many drivers, young or old. However, the difficulties are exacerbated for older drivers because of the well-documented changes which the ageing process causes. For example, slower reaction times make it more difficult for older drivers to react to a wrong lane choice; changes in visual perception have implications for the signage, which in turn affect the ability to manoeuvre round the roundabout competently. These additional difficulties and the way they affect driver performance are set out in detail in Chapter 2.

Table 14, below, summarises the main factors to be audited. This incorporates the findings from the literature study and the results of the pilot studies, in order to provide a comprehensive list of the safety and mobility issues identified so far as being relevant to older drivers and pedestrians.

Table 14; Factors to be audited

Indicator	Necessary information
Safety performance indicator drivers	• Travel time between junctions (seconds) • Instances of information over-load (units of information per unit of travel time, number of signs approaching junctions, number of items on signs) • Number of decisions that must be made per unit of travel time • Number of factors disturbing traffic flow (bus stops, pedestrians for example) • Junction characteristics such as provision of turning lanes, presence of traffic signals, number of lane choices • Percentage of signage obscured or illegible • Angle of intersection at junctions, movements from stop, number of directions of on-coming traffic.
Safety performance indicator pedestrians	• % infrastructure with physical separation of motorised and non-motorised traffic • % signalised crossings, % traffic signals with pedestrian-only phases • Any barriers to visibility • % crossings with median strip • Traffic conditions, for example, speed limit, presence of large or fast-moving vehicles such as emergency vehicles, goods vehicles or buses • % routes with parked cars
Mobility performance indicator drivers	• Speed limit • Distance between signalised pedestrian crossing points • Presence of pedestrian-only phases in signals • Presence of measures to curb vehicle speeds • Number of banned turns • Presence of parking restrictions

Indicator	Necessary information
Mobility performance indicator pedestrians	• Deviation of pedestrian route from desire line • Poorly signed/discontinuous pedestrian routes • Crossing facilities; distance between safe crossing points, proximity of crossings to other essential facilities such as bus stops, shops etc. • Average wait times to cross the road • Pavement surfacing; condition • Shared pedestrian/cycling facilities • Pavement obstructions, both moveable and fixed; for example, poor/illegal parking and vegetation. • Motorised traffic; density, noise levels, fumes or other sources of intrusion • Ease of access to public transport

Visual inspection undertaken as part of the scoping study has highlighted the difficulty of collecting information about some of the relevant variables. For example, in the case of travel time between junctions, units of information per unit of travel time, number of signs approaching junctions, number of items on signs and number of decisions that must be made per unit of travel time, the calculated figure may vary depending on the direction of travel which is assessed. Similarly, analysis of the Toll bar end junction has shown that roundabouts may be partially signalised, with some approaches or paths through the junction not encountering signals whilst others encounter several sets. In addition, some paths through a junction may be more complex than others, as a result of the location of other transport facilities such as bus stops.

This difficulty will be circumvented in the main study by considering several directions of approach and using average values.

In terms of pedestrian safety and mobility, as has previously been mentioned, large multi-lane roundabouts are problematic for pedestrians. Whilst roundabouts facilitate smooth traffic flow, in practice this can mean there are few crossing opportunities for pedestrians. It is often also necessary for pedestrians to make long detours to find the safest crossing point, rather than being able to cross directly where it is most convenient. As was highlighted by the literature, crossing many lanes of traffic at once is particularly problematic for older pedestrians.

The opinions of respondents focussed very much on the issues they faced as drivers, some of which could be categorised as driver safety issues (difficulty selecting the correct lane, difficulty correcting a wrong lane choice), and some as driver mobility issues (feeling intimidated by particular locations and looking for routes or modes that allowed them to avoid driving through the “problem” infrastructure). Future work to collect user data should aim for a more even balance of driver/pedestrian and safety/mobility issues. This could be achieved by using more interactive methods such as focus groups or structured interviews, where users can be prompted to consider the issues from different perspectives.

5.3.4. Analysis of Accident Statistics

To compare the level of risk perceived by the older drivers who responded to the questionnaire with the actual level of risk as measured by accident counts, statistics were acquired from Coventry City Council. Locations with clusters of three or more accidents in two years within 50m, with at least one vehicle occupant casualty aged 65 or older were identified. These are shown in table 15, below.

Table 15; Accident clusters in Coventry.

Map ref	No of accidents	Location description
7	5	A45 kenilworth Road, Fletchampsted Highway*
1	4	A45/A46 Toll Bar End Roundabout*
9	3	Ansty Rd/Woodway Lane
8	3	Foleshill Road, Station Street W/E
2	3	Tesco store/Ricoh Arena

**denotes at least 1 fatality at this location*

As can be seen, the top location as identified by the questionnaire is the second ranked location for accident counts, suggesting that the concerns older drivers have about this location are not unfounded The top ranked location as determined by the accident counts is not highlighted at all in the questionnaires.

It is interesting to note that all of the locations identified by the accident count are junctions, which supports the earlier assertion that urban junctions should be a priority for further research into the safety of older drivers.

It should be noted that whilst three questionnaire respondents raised concerns about location 2 (Ricoh Arena) all three of the casualties at this location were bus occupants who were injured as a result of falling as the bus arrived at or departed from the bus stop. This supports the earlier argument that policy-measures aimed at encouraging older drivers to seek alternative modes of transport should be treated with caution, as accident statistics show that older road users are more at risk as vehicle occupants or pedestrians than as drivers.

5.3.5 Results

The data collection part of the pilot study has shown that some elements which the literature has suggested may be important may prove difficult to measure in reality.

The questionnaire has highlighted issues identified by the literature study. Namely that complex urban junctions are problematic for older road users, and that where possible older drivers will try to avoid such infrastructure. As has been stated, the comments of older road users themselves tended to focus on the difficulties they encounter as drivers. Whilst this supports the earlier conclusion from the literature review (that driving is important for older drivers, and that policy aimed at promoting safe mobility for older users should not focus just on pedestrians or public transport users) it does mean that more care needs to be taken in the main collection of user data to ensure pedestrians are represented, and that participants also consider the issues they encounter when walking.

Analysis of the accident statistics has shown that the Toll Bar End roundabout (which scores highly on the elements related to high mental workload, and is mentioned by the highest number of questionnaire respondents) also has the second highest number of accidents. The highest ranked site for accidents (A45/Kenilworth Rd junction) will be assessed in the next stages of the research, in order to ascertain the role infrastructure features may have in increasing risk at this site.

As has been stated, the importance of a high accident count at any particular location is hard to ascertain without compatible data on exposure to risk. Whilst Toll Bar End and the A45/Kenilworth Rd junctions have the highest accident count, they are used by high numbers of vehicles, both being busy junctions with high traffic flows, several lanes and a mix of traffic including heavy goods vehicles and emergency vehicles. The high accident counts could merely reflect higher exposure to risk, as opposed to higher levels of risk. This highlights the importance of collecting data which can help to understand older users' exposure to risk at the audited locations.

5.3.6 Conclusions

The scoping study has been a useful exercise in trialling a number of elements of the main study, including;

- The selection of case study city
- The data collection
- The accident statistics analysis.

The scoping study has provided some important experience of the proposed methodologies, most of which have proved to be workable, though in some cases requiring small modifications.

A key finding from the scoping study is that further user data work should aim for a more even balance between comments and opinions relating to drivers and those relating to pedestrians. This could be achieved by adopting a more interactive methodology such as focus groups or structured interviews, where participants can be prompted to consider other perspectives.

5.4 Pilot Study B; Infrastructure Audit and Travel Diary Study

5.4.1 Methodology

The Infrastructure Audit and Travel Diary pilot study employ the methodologies set out in Chapter 4, but trials them on a smaller scale in order to identify any limitations and to make improvements.

5.4.2 Infrastructure Audit

To pilot the Infrastructure Audit, the city was divided into a number of Links and Places, as described in Chapter 4, with links being key routes around the city which are likely to be important for older drivers and places being destinations which are highlighted by the focus groups as containing the services and facilities that older people need. Two pilot data collection forms were produced, one each for Links and Places (Appendix B). Both were trialled at Ball Hill/Walsgrave Rd, as it was convenient to pilot both at the same location.

Ball Hill is a shopping area to the East of the City Centre, with shops on either side of the Walsgrave Road. It has a 30mph limit, and whilst on-street parking is limited, there are on-street spaces and car parks on the streets leading off the main shopping street. The road itself is busy, being extensively used by buses, as well as by emergency vehicles travelling to and from University Hospital Coventry and Warwickshire. The pavements are wide, but are used by shop-keepers for displaying stock. The shops are varied, but include banks, clothing and shoe shops, electrical shops, charity shops and small supermarkets. Walsgrave Rd itself is one the City's key arterial links, carrying traffic from the City Centre in an East – North East direction, towards strategic roads such as the M6 and M69. It also links the rest of the city to the main hospital (University Hospital Coventry and Warwickshire), as well as providing access to a number of retail and leisure activities on the eastern edge of the city, including a multi-screen cinema, a number of large supermarkets and hotels, gyms and restaurants, all of which were highlighted by the focus group participants as being important places for them to visit. It is, in places, an area with high pedestrian traffic flows, and a number of crossing points and junctions. The data collection form was designed using examples from existing literature, with additional elements included to capture specific issues.

The area was visited 3 separate times between February and March 2011, in order to get an idea of the effects (if any) of time of day, day of week and weather conditions, and also to identify temporary issues, as the highly dynamic nature of barriers to mobility had been highlighted by the literature review. The draft infrastructure audit data collection form was used to record identified instances of the factors which had been highlighted by the focus groups and literature study as being important for safety, mobility or both. Photographs were taken where relevant factors were identified. Table 16, below, identifies the factors which the infrastructure audit was designed to identify.

Table 16; Factors identified through infrastructure audit

LINKS		PLACES	
Feature	**Rationale for inclusion in audit**	**Feature**	**Rationale for inclusion in audit**
Poor sightlines	Deterioration in vision: Perceiving and responding to cues more difficult. Muscle degeneration: turning to look becomes problematic	Uneven/poorly maintained footpaths	Trip hazard
Provision of turning lanes	Increased risk where older users turn across on-coming traffic	Shared cycle/pedestrian facilities	Intimidating for older pedestrians
Obscured or illegible signage	Deterioration in eye sight.	Lack of crossing provision	Difficulty crossing roads
Complexity of information on signs	Increases mental workload.	Poorly sited or badly designed crossing facilities	Increases road crossing difficulty
Junction complexity (number of route/lane choices)	Increases mental workload	Unsuitable design and/or location of pedestrian access to public transport	Limits older people's mobility
Presence and type of traffic signals	Increases mental workload	Presence of dropped kerbs and tactile pavement surfaces	Trip hazard
Speed limits	Influences adoption of strategies and modified behaviour	Vehicular obstruction of footpaths	Limits mobility

5.4.3 Travel Diaries

For the Travel Diary Pilot, a draft diary was produced and distributed to five volunteers who had previously returned the pilot questionnaire. They were selected on the basis that they had previously identified urban locations in Coventry as being problematic. It was felt that these respondents were more likely to be frequent users of the infrastructure in Coventry which the main study would focus on, whereas questionnaire respondents who identified motorway junctions or locations in nearby towns such as Nuneaton might not be. The volunteers ranged in age from 67 to 85, with one who declined to give their age. Two volunteers were male and two female, with one again not completing the information.

The volunteers filled them in over a period of 7 days, and provided feedback on the experience. (Appendix C)

The aim of the travel diary activity is to collect information about;

- The distances older road users travel in urban areas,
- the main modes they use,
- the number of trips they make,
- the types of infrastructure they use (or do not use) and
- any patterns those journeys exhibit, with regards to, for example, day of the week or time of the day.

The purpose of this activity is to collect data on older road users' experiences of traveling through and to the locations identified as being particularly poor for mobility or safety. This will help to validate the calculated performance indicators by ensuring that the locations which are identified are the ones which older road users feel present problems, and will also enable a proxy measure of exposure to risk to be calculated.

The aims of this activity are thus to discover;

- Whether or not the locations have been rated correctly and verify that the results of the analysis of infrastructure reflect the experiences of the older road users themselves (validation of performance indicators). In other words, that older road users do indeed find the locations identified as having high barriers to mobility more problematic than those with low barriers, and to quantify the impact on older people's mobility of the barriers identified.
- To act as a proxy measure of exposure to risk, by establishing whether any of the barriers are sufficient to cause older road users to avoid the specific locations in question, or to avoid making the journey at all. This will enable relative accident rates to be estimated for the identified locations.

It is clearly important that the diary records useable and relevant information, but also that it is user-friendly and provides data that can be used in conjunction with the infrastructure audit data to provide a complete picture.

5.4.4 Results

The pilot data collection form for the infrastructure audit appeared to work well. It was relatively easy to identify and record barriers to mobility.

One problem with the travel diaries was immediately apparent, with the boxes provided clearly too small for the respondents to write all of the information in that they wished to convey. The column for recording trip purpose was not sufficiently large for those who opted to describe trip purpose in their own words. The option to code the information was offered, with some respondents doing this, but for those who wanted to explain more fully, more space would have been useful.

This was also the case for the column inviting volunteers to describe any difficulties they encountered. Other than where no difficulties were encountered, the space provided was inadequate, with volunteers having to find space elsewhere on the form to make more detailed comments.

However, a more fundamental difficulty with the approach was highlighted by the pilot study; the approach of taking several different links and places distributed across the city meant that most of the travel diary volunteers did not visit any of the links or places at all during the trial period. Whilst this was only a small pilot, with few volunteers and only a short trial period, it was recognised that this could be a significant problem if it occurred during the main data collection exercise. As a result of this, it was decided to group the links and places into zones, dispensing with some of the more outlying ones, and concentrating recruitment of travel diary participants for the main study in the residential areas within the zones. In this way it was hoped to ensure that there would be better cohesion between the data collected by the infrastructure audit and the data collected via the travel diaries when the main study was done.

Another major limitation of the travel diary approach was the influence of habit on the journeys taken: In some cases, participants recorded journeys as being unproblematic, where in fact they had not taken the most obvious or the shortest route. It may be that they had used a particular route for years, without giving any thought to why they did so, hence the effect of other factors such as changes to the road layout, changes in traffic conditions, or the presence of new buildings or facilities were not incorporated into their decision-making. It was therefore felt that for the main study a more interactive approach would be needed, whereby participants could be encouraged to think more deeply about the reasons for their choices and could be presented with and comment on the alternatives which they did not select.

5.5 Conclusions

The pilot study has provided some important experience of the proposed methodologies, most of which have proved to be workable, though in some cases requiring small modifications. In terms of meeting the stated aims and objectives of the study, these methods seem to be appropriate. .

This chapter has described the way in which the proposed methodologies have been trialled, and the modifications that were subsequently made to some elements.

The following chapter presents a qualitative study building on the questionnaire work undertaken as part of the scoping study and extends it further. Rather than the more prescriptive format of the questionnaires, the qualitative study allows participants more freedom in identifying the issues which they face in the urban environment, and provides the opportunity for them to highlight the services and activities that are important to them.

The results of the qualitative study inform the data collection activity of Chapter 6 and help to ensure that the focus of the data collection is appropriate and relevant.

CHAPTER 6: QUALITATIVE STUDY OF OLDER ROAD USERS' NEEDS AND EXPERIENCES

6.1 Introduction

Information about users' needs and experiences is an essential component of safety and mobility analysis: Without user data it is difficult to understand the interactions between the environment and the road user and the implications thereof for designing infrastructure which protects users from traffic risk whilst enabling them to access the services and facilities they need.

As well as identifying suitable locations for infrastructure audits and highlighting the key variables, user data may offer other analytical possibilities. For example;

- To apply weightings when deriving composite performance indicators. In other words, where an identified barrier is felt by users to significantly impact on their safety or mobility, that factor can be given a greater importance in the final indicator calculation.
- To provide a means by which proxy measures of exposure to risk can be derived:

As has been stated, road safety is traditionally monitored using counts of accidents or casualties. However, such analysis, in order to provide meaningful comparisons requires detailed and accurate exposure data. Earlier chapters have highlighted the difficulty of collecting exposure data for specific groups of vulnerable road user. However, without knowing the numbers of older pedestrians, the number of journeys they make in an area, or the distance travelled, it is difficult to say whether a given number of accidents represents an unacceptable level of risk for this group or not.

This, coupled with the phenomenon highlighted in the chapter 2, whereby older road users tend to avoid infrastructure which they find problematic, makes it difficult using conventional methodologies such as crash counts to evaluate the extent to which the infrastructure in some locations may be more or less safe for older road users. The collected user data will aim to provide a partial solution to this issue by collecting information about:

- The types of journeys older road users make in urban areas,
- Their mode choice and the underlying reasons for it
- The number of trips they make,
- The types of infrastructure they use (or do not use) and
- Any patterns those journeys exhibit, with regards to, for example, day of the week or time of the day.

The collected user data will inform the selection of locations at which to undertake audits by helping to identify areas which have the facilities and services that older people wish to use. It will also inform the selection of variables to be recorded, by identifying (in conjunction with the literature study) the barriers to and facilitators of safe mobility.

The following sections set out the methodologies by which the user data was collected, present the results obtained, and discuss the implications for the analysis which follows in Chapters 7 and 8.

6.2 Methodology

Two linked methodologies were used; the first, a focus group activity was designed to obtain user data about the generalities of how the infrastructure in the case study city was used by older people, and how they felt about their mobility and safety at these locations. The second methodology, which used a case study approach, was intended to collect micro-level data about individuals' journeys through the infrastructure, and how they might be affected by highly dynamic factors such as traffic conditions, parking and weather.

6.2.1 Focus groups

Four focus groups were undertaken, with the aim of collecting qualitative data to support and inform analysis of quantitative data (for example, accident statistics and data about the features of the road infrastructure) later in the study. As the feasibility study highlighted the importance of recruiting participants who regularly used the urban infrastructure a priority was placed on recruiting participants who lived in and around the identified Links and Places. This was done by using residents associations (where they existed), by using personal contacts, and also the previous participants and their networks. An important objective was to understand the services and activities that older people particularly need to access, as well as those that they felt served important social functions. Factors in the urban environment which presented barriers to mobility and accessibility were explored through open discussions, initiated by an informal presentation of the project and supplemented by posters showing photographs and maps, which attendees were invited to comment on, either verbally, or by writing comments on post-its and sticking them to the posters.

As an introduction, the aims and objectives of the study were presented, and the way in which the contribution of the participants would help to meet them was explained. Participants were then encouraged to contribute in any way they wished to the discussion.

Following the results of the scoping study, described in Chapter 5, participants were explicitly asked to consider ALL the journeys they made, and all elements of the journey regardless of the mode used. The need to consider any part of a journey made by foot (for example, walking to a bus stop or parked car) was also highlighted. The discussion points were recorded at the time, by both the facilitator and an additional scribe. Results were verified by comparing the two sets of notes.

A set of posters was produced which used photographs and maps of the case study city to illustrate different types of infrastructure. Focus group participants were encouraged to examine the posters, and from what they saw on them, coupled with their own experiences of using the infrastructure in question, to comment on any features which they felt were important, which had an impact (positive or negative) on their journey, or which they had any particular opinions about. Comments were made either verbally or by writing them on Post-it notes and sticking them to the posters. Participants were encouraged to note all their opinions, even if they repeated comments already made by other participants (or indeed if they contradicted them). As participants examined the posters, general discussions developed, as a consequence of which additional issues were identified. Participants were encouraged to add notes about these to the posters, but a scribe was present to make detailed notes of any relevant conversation in case detail of the discussion was lost when participants wrote down their comments in order to record them on the posters.

Figs 29 and 30 show focus groups taking place. Fig 31 shows one of the posters with comments attached.

Fig 29; focus group

Fig 30; focus group

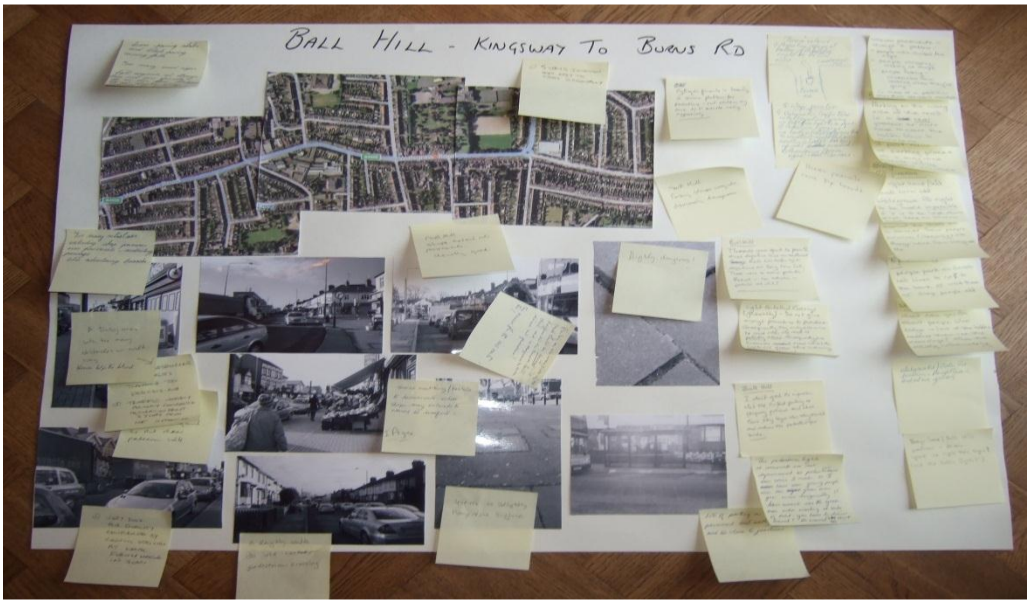


Fig 31; focus group, showing illustrative poster with participants' comments

6.2.2 Collection of micro-level data

Whilst the focus groups were a method by which general opinions could be collected about the infrastructure and its effect on older people’s perceptions of safety and mobility, it was felt that they did not provide enough detail about how older people make their journeys. In order to collect information about older people’s route and mode choices, and any other factors that influence their behaviour when they are making trips, a case study activity was designed. This involved recording in detail the journeys made by a selection of the participants, the route and mode they chose to use, and the time of travel, and any reasons why alternatives were rejected. This was done by carrying out structured interviews with the participants either before or after the focus groups (as determined by when they arrived at the focus group, with early arrivals being interviewed before and those with limited time available being re-contacted to be interviewed after). In this way it was possible to identify cases where shorter or faster routes were rejected precisely because of issues with the infrastructure, or where short journeys were made by car or public transport rather than on foot, because of the barriers to safe mobility for pedestrians that older users felt were there.

The case study data was considered in conjunction with the focus group data, in order to build a more complete picture of the barriers to mobility and safety, as experienced by the older road users themselves.

6.3 Results and discussion

6.3.1 Participant Information

Four focus groups were held, with the numbers and ratio of male:female shown in table 17, below. Initially four groups were held because of the availability of venues and participants, with the possibility of holding more existing should insufficient information result from the initial groups.

Table 17; Focus group participants

DATE	PARTICIPANTS	MALE-FEMALE	AGE RANGE
2010	8	4-4	65 - 80
2010	7	3-3	67 - 91
2010	7	2-5	61 - 77
2011	9	4-5	67 - 79

Participants were selected via the Women's Institute (WI) and residents' association groups, with some male participants being the husbands of WI members. The reasons for recruiting this way were the convenience of being able to speak to existing, organised groups of people, the fact that those people were relatively mobile and active, and the fact that they were familiar with and regularly used the infrastructure in the case study city. The discussion was initiated by explaining the aims of the project, and inviting participants to discuss the places that were important to them and to explore their experiences of travelling there. Whilst the analysis of the discussions that followed is grouped here into topic areas, this is for ease of presentation and does not follow the pattern of the discussions as they took place. As might be expected, these were much more random and disorganised, as people's comments generated spontaneous conversation which then developed according to the participants' contributions.

6.3.2 Activity Patterns

Initially, participants were asked to discuss the type of activity that was most important to them, and to identify places they wanted to be able to get to on a weekly basis. The main activities identified were leisure-related, and included; craft group, library, theatre, evening classes, museums, restaurants and "keep-fit" classes.

A number of activities related to health and well-being (such as University of the 3rd Age, Church, hospital and Doctors) were also mentioned. Some participants also undertook caring responsibilities (for example, for grandchildren or neighbours) which had an impact on their travel patterns.

There was some discussion around the issue of how their activities differed from those of average age or younger people: The main difference highlighted was that participants felt they were likely to be travelling at different times of the day. It was felt that outside congested peak periods, vehicle speeds are higher, making traffic more intimidating, especially (though not exclusively) for pedestrians. None of the participants was still in employment, meaning they were not making commuting journeys. All preferred to travel outside the peak, for reasons connected to traffic conditions (private transport), pricing (public transport) and a sense that peak time travel was stressful and inconvenient. This might appear on the face of it to contradict the earlier finding (i.e. that traffic conditions are more intimidating outside the peak). When there was little control over travel time decisions (for example, when attending early morning hospital appointments) they felt their needs were poorly catered for. Two participants (both male) stated that they used different routes when travelling in the peak, to avoid parts of the network they found problematic.

6.3.3The Transport System

The most commonly used modes were car (as passenger or driver), walking and bus, with the difference almost always being determined by end destination. Places that were thought to be difficult or expensive to drive to or park at were accessed by bus. Most felt that free bus passes did not influence mode choice, but this may have been a reflection of the personal circumstances of these participants, for whom cost may not be a key determinant of mode choice. More financially constrained older road users might place more emphasis on the comparison of cost between different modes.

The biggest issues faced with respect to bus travel were;

- Crossing the road to/from the bus stop on either the outward or return leg; this was agreed by **all** participants to be a problem.
- Personal safety when using public transport, which was felt by two male participants to be an issue. However, two female participants disagreed strongly, saying they had never felt at risk on the bus, regardless of where

they sat (upper or lower deck, close to the driver or not). No one had specific examples of problems they had encountered whilst on the bus, which may suggest that the perception some users have of safety on public transport is not necessarily a good indicator of the risk. Nevertheless, if people do not feel safe, this in itself is an issue which should be addressed.

- The need to have the correct fare ready if travelling during peak periods. This was an issue not only because of the inconvenience of needing to know it, but because poorer circulation in the fingers makes it difficult to have the money ready, especially in colder weather.

As has been stated, bus travel is excluded from the analysis (except for the journey to and from the bus stop, at which point users are considered to be pedestrians). However, some relevant points can be noted here. Firstly, pedestrian access to public transport interchange WAS felt to be an important issue, hence it will form part of the analysis of infrastructure which follows in the next chapter. Secondly, perceptions of personal safety, whilst highly subjective, can have an influence on the travel decisions of older road users. As a definition of mobility has been adopted which includes the *possibility* to make a journey, these subjective assessments of journey characteristics should be incorporated, even if the reality is different from the user perception.

6.3.4Driver safety

When driving, all participants agreed that roundabouts caused a significant problem, identifying the following as particular issues;

- Lane-keeping
- Speed of on-coming traffic
- Turning the head to get a clear view of on-coming traffic
- Roundabouts with traffic lights

One participant suggested that the increased land-take of large roundabouts compared to other junction types made them particularly unsuited to urban areas, but all participants agreed that they found simple signalised junctions easier to negotiate.

Figures 32 and 33, below, show a location approximately 0.75 miles from Coventry City Centre, close to bus stops, a park and a doctors' surgery which a number of participants agreed was problematic. As can be seen, the approaches are wide, with several lanes of traffic.

Whilst there is a 30mph limit here, all participants felt vehicles speeds were excessive, making it hard for them to make decisions about the correct lane and when it is safe to pull out. The wide, open feel of the roundabout and the segregation of pedestrians may be factors which contribute to higher vehicles speeds, by making drivers feel safer and less aware of how fast they are travelling. Two commented that they frequently wait for what seems like an excessive time to pull out onto the roundabout, which can make them feel anxious about the delay to vehicles waiting behind them and make them feel under pressure to accept a smaller gap than they feel comfortable with. From a pedestrian point of view, the road layout means that in order to cross the roundabout, it is necessary to make long detours up the arms of the roundabout, increasing the distance pedestrians have to walk. Higher vehicle speeds also increase the risk for crossing pedestrians, whilst the lack of safe gaps in the traffic increases crossing difficulty.

Fig 32; Junction of the A444/Binley Rd, Coventry.

Figure 33; Junction of the A444/Binley Rd, Coventry.

Table 18, below summarises the main comments made with respect to driver safety.

Table 18; Main comments made with respect to driver safety

Feature	Typical comments
Narrow angle of observation	“Difficult to see traffic from all directions”
Large, multi-lane roundabouts	“I find this difficult as a pedestrian and as a driver. “roundabout was totally unnecessary in the first place. It would have been better to have traffic lights.
Traffic flow	“Traffic comes rather fast” “traffic drives too fast” “at peak times, traffic heading out of town blocks the exits” “fast-moving traffic, with flower tubs obstructing the view” “Two lanes suddenly merge into one – traffic is very fast”

6.3.5 Pedestrian Safety

As has been demonstrated in Chapter 2, the main risk to older pedestrians relates to road crossing. A number of problems with road-crossing were highlighted by the focus group participants.;

- Facilities were felt to be located not where they are most needed, but where they cause least inconvenience to motorised traffic
- The time allowed for pedestrians to cross may not be enough (this was again blamed on the need to prioritise traffic throughput)
- Some crossing facilities were poorly designed with respect to the movement of motorised traffic. For example, requiring pedestrians to cross two halves of a road separately, waiting in the centre for the signals to change again.

A specific example where participants felt the location and design of crossing facilities is particularly poor is shown in figure 34, below.

Figure 34; Shops on Kenpas Highway, Coventry.

A number of participants said they would prefer not to use the shops pictured, rather than try to cross the road themselves or detour to the crossing facilities provided.

It was suggested that large roundabouts in urban areas also cause crossing problems for pedestrians, partly as a result of the continual traffic flow (particularly when crossing close to or on the roundabout), but also because of the extent to which vehicles build up speed on large roundabouts.

Table 19, below, summarises the main comments made with respect to pedestrian safety

Table 19; Main comments made with respect to pedestrian safety

Feature	Typical comments
Crossing Issues	"People crossing are in danger from people turning illegally" "light-controlled crossings do not give enough priority to pedestrians" "pedestrian lights are not synchronised so pedestrians can cross both roads." "You cannot see the green man when waiting at the side of the road" "pedestrian crossings are badly sited, causing traffic to back up and pedestrians to ignore the signals" "Pedestrian refuge is poorly sited" "Junctions not easy to cross" "Light sequence not user-friendly – the no turn from Walsgrave Rd is not always observed *(by drivers),* which is confusing for pedestrians"
Large, multi-lane roundabouts	"I find this difficult as a pedestrian and as a driver" "roundabout was totally unnecessary in the first place. It would have been better to have traffic lights. "roundabout is too large, which promotes high traffic speeds. Traffic lights would have been better, especially for pedestrians" "Crossing the carriageway is dangerous (because)traffic accelerates coming off the roundabout"
Traffic flow	"traffic drives too fast"

6.3.6 Driver Mobility

One location at which participants were particularly keen to comment on issues around driver mobility was Walsgrave Rd, in the east of the city. Walsgrave Rd is the main road through Ball Hill, which is a busy shopping centre. It is one of Coventry's "Primelines", a bus-priority corridor and one of the city's few "Red routes". It is also one of the City Council's Air Quality Management Areas. In the light of this, modifications were made to the infrastructure in 2007 for the express purpose of facilitating the throughput of motorised traffic. These changes generated much discussion amongst the participants, who were not happy with the results. They felt that the new measures had failed to improve congestion whilst making the situation less convenient for local traffic.

In consequence, drivers largely ignored elements like parking restrictions and banned turns because they were not considered to be fit for purpose. In addition, it was felt that air quality monitoring proved that the situation had worsened, which participants blamed largely on the changes undertaken as part of the Primelines initiative. Table 20, below, summarises the main comments made with respect to driver mobility

Table 20; Main comments made with respect to driver mobility

Feature	Typical comments
Banned turns	“Everyone ignores them” “They don’t serve any purpose”

6.3.7Pedestrian Mobility

Other issues that caused concern to participants when they were walking were: Uneven pavements, including “tactile” surfaces intended to help identify features such as safe crossing point, but which were felt to present a hazard to arthritis sufferers and others less steady on their feet; shared cycle/pedestrian facilities, which were thought to lead to confusion about who has right of way.

The perceived safety problems caused both to older drivers and pedestrians of large multi-lane roundabouts have already been mentioned. In addition, participants felt that such infrastructure presented a barrier to pedestrian mobility, as a result of the large detours that are often required in order to cross. Figures 32 and 33 (above) illustrate this point. As can be seen, pedestrian provision is via pathways with shared cycle provision, protected by guard rail and with dedicated signalised crossing provision (this is also shared with cyclists). However, in order to cross, pedestrians must make significant detours along the arms of the roundabout. The additional walk distance will cause an issue for some less mobile pedestrians, however, another issue with such large detours arose from it not always being clear which route pedestrians should take.

Two people commented specifically on the signage of pedestrian routes;
“subways and paths not well signposted – more directions needed” , and
“Signs difficult to read with letters missing”

This shows that signing of walk routes is important, even for people with local knowledge. Much work has been done examining the issues around driving cessation (for example, Brace et al, 2006, Marattoli et al, 1997). For those who have been used to making their journeys by car, becoming a pedestrian may present unexpected changes of route, especially in areas with extensive grade separation of motorised and non-motorised traffic such as the Coventry ring road. Providing convenient, pleasant and well signed pedestrian routes may be a factor in helping the transition for drivers who elect to cease driving.

The changes in Walsgrave Road resulting from the “Primelines” initiative have already been discussed in the context of driver mobility. However, these were also felt to have had an impact on pedestrian mobility, through inadequate crossing provision, designed to minimise the impact of pedestrians on through traffic. As with the parking restrictions and banned turns, participants felt that dedicated crossing provision was largely ignored as a result of not being fit for purpose. Whilst participants expressed disapproval of pedestrians (especially older ones) who “dodge the traffic”, it was also recognised that if dedicated crossing provision was inconvenient either in its location or design, then this behaviour was an inevitable consequence. A brief discussion centred on the question of lowering speed limits, as a way of both addressing congestion (in the same way that variable speed limits on motorway try to), and improving the situation for pedestrians, but most felt that this was unrealistic, given the route’s importance as a link to the main hospital and the City’s accident and emergency facility. This highlights the difficulty of balancing the needs of different users groups when designing traffic management policies. Table 21, below, summarises the main comments made with respect to pedestrian mobility.

Table 21; main comments made with respect to pedestrian mobility

Feature	Typical comments
Uneven/poorly maintained footpaths	“Trip hazards” “shabby-looking…. Shows signs of poor upkeep” “Footpath looks uncared for” “poorly maintained” “loose pebbles – trip hazard” “all surfaces look uneven” “surface unsuitable for wheelchairs” “loose paving slabs and block paving cause falls” “Highly dangerous”
Shared cycle/pedestrian facilities	“The cycle path is on one side at the top of the subway, but switches halfway along” “It’s a steep slope into the subway – cyclists can come down very fast” “cycling on the pavement is becoming a serious problem for pedestrians. Not children but aggressive adults”
Lack of crossing provision	“not easy to cross” “there used to be another subway here but it closed. Why?” “It’s a long walk from the teachers centre into town now the subway has closed” “Subways not well signposted” “It’s such a long detour to use the crossing it’s not surprising lots of people don’t bother” “It’s difficult to walk from Kingsway towards town. It’s a long way round the island” “There are too many barriers round the grassed areas” “Pedestrians have to cross at light-controlled crossings

	some way up each arm of the roundabout – just too much priority afforded to the traffic over pedestrians” “Pedestrian lights are badly timed. By the time they come into effect after the button is pressed, the traffic has often gone” “We ignore the lights and cross where we should not” “To walk into town there is a big detour for the pedestrian crossings” “We do not cross at the lights” “Crossings too far up to be convenient for people walking to town” “Distance between crossings is too great”
Presence of vehicular obstruction of footpaths	“Larger vehicles should not be allowed to park here” “cars parking cause a hazard to pedestrians” “Very poor parking makes it difficult for pedestrians” “agreed. You cannot see, so V dangerous” “pavement often obstructed” “Cars parking on the pavement is a constant hazard”
Presence of dropped kerbs, tactile pavement surfaces, steps or other obstructions to walkways	“Too many obstructions on the walkway – heaven help the blind” “Signs obstructing pavements are a danger to pedestrians” “pavement often obstructed”

6.3.7 Other issues

Two other key issues which were raised several times by participants were those of personal safety and the relationship between transport (in terms of whether people can get where they want to go, can park when they get there etc) and economic activity. The issue of personal safety was raised both in the context of bus travel, and also when discussing grade separated crossings such as subways, and dedicated pedestrian provision such as they found extensively in the vicinity of the central ring road.

The Coventry ring road is somewhat unique compared to the other infrastructure assessed, in that it is purpose-built with the intention of catering separately for the needs of pedestrians. It might be expected that this would be the location at which mobility for older pedestrians was best catered for. The separation of motorised and non-motorised traffic should ensure that the infrastructure is also very safe (in terms of traffic risk) for pedestrians.

In the case of this particular location, concerns about vehicular obstructions and traffic flow were seen to be less relevant, as a result of the grade separation. Access to public transport was also less relevant, as road users who wished to use public transport would not generally have walked this route, as it is not close to bus or rail routes.

Additional comments not covered by the factors previously identified revolved mainly around personal safety issues. However, as was the case at previously, people's perceptions of whether or not they were safe using particular transport infrastructure differed. Comments about the use of subways included;

“Too lonely to walk along here at night or on your own”

“I would hesitate to use it”

However, other comments included;

“Well lit – I have used it when plenty of people about” and “This subway is quite safe – it is used by a lot of people going to/from Elm Bank Teachers Centre and office workers” (on which someone had added “agreed”)

Only one person made a positive comment about the pedestrian infrastructure around the ring road (“Looks very good – lots of green”).

Fig 35, below, shows the entrance to the subway close to the Elm Bank teachers’ centre.

Fig 35; Entrance to the subway close to the Elm Bank teachers’ centre

There was much discussion about the contrast between the shops at Quinton Parade, in the south of the city and those at Ball Hill, in the east. Quinton Parade was mentioned in the context of both driver mobility (inadequate parking provision) and pedestrian mobility (presence of parked cars blocking the footpaths). Much of the discussion centred on the popularity of the shops, with many participants feeling that few solutions were available to policy-makers as long as the shops remained so well-used, and so many customers opted to drive there. Many felt that it was not so much the number of vehicles as the lack of parking that was the issue: It was felt that the presence of so many vehicles clearly looking for spaces (or parked illegally) caused congestion and exacerbated safety and mobility issues.

It was pointed out by a participant that the extensive parking in front of the shops was created after 1963, when a large paved frontage was turned into the service road and additional parking. Fig 36 (below) shows how the area looks now, with the area to the left (between the shops and the traffic signal) once being given over entirely to pedestrians. The heavy demand currently placed on the space can be seen by the fact that there are cars parked in the designated bays (on the left) and on the roadside (on the right). However, it can also be clearly seen in the picture that there are cars in the roadway waiting to park, and parked on the footpaths.

Some participants contrasted this location with the lower reaches of Ball Hill, which many felt they no longer visited due to the poor quality of the shops and the number of empty units. Some made the point that the shops at Quinton Parade were good quality local shops, the continued viability of which should be a priority for policy-makers. The issue of supporting economic development and maintaining community facilities such as shops, whilst minimising the undesirable side-effects of motorised traffic is not an easy one to address.

Fig 36; Current view of Quinton Parade

6.4 Case Studies

The aim of the case studies was to collect more detailed data on the individual journeys made by older people, in order to look for evidence that they DO avoid locations or situations where they feel unsafe or where their mobility is impeded.

Participants at the focus groups were asked to describe journeys they regularly make, the route taken and mode selected. This took the form of a structured interview. Whilst a travel diary approach was piloted earlier in the study, it was found that this did not provide enough detailed information about the processes by which older people make their journey choices. It also meant that there was no opportunity to ask participants to consider the alternatives and to explain why they had not selected them. In addition, when travel diaries were completed, in many cases during the period in which the diary was completed, no journeys were made which provided any insight into the issues under consideration. Structured interviews therefore offered the opportunity to consider journeys which were made semi-regularly (for example, for medical appointments) rather than just those which happened to be made over the data collection period.

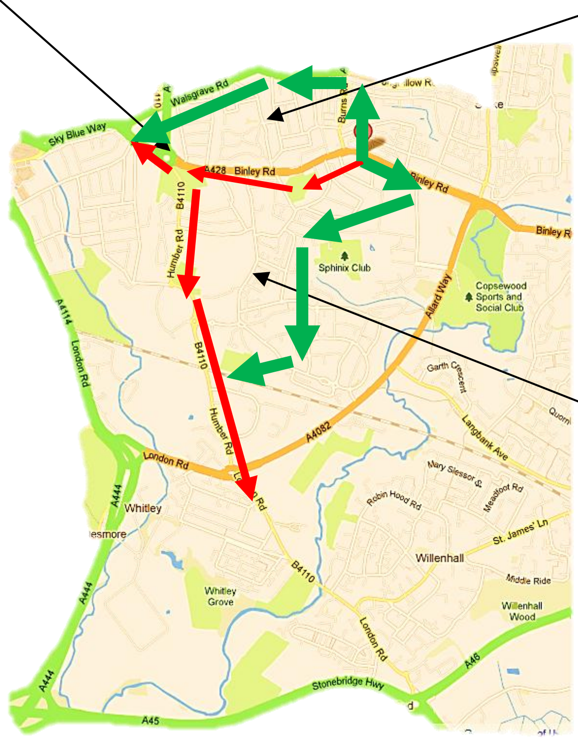
The collected data is presented in Appendix D. The case studies presented here are those where the infrastructure features encountered at different locations had been a decisive factor in the journey choices made. Table 22, below summarises the case studies presented in the following sections.

Table 22; Summary of the presented case studies

Number	Description	Number of participants	Issue	Affected group
1	Route change to avoid junction of A444/Binley Rd.	2	Traffic flow is fast and continuous, making safe gap selection problematic	Drivers
2	Route change to avoid public transport interchange at Coventry station	1	Traffic flow is heavy, pedestrian crossing facilities are poorly located, carriageway is wide. Road crossing is necessary to change bus services	Pedestrians/public transport users
3	Mode switch from walk to car to avoid dedicated pedestrian infrastructure	1	Some pedestrian routes are poorly signed, not well-lit and pedestrians do not feel safe using them..	Pedestrians
4	Route switch to avoid right turn at A45/Kenilworth Rd junction	1	Traffic flow is fast and continuous, making safe gap selection problematic	Drivers
5	Route switch to avoid confusing road layout at Binley Rd/Allard Way	2	Road layout and lane markings are confusing, meaning that other drivers often make unpredictable manoeuvres	Drivers
6	Route switch to aviod Junction of Daventry Rd and London Rd and Daventry Rd and Leamington Rd	2	In both cases, the angle of the junction makes observing on-coming traffic difficult. This is felt to be exacerbated by traffic speed	Drivers

The following sections present and discuss the case studies and draw conclusions about any implications they might have for analysis of safe mobility in urban areas.

6.4.1 Journeys avoiding fast-moving, busy roundabout



Location of problem roundabout

Participant 1; Rejected route/selected route

Participant 2; Rejected route/selected route

Fig 37; Case study number 1; route change to avoid roundabout

Figure 37, above, shows two alternatives routes which focus group participants said they used in order to avoid the junction of the A444 and Binley Rd. Figures 32 and 33, presented earlier, show the roundabout itself. Several focus group participants made general comments about this roundabout, including that the traffic came too quickly, that the sightlines on the approaches were not good, and that they felt pressurised into accepting smaller gaps than they would like, because of other traffic. However, two participants said that they actively avoided the roundabout, especially when making journeys which would involve entering the roundabout from the east side, on the Binley Rd.

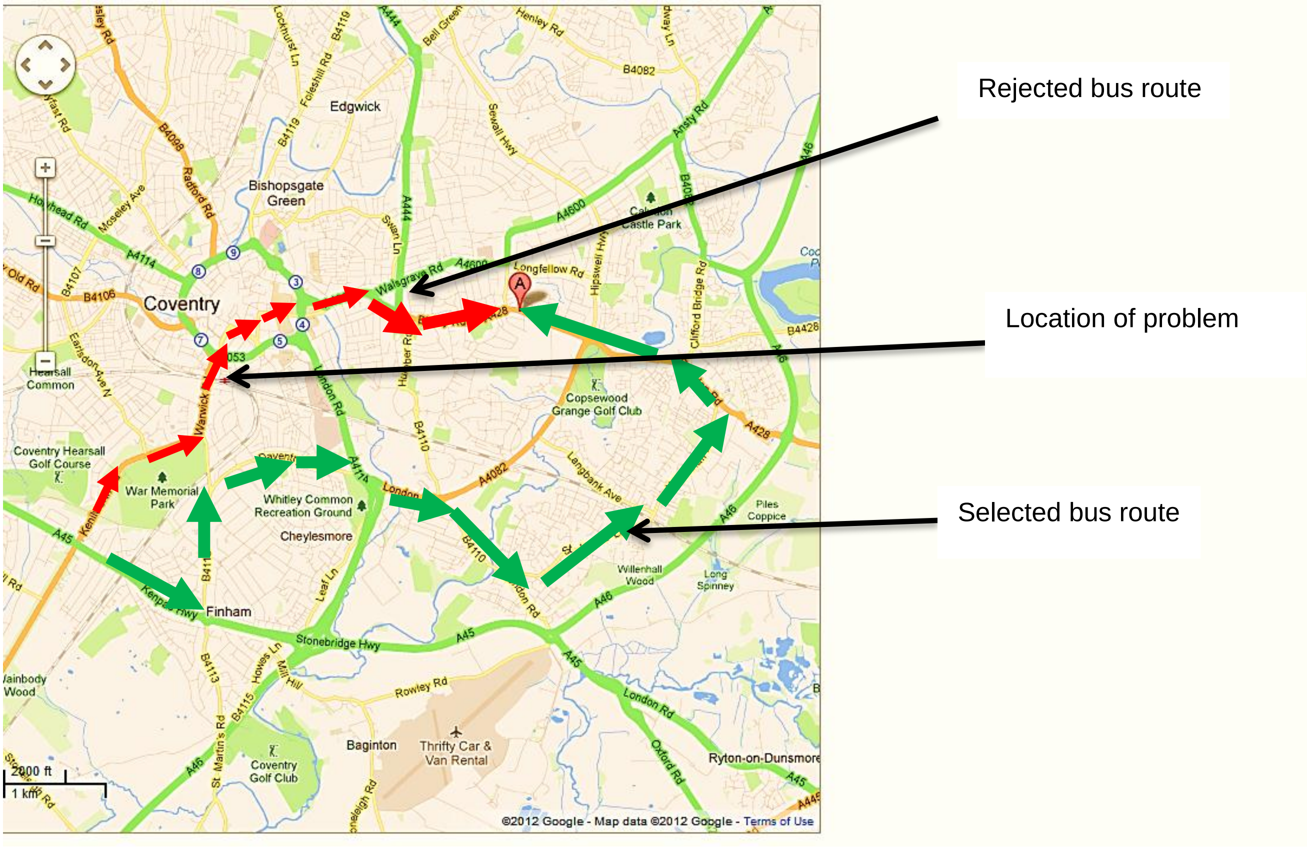
Fig 38; A444/Binley Rd, pictured from Binley Rd

As can be seen from Figure 38, above, traffic entering the roundabout from this direction must yield to traffic coming from the A444. The A444 is a wide road with several traffic lanes, a predominantly 50mph limit, and with a downhill approach to the junction. All of this may contribute to traffic coming from this direction at relatively high speed, which the participants found problematic.

In the case of participant 1, the alternative route selected involves making a left turn at an un-signalised junction, and a left turn at a signalised junction. In the case of participant 2, the selected route involves turning left then right then left again, all at un-signalised junctions. The implications of these decisions for safety, mobility and the drivers' exposure to traffic risk will be explored further in Chapter 9.

6.4.2 Journey avoiding interchange at Coventry Station

Figure 39, below, shows an alternative route selected by a participant who found public transport interchange at Coventry Station to be problematic. Whilst public transport users are not the focus of this work, this case study has been included because the problems with the journey arise whilst the older road users is transferring between bus services, at which point she is a pedestrian. In order to change buses here, it is necessary to cross several lanes of traffic and then walk down a flight of steps. By contrast, the alternative route, although still requiring a change of service part-way, does not require the user to cross the road. The issue of bus stop location and how it might affect older people's mobility was discussed in Chapter 2. This case study provides support for the idea that this might be a real constraint on older users' mobility, particularly in case where alternative routes are not available.



Rejected bus route

Location of problem

Selected bus route

Fig 39; Case study number 2: Route change to avoid interchange at Coventry Station

6.4.3 Mode switch to avoid dedicated pedestrian infrastructure

Figure 40, below shows a switch of mode undertaken to allow the user to avoid the dedicated pedestrian infrastructure found in and around the City Centre. For this participant, the problem arises when a number of trip purposes are combined, meaning that several locations in or around the City Centre need to be visited. Rather than selecting a convenient car park for all the locations which need to be visited, this participant opts instead to move the car each time, not because the walk distance is too great, but because she perceives the dedicated infrastructure to be unsafe (through risk of crime, rather than risk in traffic). In this instance, the first location visited was a retail park close to the station, and the second a large store in the city centre. The distance between the two is approximately 0.5mile; moving the car incurs additional parking charges though the time taken is probably comparable to walking. This provides evidence that road users consciously evaluate the options available to them, and that perceived issues with the provided infrastructure can lead to changes in behaviour.

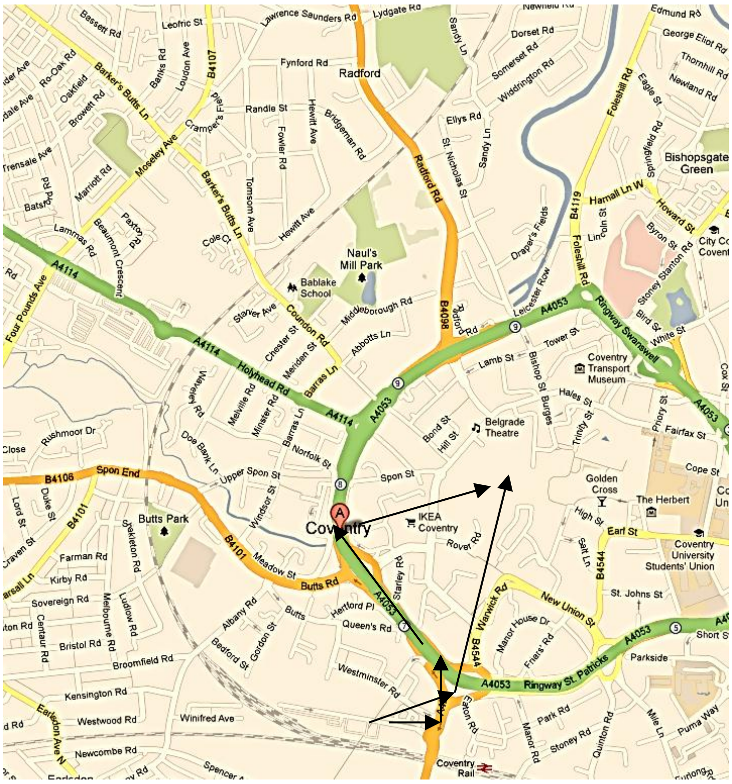
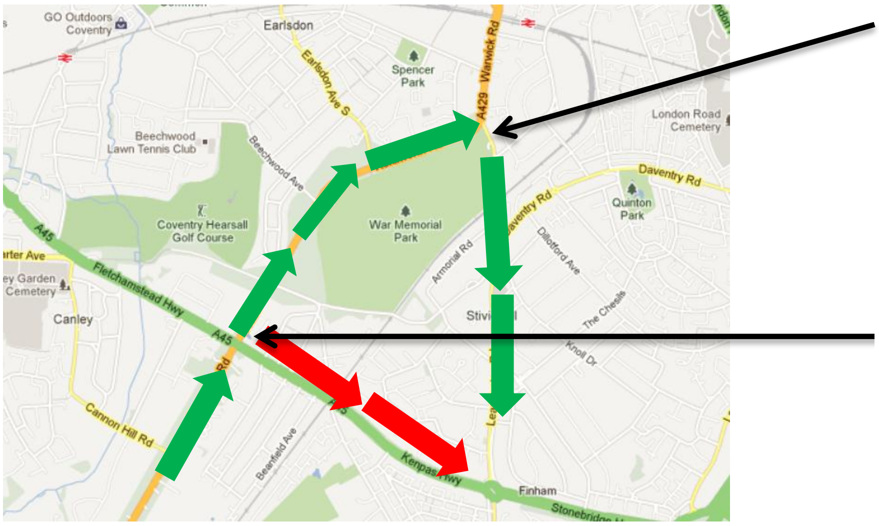


Fig 40; Case study number 3: Mode switch to avoid dedicated pedestrian infrastructure

6.4.4 Route switch to avoid un-signalised right turn



Signalised right turn

Un-signalised right turn

Fig 41; Case study number 4: Route switch to avoid un-signalised right turn

Figure 41, above, shows a route switch made to avoid a junction where right turning traffic must yield in favour of a fully signalised one. As was established in Chapter 2, older drivers are more likely to make errors when they have to yield to other traffic. Signals which require drivers facing a green light to yield, as is the case here, increase risk for older road users. Signals where right turning traffic has a separate phase (as is the case for the selected route) are safer for older drivers.

6.4.5 Route switch to avoid confusing road layout

Figures 42 and 43 show the road layout at the approach to the junction between the A428 Binley Rd and Allard Way, to the east of the City Centre.

Figure 42; approach to junction of A428 and Allard Way

Figure 43; approach to junction of A428 and Allard Way

One traffic lane has been turned into a bus gateway: On the left of figure 42 the bus lane itself can be seen. When buses approach, vehicles in the two right hand lanes are stopped by the signals, so that the bus can pass any queuing traffic. Once past the signals, the traffic lanes veer to the left, as can be seen in figure 43, meaning that drivers must steer left in order to stay in lane. Participants felt that even though they were aware of the slightly counter-intuitive layout, other road users weren't, meaning that whilst some drivers did steer left to stay in lane, others drove straight ahead, crossing the lane markings and presenting a hazard. Whilst neither participant specified a particular alternative route, two did say that they actively avoided this infrastructure when possible.

6.4.6 Route switch to avoid narrow angle of intersection

Figure 44 shows a route switch to avoid two junctions where the angle of intersection makes observing and yielding to other traffic problematic.

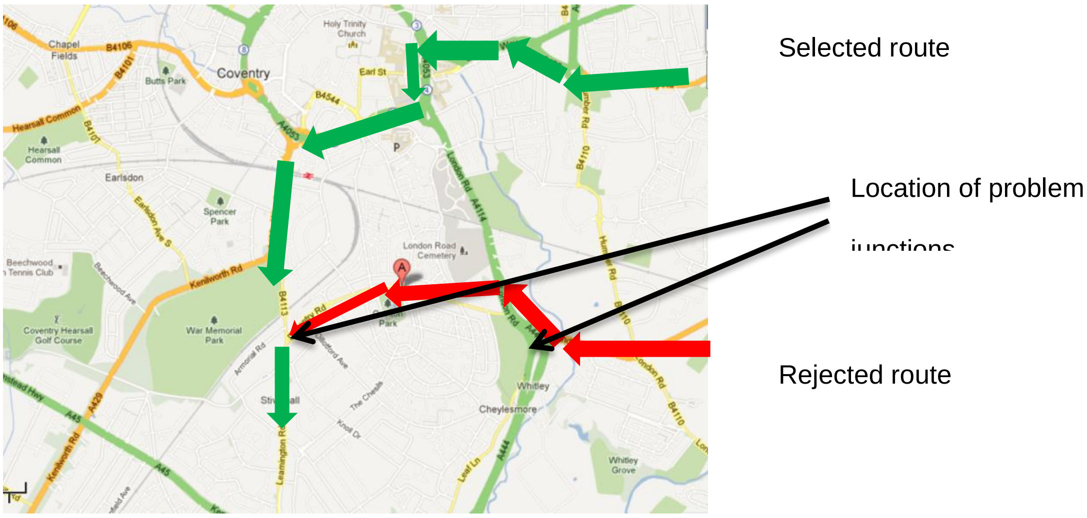


Figure 44; Route switch to avoid the Daventry Rd/London Rd and Daventry Rd/Leamington Rd junctions

The first of these junctions (Daventry Rd/London Rd, on the right of Fig 44) is also represented in Figure 24, as it was mentioned by participants in the pilot studies as being problematic. The layout of the junction makes it necessary for drivers to merge between traffic coming from the left, meaning they must observe traffic both in front of and behind them, making complex judgements about speed, distance and gap acceptance. In the case of the Daventry Rd/Leamington Rd junction (in the centre of figure 44) the narrow angle of the junction makes observation difficult.

6.5 Discussion

The activities and services identified as being important for older users to access are varied, and in many cases do not differ vastly from those one might expect any group of adults to use. As was discussed in Chapter 2 many existing studies of mobility and accessibility group older road users with either socially excluded groups (for example, the unemployed) or with other mobility-limited groups such as the visually impaired or wheelchair-users. Whilst poor health and disability do generally increase with age, there are nevertheless significant numbers of older people who despite being healthy and active, have different mobility needs from younger users. For this reason, it is not always appropriate to consider the needs of older users alongside those of other user groups with which they may have little in common.
Similarly, whilst previous work in the field of accessibility and mobility has often focussed on pedestrians and public transport-users, it is clear that for a significant (and arguably rising) number of older road users, the car is the main transport mode. The degree to which road infrastructure takes account of the needs and limitations of older drivers must therefore be assessed.

Road crossing has been highlighted as a significant area of concern in terms of both mobility (for example, where long detours are necessary to access crossing facilities) and safety (for example, where motorised traffic continues to move during the pedestrian phase of the lights). Similarly, segregation of different categories of road user (for example, by the use of pedestrian guard-rail) is one way of attempting to reduce vulnerable road user casualties. However, for older pedestrians, the design of such infrastructure is a significant issue. Facilities which require lengthy detours are a barrier to mobility. Whilst grade separation may reduce casualties at the locations in question, this may happen at the expense of making the trip almost impossible for some older pedestrians. This in turn has implications for the sustainability of local businesses, the “liveability” of the local environment, and social exclusion for those without access to alternative facilities or transport modes. It is also at odds with other government initiatives aimed at promoting more environmentally-friendly lifestyles.

The importance of crossing provision supports the results of earlier work reported on in Chapter 2, and in consequence, the location and design of road crossing facilities will form a key part of the infrastructure audit.

The results suggest a number of areas where the interface between safety and mobility for older road users is not well-managed. For example, whilst roundabouts are known to be generally safer for motorised vehicles than other junction types with conflicting vehicle movements, they are problematic for older road users, both as drivers and as pedestrians. There is supporting evidence from existing studies that the increased mental workload and the complexity of decision-making required lead to an increase in errors by older drivers at such intersections (Federal Highway Administration, 2000).

The trade-offs that must be made in urban infrastructure design will be explored in the analysis of calculated performance indicators, but examples of these trade-offs include;

- between the safety of older road drivers and the safety of “average” drivers, as illustrated by the use of large, multi-lane roundabouts in urban areas
- between the mobility of drivers and the safety of pedestrians, which focus group participants felt had driven the decisions about the location of pedestrian crossing facilities
- between the safety of pedestrians and the mobility of pedestrians, which leads to the introduction of grade separated traffic and dedicated pedestrian infrastructure, but which can mean pedestrians having to make lengthy detours

The presented case studies provide some evidence that older road users do avoid traffic situations where they do not feel confident. This supports the work discussed in Chapter 2, which described various types of coping strategies which older road users might employ, such as limiting their driving to familiar roads, or not driving at night. It also supports the hypothesis that older drivers’ exposure to traffic risk may be lower at infrastructure they find problematic, and that this may provide a partial explanation for lower accident rates at those locations.

These case studies will be explored further in Chapter 8, where they will be compared to accident data and the calculated performance indicators, in order to validate the calculated performance indicators and their potential contribution to policy design and monitoring.

6.6 Study Limitations

An acknowledged limitation when collecting data about people's mobility is that the least mobile are those whose views are often most difficult to capture, as they may not be mobile enough to access the places and services used to recruit participants. However, in this case, what is important is to gather general information about the services and activities older people use, and identify the features of urban infrastructure that cause additional difficulties for them. As a result, it was felt that participants do not have to be the most mobility-limited older road users to provide useful insights. For those older users with severe mobility constraints, the design of infrastructure may be a much smaller factor in influencing their journey choices than it is for the more mobile older users: It is likely to be the case that older users with more profound health issues face more fundamental barriers to mobility than the infrastructure features identified here.

In addition, it is recognised that the participants were not necessarily representative, in terms of their income levels, as a consequence of being recruited via the Women's Institute and residents' groups in relatively prosperous areas of Coventry. Whilst it is not thought that this would be likely to have a significant impact on the effect of barriers to mobility in the urban environment, it may have affected the services and activities that were mentioned as being important. It might also have influenced the views expressed regarding mode choice; free bus travel was felt quite strongly NOT to be a big influencer of mode choice, but for older road users in more economically challenged circumstances, journey cost might have been more important. In areas with lower levels of income, the car may have been a less important mode than was the case for this particular group of participants. In consequence, pedestrian mobility factors may have been given less priority by this particular group of road users than might have been the case for other groups.

In addition, whilst the presented case studies provide evidence for a reduction in older users' exposure to risk at problematic infrastructure, they do not provide any indication of how widespread this phenomenon might be. For those participants who did change route or mode to avoid specific infrastructure, the perceived barrier was clearly felt to be significant. However, other users of the infrastructure may not have encountered similar difficulties. What the case studies provide is evidence that this process of adapting travel behaviour exists. They do not allow conclusions to be drawn about the degree of difficulty which will cause users to adapt their behaviour, nor do they allow judgements to be made about how typical these scenarios are.

6.7Conclusions

The results of this qualitative study have facilitated an understanding of the services and activities that older people particularly need to access, as well as those that they feel serve important social functions. Factors in the urban environment which present barriers to safety and mobility for older road users have been identified and explored, and this – in conjunction with the literature study - has enabled an inventory of barriers to safe mobility to be produced. The qualitative data collected will feed into the design of the infrastructure audit, but will also support and inform analysis of secondary quantitative data such as accident statistics later in the research.

The results of the focus groups demonstrate that certain features of urban infrastructure do cause safety and mobility issues for older road users. The results also indicate that the resultant safety or mobility issues can cause users to change their travel behaviour. In addition, it has been established that there is sometimes a conflict between the engineering solutions implemented to promote road safety and the accessibility of services and facilities for older people.

The following chapter presents an audit of urban infrastructure for the case study city of Coventry. The degree to which the factors identified as being problematic by either the literature study, focus groups or both are encountered by road users will be assessed, and performance indicators for safety and mobility for both drivers and pedestrians will be derived. Further stages of the work will compare the calculated performance indicators with accident counts and proxy measures of exposure to risk for the locations identified as being 1) important to older people and 2) problematic, in order to assess how policy priorities might differ if a broader range of information was used when determining them. This will enable analysis of how road safety targets are framed, how other planning objectives are affected by them, and what the implications are for older people's quality of life to be undertaken. The results will form a set of recommendations for progressing both road safety and mobility using performance indicators. These will incorporate traditional "outcomes" measures such as accident and casualty counts, but will weigh these against measures of the extent to which the provided infrastructure is a barrier to mobility for older users.

CHAPTER 7: ANALYSIS OF INFRASTRUCTURE IN CASE STUDY CITY

7.1 Introduction

This chapter sets out the work undertaken to assess the infrastructure in the case study city, according to the methodology outlined in Chapter 4. The aim of the audit is to collect the necessary data to determine the extent to which the infrastructure protects users from traffic risk whilst at the same time facilitating their continued independent mobility. Data collection concentrates on key zones within the urban area of Coventry, aiming to identify those features which present a barrier to mobility for older drivers and pedestrians, or which may impact on their safety.

As described in Chapter 4, the work has two separate but linked elements – safe mobility for older drivers, and safe mobility for older pedestrians. The results presented in this chapter describe and illustrate the identified barriers to safe mobility. The methodology by which the analysis of infrastructure has been undertaken, the results obtained, conclusions drawn and the implications for the calculation of performance indicators for safe mobility which follows are all described and discussed.

7.2 Methodology

The data collection involves infrastructure audits, performed on existing road infrastructure in a number of zones around the case study city. For both safety and mobility performance indicators, the audits are done and presented in a thematic manner, in other words they are designed to look for specific features, as identified by the literature reviews described in Chapter 2, and the user data described in Chapter 6. A number of factors which increase difficulty for older road users have been identified: The infrastructure audit will look for incidence of those factors in a number of zones around the city, in the order that the degree to which older users' safety and mobility are catered for can be assessed.

7.2.1 Background

Data collection concentrates on key infrastructure features within the urban area of Coventry. To facilitate data collection, the City has been divided into a number of zones using information collected from the focus groups. Zone boundaries were drawn on the basis of the links and places they incorporate and provide access to, where links are key vehicular routes around the city which are of importance to drivers, and places are destinations which contain the services and facilities older people need to access, such as shops, banks, libraries and surgeries. These will be of most importance to pedestrians.

As well as offering the facilities and services which were identified by the focus groups as being important, zones were also selected for the different social and economic factors they exhibit, in order to assess whether there is any relationship between the quality of the infrastructure and other soci-economic factors. The zones are also designed to cover the city in a geographical sense (being located in different parts of the city) and are diverse in terms of the road environment itself, the type of traffic carried, and the type of area the road passes through. Some are busier roads with a more diverse range of traffic, whereas some are quieter local roads.

An audit of infrastructure was undertaken within each of the zones to identify and map the instances of features which are a barrier to safe mobility. Data collected about the Links was used to assess safe mobility for drivers, whilst data collected about Places was used to assess safe mobility for pedestrians. These two were then combined to provide an indication of the safe mobility for older road users in each of the zones.

7.2.2 Zone descriptions

The case study city was divided into three zones; central, south and east. These are shown in figures 46 – 48. The incorporated Links and Places are described in table 23, below

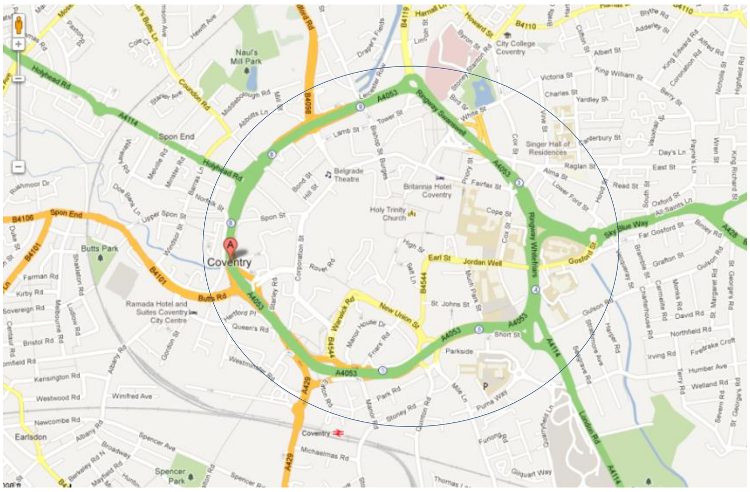


Fig 46; Location of Central Zone

The central zone contains the main shopping and business centre, as well as important public transport and leisure facilities such as the bus and railway stations, and main sports centre. The central area differs from the others, in that there is much purpose-built dedicated pedestrian and cycle infrastructure in the central zone. The issues involved in balancing the competing needs of different road user groups may be not be the same in this zone as in others where there is more need for users with widely differing characteristics to share infrastructure.

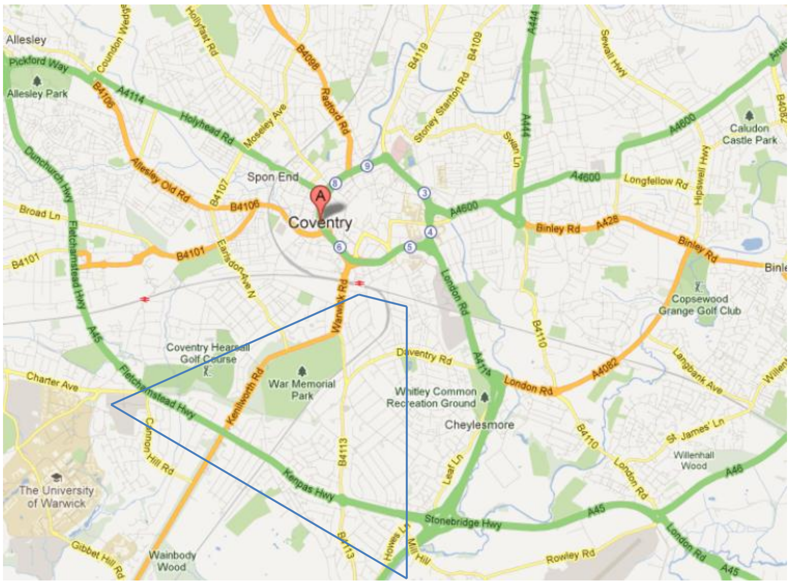


Fig 47; Location of south zone

The south zone is a predominantly affluent area of the city, with a mixture of residential and shopping streets. Its southern-most border is the A45, a wide distributor road providing access towards Birmingham and the M42/M6 in one direction and London and the M45/M1 in the other. It also provides a link round the city from the M69 and Leicester to the Northeast to Warwick and Stratford to the Southwest.

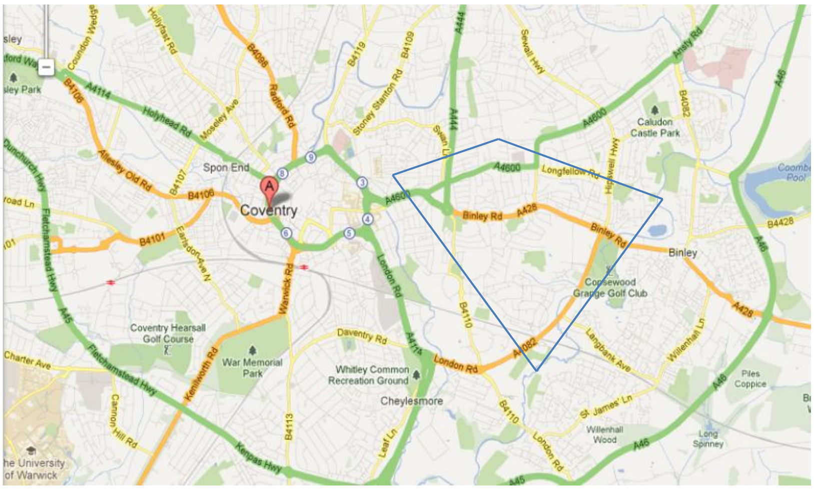


Fig 48; Location of east zone

The east zone is much more mixed in character, with popular, green suburbs as well as areas with poorer quality housing. It has two locations with busy local shops, and is also the location of the city's main hospital, meaning that the two main routes through it (Binley Rd and Walsgrave Rd) are often busy with buses and emergency vehicles.

Table 23, below describes the location of and key infrastructure within each zone.

Table 23; Description of zones

Zone Name	Zone location	Key infrastructure	Number	Description
Central	Area bounded by inner ring road, infrastructure immediately adjacent to it.	Ring road	L1	Grade-separated distributer road with shared dedicated cycle and pedestrian provision.
		Railway station	L2	Focal point for rail services with bus interchange and access to the city centre and suburbs for pedestrians and drivers.
South	Area bounded by main Coventry/Birmingham railway line, A45 and B4114	A45/Kenpas Highway	L3	Access for local shops and facilities. Main route for traffic round south of city, including to Warwick, Birmingham.
		Quinton Parade	L4	Access for local shops and facilities. Mainly local traffic
		Earlsdon High St	L5	Access for local shops and facilities. Mainly local traffic
East	Area enclosed by Walsgrave Rd, Binley Rd and Brays lane.	Walsgrave Rd	L6	Access for local shops and facilities. Main route for traffic to east of city including Leicester and University Hospital
		Binley Road	L7	Access for local shops and facilities. Main route for traffic to Rugby and to University Hospital
		Ball Hill	L8	Access for local shops and facilities. Main route for traffic to east of city including Leicester and to University Hospital
		London Rd	L9	Provides link from southwest to northeast. Has a large supermarket and housing.

The following sections describe the themes which the audits will encompass and the rationale for their inclusion.

7.2.3 Safe Mobility for drivers

The audit of Links will collect the necessary data to assess the safe mobility of older drivers. Review of the previous literature, in conjunction with the results of the focus groups has identified the physical features which present a barrier to the safe mobility of older drivers. These features are described in table 24, below.

Table 24; Features presenting a barrier to the safe mobility of older drivers.

Feature	Rationale for inclusion	Reference
Short travel time between junctions	Time pressure increases mental workload	Davidse (2007)
Speed limits	Higher speeds reduce the time available to observe and react to hazards and increase the severity of accident consequences	West (1998)
Obscured or illegible signage	Deterioration in eye sight makes perceiving and responding to cues more difficult	Sanders et al (2002)
Complexity of information on signs	The more units of information that must be attended to per unit of time, the greater becomes the possibility of an error.	Elvik (2006)
Junction complexity (number of route/lane choices)	Complex traffic conditions lead to difficulty in appropriate decision-making for older drivers	Fildes at al (2000) Holland (2001)
Complex traffic flow (because of, for example, traffic signals, bus stops and other perturbations to flow)		

Poor sightlines or acute angle of intersection	Deterioration in eye sight makes perceiving and responding to cues more difficult. Muscle degeneration makes turning to look problematic	Brace et al, (2006).
Necessity to yield and provision of turning lanes	Older people have more accidents where they are required to turn across the path of on-coming traffic.	Holland (2001) Garber and Srinivasan (1991)

In the case of older drivers, a key finding of both the literature study and focus groups was that junctions presented a major problem for older drivers, with the more complex ones being particularly difficult. The factors which influence the degree of difficulty an older driver experiences when navigating a junction are the complexity of the traffic situation, and the extent to which he or she can bring his or her own experience to bear on the task. Hence the data collected relates to;

- The amount of information that has to be processed (number of traffic lanes, number of road-signs, presence of other complicating factors such as pedestrians)
- Any reductions in the quality of the information (poor visibility of signs or pavement markings)
- Presence of time pressure (anything which obscures the view thus reducing decision time, speed of approach)

The street audit focuses on identifying and mapping instances of road infrastructure which do not cater well for the needs of older drivers, as a result of these features being present. The audit approach looks at the links themselves, but also the major intersections along the links.

Links which score highly for barriers to mobility are likely to include; ones with junctions where the mental and visual workload imposed on older drivers by the design is high, links where the scope for drivers to adopt coping strategies is low, links where the information available to the driver is confusing, or cannot be read from a sufficient distance.

7.2.4 Safe Mobility for older pedestrians

The audit of places will collect the necessary data to assess the safe mobility of older pedestrians. The literature review described in Chapter 2 identified Street Audits as a useful methodology for assessing the mobility of older pedestrians in urban areas. A number of key features which the literature review suggested would affect older people’s mobility in urban places were identified. These are listed in table 25, below.

Table 25; Features presenting a barrier to safe mobility for older pedestrians

Feature	**Rationale for inclusion**	**Reference**
Physical separation of motorised and non-motorised traffic	Separation of pedestrians and motorised traffic reduces conflicts	Retting et al (2003)
High traffic flows and/or speed	Higher vehicle flows and speeds are strongly associated with greater likelihood of pedestrian crashes and injuries	Retting et al (2003)

High number of traffic lanes	Older pedestrians are over-represented in crashes involving wide streets or where there is a high number of lanes.	Zegeer et al (1993) Zegeer and Bushell (2011)
Barriers to visibility	Drivers often report not seeing pedestrians prior to accidents	Retting et al (2003)
Dedicated crossing provision	Older pedestrians are less able to perceive and respond to traffic	Oxley et al (1997)
Presence of median strip	Use of median strip improves safety for older pedestrians	Oxley et al (2004)
Presence of parked cars	Slows traffic and protects adult pedestrians	Dumbaugh (2008)
Deviation of pedestrian route from desire line (including at dedicated crossings)	Increase walking distance and/or time taken	Dumbaugh (2008)
Steep slopes and/or steps	Present barrier to older people's mobility	Jones and Titheridge, 2006
Uninviting local environment, including poor lighting, traffic noise, fumes et	Affects walk access. Poor lighting affects pedestrian conspicuity	Titheridge and Soloman, 2007 {{140}}
Shared pedestrian/cycle infrastructure	Micro-level details such as bicycles present large obstacles to walk access	Titheridge and Soloman, 2007
Uneven or damaged surfaces Presence of tactile surfaces Pavement obstructions (Street furniture, stock displays, parked vehicles)	Pavement condition and hazards influence walk access	Jones and Titheridge, 2006
Unsuitable design and/or location of pedestrian access to public transport	Presents a barrier to pblica transport access	Jones (2010)

A key finding of both the literature study and focus groups was that crossings presented a major problem for older pedestrians. The factors which influence the degree to which crossing is difficult include; the number of lanes of traffic to be crossed, whether all lanes must be crossed at once, or whether there is a divided carriageway and/or central refuge, and the type and location of dedicated crossing facility.

Other factors which have an effect on older pedestrians' safety and mobility include shared pedestrian/cycle provision, uneven pavement surfaces (including "tactile" surfaces) and obstructions to the footpath such as parked vehicles, street furniture, and cafe tables.

The Street Audit identifies and maps instances of these barriers to safe mobility, for each of the Places included in the study. Conclusions are then drawn about the extent to which the assessed Place has high, medium or low instances of barriers to safe mobility.

7.2.5 Overall Safe Mobility Per Zone

In Chapter 8, the two sets of indicators (safe mobility for drivers and safe mobility for pedestrians) will be combined, in order to assess whether there are trade-offs between safe mobility for different user groups, or whether there are examples of zones within which safe mobility for older road users is well catered for, regardless of which mode they may be using. Where there may be trade-offs between safety and mobility, these are also identified. Where examples of good practice exist, the factors which enable particular locations to cater well for older road users will be identified, in order that they can form the basis of best-practice recommendations.

Any external factors which appear to correlate with facilitators to safe mobility for older road users (for example, economic or social factors) will be identified.

7.3Data Collection

Data collection was undertaken over a period of 6 months from January 2011 to July 2011. A small scale pilot of the data collection forms was undertaken, as described in Chapter 4, following which some minor modifications were made. The purpose of the data collection forms was to facilitate identification of the features which inhibited safe mobility for older drivers and older pedestrians.

The locations identified for inclusion in the study were visited in turn, and an audit sheet (Appendix E) was completed. In addition, any additional factors which could have presented a barrier or facilitator to older people’s mobility were noted. Examples of the barriers and facilitators were photographed, and conclusions were draw about the overall effect on mobility.

In order to collect the necessary data for safe mobility for **drivers**, each location was visited a number of times during free-flow traffic conditions. Each route was driven at free-flow speed, except where keeping up with prevailing traffic conditions would have meant exceeding the speed limit. In such situations, the route was driven at the posted limit. Video footage was taken, in order to calculate journey times along the route, but also to allow analysis of factors such as

- Time between junction signage becoming visible and lane-change decisions needing to be made
- Travel time between junctions
- Time taken to travel through junctions

Where possible, each location was also visited on foot, so that features such as visual obstructions, pedestrian activity, and perturbations in traffic flow could be observed and recorded.

In order to collect the necessary data for safe mobility for **pedestrians**, each location was visited a number of times at different times of the day and week. All of the locations were visited on foot, in order that an understanding could be gained of how pedestrians experience the infrastructure. A walk-through was done and several sets of data collected. The data covers three domains; the first deals with general information about the location, the second with junctions and crossing provision, and the third with pedestrian access to public transport facilities and services. The values and variables collected are presented in Appendix F

7.4 Data Analysis Techniques

This chapter provides a qualitative analysis of the data collected via the infrastructure audit. Results for each of the zones are presented in turn, with descriptions of the type of features found, analysis of the likely impact on safe mobility, and conclusions drawn about the likely suitability of the audited infrastructure for both drivers and pedestrians. Illustrations are provided of both good and bad practice, with discussions presented about the likely impact on driver and pedestrian safety and mobility of the highlighted examples.

In Chapter 8 the data collected via the infrastructure audit will be used to derive performance indicators for safe mobility for older road users in urban areas. This will present a more quantitative measure of safe mobility which will then be compared to secondary data such as accident and casualty numbers and rates for locations covered by the infrastructure audits. This will allow a complete picture about the infrastructure in the case study city and its likely impact on the safe mobility of older road users in the urban area to be presented. Comparisons can then be drawn with traditional analysis of road safety using outcomes-based measures, in order to determine what, if anything, performance indicator analysis can add to the debate.

7.5Results – Central Zone

7.5.1 Central Zone - Introduction

The significant Link in the City Centre Zone is the Coventry Ring Road. Constructed in the aftermath of extensive World War Two bomb-damage, the Coventry Ring Road was innovative at the time of its construction. It facilitates relatively smooth traffic flow around the centre, with a 40 mph speed limit, and infrastructure which is mostly grade separated (with the exception of one junction). The design encourages traffic joining and leaving the ring road to merge in turn without the need for either to stop. This minimises inefficiencies at the junctions by reducing stop-start traffic movements and the “lost time” of the safety margins that must be built into the phases at signalised junctions. There is much planned separation of motorised and non-motorised traffic, with little scope for through traffic in the centre thanks to many of the in-bound ring road junctions leading only to car-parking facilities. Much of the remaining central infrastructure is accessible only to public transport. Pedestrian facilities are provided through a network of subways and bridges, shared in many cases with cycle lanes. The junctions are closely packed together, with a total of 9 junctions in approximately 1.4 miles of total road length[4]. Anecdotal evidence suggests that people find the ring road difficult to drive around and unattractive and inconvenient to walk around.

(www.CBRD.co.uk, http://www.bbc.co.uk/dna/h2g2/A210484) It has been included in the audit of infrastructure because it is the means by which all drivers would access city centre facilities, as well as being the main route for traffic between those suburbs which are closest to the centre. Car parks for key facilities such as the main swimming baths, Cathedral, the shopping centre, Coventry University and Council Offices are almost all accessed via the Ring Road, meaning that it is a key piece of infrastructure for older drivers wishing to access these facilities. Figure 49, below, shows the layout of the Ring Road.

The Railway Station area and nearby Central Six retail parks are important locations for both drivers and pedestrians, and other traffic-generating activities are located in the vicinity of the ring road. The infrastructure has been modified in several locations, primarily to improve the environment for visitors anticipated during the 2012 London Olympics. As a result, some main bus routes through the city have been redirected, and areas which were once accessible to vehicle traffic have been

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[4] Coventry City Council, private conversation, 17th December 2010

closed. As part of these improvements, controversial new Shared Space schemes have been opened in the centre. These will be discussed in Chapter 8.

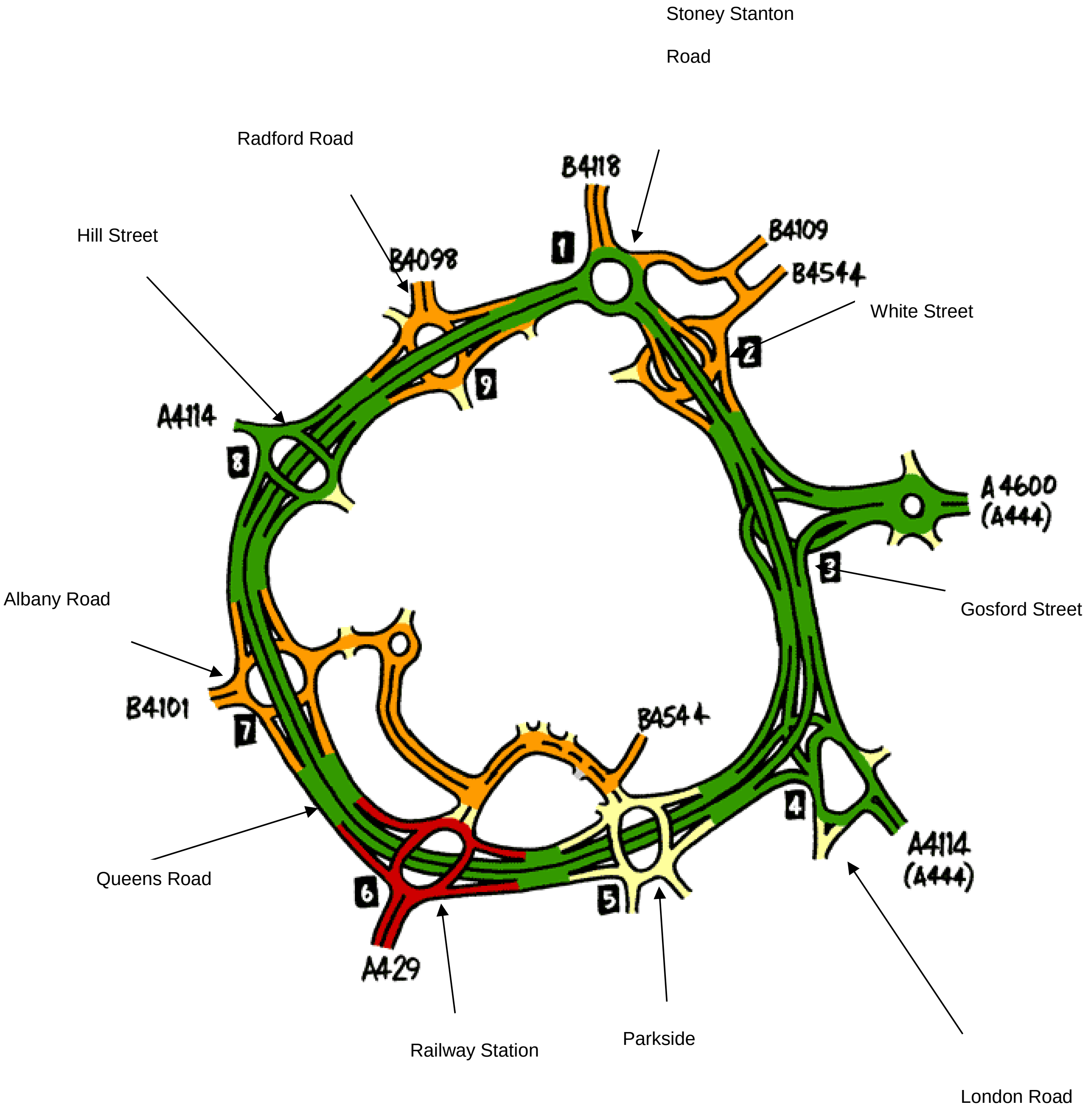

Fig 49; Coventry Ring Road. Source; Adapted from CBRD.co.uk

Due to the large area spanned by the Ring Road relative to the other locations, the ring road has been assessed in sections, divided by the junctions. This was in order to facilitate the data collection, and reporting of the results. However, for the purposes of analysis, it is considered only as one location.

Appendix G provides a summary of the results of the assessment of links in the central zone.

7.5.2 Central Zone - safe mobility for drivers

Barriers to safe mobility for older drivers were found throughout the central zone. The ring road is predominantly free-flowing, with fast moving traffic, closely packed junctions, and detailed signage. It is necessary for drivers to make complex judgements in short time windows, and the necessity to merge with other traffic whilst exiting and joining the ring road mean that it is difficult for drivers to adopt their own coping strategies with respect to gap acceptance and speed.

At junctions there are complex lane choices to be made, and many manoeuvres require drivers to look both directly in front of them and behind and to the side as they move across the junction. This is likely to be difficult for those with limited neck mobility and reduced peripheral vision.

However, there is no pedestrian or bicycle traffic on the main carriageways of the ring road, meaning traffic flow is generally smooth. Similarly there is no bus traffic or bus stops.

Figure 50, below shows a typical view of the ring road.

Fig 50; Typical view of ring road

Figures 51 and 52 show the exit ramp for Coventry Railway Station. At the bottom of the ramp, traffic using the access slip road for the station must merge between traffic joining the ring road.

Fig 51; View of exit slip road at Railway Station – bottom of ramp

At the top of the ramp (shown below), traffic from the left hand lanes (leaving the station) must merge between traffic from the centre two lanes (leaving the ring road for access to the station and some City Centre car parks). At the same time, traffic in both lanes must give way to traffic already on the roundabout. It is therefore necessary for drivers to make several complex judgements about the speed and distance of other vehicles simultaneously. In addition, traffic queues build at peak periods, meaning that traffic flow on the roundabout itself can be unpredictable.

Fig 52; View of top exit slip road at Railway Station – top of ramp

Fig 53; View of top exit slip road at Gosford St

Figure 53, above, shows an exit slip at Gosford St. Unlike most of the other junctions, this is one location where pedestrians DO have to cross the road, due to the lack of grade separated crossings here. As a result of its proximity to Coventry University, part of which can be seen in the top left of the picture, pedestrian flows may be relatively high. Depending on the route selection made when leaving the ring road here, some drivers will find it necessary to cross several lanes of traffic whilst merging with other vehicles, and being aware of pedestrians and potential traffic queues. All of this suggests that this infrastructure may generate a traffic situation which older drivers may have difficulty coping with.

Figure 54, below shows a typical view of the ring road which clearly depicts the on/off ramps and the extent to which drivers must look both ahead, behind and to the side when joining or leaving. As can also be appreciated, the infrastructure is very open, with few items of street furniture close to the travelling lanes, meaning that drivers' perceptions of speed and risk may be affected.

Fig 54; Typical view of ring road infrastructure

7.5.3 central zone – safe mobility for pedestrians

As has been stated, much of the infrastructure in the central zone was purpose-built after the war to provide for grade separation of motorised and non-motorised traffic, with through traffic encouraged away from the main shopping and leisure activities of the centre. This was very much the ethos promoted by the Buchanan Report described in Chapter 2, though the construction of the Coventry Ring Road predated it by some years. Given this almost total separation, pedestrian safety issues are not expected to be the main concern in this location. However, there is evidence that where crossing at grade *is* required in the central zone, it is not well designed for pedestrian safety. Fig 55, below, shows an un-signalised crossing close to the railway station: As can be seen, the traffic lane is wide, with approaching traffic obscured by the curve of the carriageway and the landscaping. In this case, the road to be crossed leads directly off the ring road. The speed limit is 40pmh, and as a result of the road geometry, visibility of pedestrians will be very poor for drivers approaching the junction. There are no parked cars, which have been shown to provide "friction" and offer some protection to older pedestrians. Similar examples were found elsewhere, including at Gosford St (presented above in figure 48. However, at-grade crossings were not commonly found in the central zone, and unsignalised ones were even less common. Better data about how the ring road is used by pedestrians would enable more robust conclusions to be drawn about the potential impact on safety of these crossings, as it may be the case that the unsignalised at-grade crossings are little-used, either because of pedestrian concerns about their safety, or because they are on less-used pedestrian routes.

Fig 55; At-grade crossing in central zone.

Pedestrian mobility issues were much more of a concern in the central zone than safety issues, with frequent examples of increased walk distances, obvious deviation of the pedestrian route from the desire line, many routes requiring steps or ramps to be climbed, and examples of a poor or unattractive environment.

Deviation of the safe pedestrian route from the desire line is an almost inevitable consequence of the separation of motorised and non-motorised traffic. It occurs most frequently in relation to pedestrian crossing points, where a detour is required to reach dedicated crossing points, as illustrated in figure 56, below.

Fig 56; Deviation of pedestrian desire line from safe pedestrian route

As is shown by figure 57, this situation can result in pedestrians ignoring crossing provision, though in cases such as this, where there is extensive use of guard rail, this may not be an option for the more mobility-limited pedestrians.

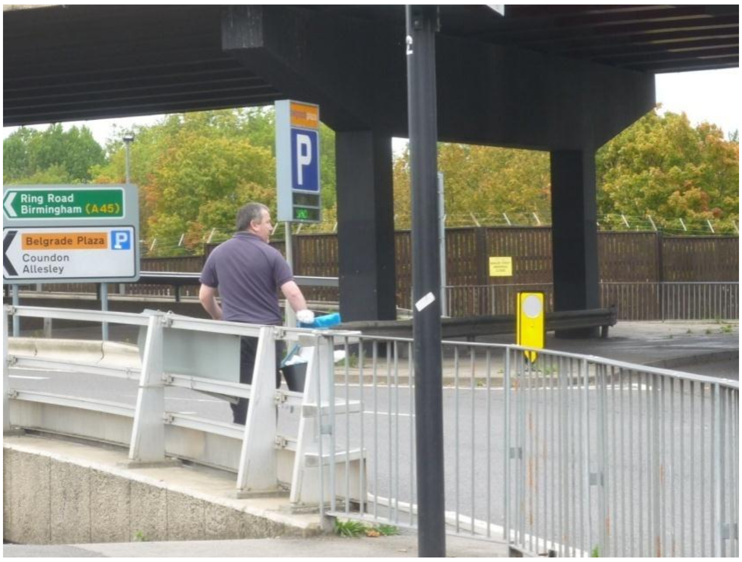

Fig 57; Potential consequences of deviation of safe pedestrian route from desire line

Fig 58; Evidence of deviation of pedestrian route from desire line

Fig 58 shows an example of evidence of a deviation of the pedestrian route from the pedestrian desire line. In some cases the implications of this may be inconvenience to pedestrians (hence an effect on mobility), whereas in others the effect may be to increase risk (for example in cases where pedestrians must cross several roads where the more direct route would involve only one crossing). However, in either case it does suggest that infrastructure is not catering well for the needs of pedestrians.

Poorly located and/or poorly designed crossings were also a frequently occurring phenomenon. Many crossings involved a lengthy detour for pedestrians, such as that shown in figure 59, below.

Fig 59 Pedestrian crossing close to Butts Rd, showing detour along slip road

It was rare in the central zone for there to be no dedicated crossing provision, however, there were cases where dedicated pedestrian infrastructure in the vicinity of the ring road abruptly ended. Fig 60, below shows one such case.

Fig 60; End of pedestrian footpath close to Railway Station

In this case, two alternative safe pedestrian routes between the Railway Station and the City Centre are available close to this location, but the footpath here also appears to head in the right direction before ending alongside the ring road, with guard rail preventing pedestrians from going further.

The design of the ring road, and specifically the extensive separation of motorised and non-motorised traffic means that significant changes of level are a frequently occurring phenomenon, in order to provide for grade-separated crossings. All of the crossings assessed provided pedestrians with a choice of steps or ramps to access the subways or over-bridges. However, the ramps usually involve a lengthy detour compared to using the steps. In addition, the slopes provide access for cyclists as well as pedestrians. In cases where the slope is steep, this could result in cyclists travelling at speed through the subway, potentially posing a risk to pedestrian safety.

Figures 61, 62 and 63 show examples of subway access which are typical of those found throughout the central zone.

Fig 61; Subway access via steps

Fig 62; Subway access via a ramp, showing shared cycle/pedestrian pavement.

Fig 63; Over-bridge at Hill Street, showing length of the ramp access

Uneven and damaged surfaces were found throughout the central area, with pavement maintenance being particularly poor in some areas. Figures 64, 65 and 66 below, are typical examples.

Fig 64; Example of damaged paving

Fig 65; Example of damaged paving

Fig 66; Example of poorly maintained infrastructure

This presents a barrier to mobility, particularly for the less physically able who are susceptible to trips and falls. Shared pedestrian/cycle infrastructure is a frequently-occurring phenomenon in the central zone. This may be because the nature of the Coventry Ring-Road, as previously described, means it is particularly suited for motorised traffic, with much planned separation of motorised and non-motorised traffic. The subways and over-bridges also provide for pedestrian and cycle routes which are generally shorter and more direct than the corresponding vehicular route around the city centre. However, in many cases these shared routes were poorly marked out, meaning that it was sometimes unclear which side of the path was for cyclists and which for pedestrians. In some cases, the only indication came at the end of the cycle route (as shown in fig 67, below). In one instance the cycle path changed from one side of the path to the other mid-way along, which again could be confusing for both pedestrians and cyclists, and increases the risk of collisions. In many locations, the possible impact on safe mobility of this type of shared infrastructure was exacerbated by inadequate or degraded pavement marking, such as those shown in figures 67-69. Shared pedestrian and cycle infrastructure was shown by both the literature review and user data to be a concern.

Fig 67; Unclear marking of pedestrian/cycle paths, with degraded pavement markings

Fig 68; Unclear marking of pedestrian/cycle paths, with degraded pavement markings

Fig 69; Inadequate marking of pedestrian/cycle paths, with degraded pavement markings

When walking around the ring road, it is not always clear where the safe pedestrian route is. Figure 70 shows the signage at Parkside, close to Coventry University and on the edge of a large business park with hotels and other facilities. City Centre buildings can be seen in the top centre of the picture, but the pedestrian route to the Centre leads in the opposite direction, with pedestrians needing to locate a crossing several metres in the other direction, before turning back on themselves to enter a subway which leads to the city centre. Several pedestrians were seen ignoring the pedestrian route at this location, choosing instead to climb over the guard rail and walk in the carriageway, as is shown by figure 65.

Fig 70; Poorly signed pedestrian route

Fig 71; Pedestrian in carriageway

This was not an isolated case, as is shown by figure 72, where the sign states that the underpass is closed, but no indication is given as to where the alternative route (if there is one) can be found. Several pedestrians were seen crossing in the carriageway at this location, as is shown by figure 57, presented earlier, and figure 71, above. Whilst pedestrians without mobility limitations may opt to climb the barriers, more mobility-limited pedestrians may find this impossible; this raises questions about their behavioural responses and whether some opt not to make the journey, or to not make it on foot as a consequence.

Fig 72; poorly signed pedestrian route

Fig 73 Pedestrian walking in carriageway

In contrast, figure 74, below, shows an example of good signage for pedestrians, located at the side of a wide, smooth area of paving in an attractively landscaped environment, close to the theatre and main shopping area. This may reflect the likely importance of this location to pedestrians, compared to some of the other less-used locations. It may also be related to issues around tourists (who are less likely to be able to use local knowledge to find their way around) and the viability of the city centre: If the environment is poor potential visitors may avoid the city. As Coventry has good road and rail links to other popular centres such as Stratford Upon Avon and Birmingham, and is only an hour by train from London, the impression that shoppers and other visitors form of the facilities may be prioritised over the investment in infrastructure predominantly used by locals.

Fig 74; Example of good pedestrian signage

Many examples of obstructions to the footway were found. In the central zone these included obstructions caused by street furniture, landscaping such as large trees, and bollards. Obstruction caused by vehicles was rare in and around the ring road due to the extensive planned separation of vehicles and pedestrians.

Fig 75 shows a piece of furniture which it is assumed is designed to keep cyclists from using the footpath through the park. It is unclear why this should be necessary at this location when so much of the pedestrian infrastructure in the central zone is shared with cyclists. However, this would not only prevent cyclists from using the path, but would also make access impossible for older people using mobility aids such as Zimmer Frames, as well as preventing access for other groups such as people with prams and anyone using a wheelchair.

Fig 75; Obstruction to the footpath caused by street furniture

Fig 76, below depicts a wide area of footpath which is partially blocked by a tree, with cobbles and a drianage gully taking up much of the rest of the available space. Whilst the remaining area of footpath is probably adequate for the needs of most pedestrians, it is unclear why so much of it is obstructed in this way. This location is close to the railway station, with a primary school and offices nearby, and a walkway to the City Centre on the left of the picture. Pedestrian activity here might therefore be expected to be high.

Fig 76; Obstructed footpath

Fig 77 Shows a footpath obstructed by poorly considered road signage, exacerbated by the presence of bollards in the centre of the pavement. Immediately behind the sign a signalised crossing can be seen. This provides access to the City Centre and major attractions such as a large IKEA store, cinema and restaurants, suggesting that facilitating pedestrian access here might be desirable.

Fig 77; Obstructed footpath

There were few examples in the Central Zone of pavements obstructed by stock displays and other business-related items such as advertising or cafe furniture. This is largely because the infrastructure assessed did not have significant retail activity.

A combination of factors contributes to the impression that much of the infrastructure in the central zone is not an attractive environment for pedestrians. The reasons for this vary from location to location, but include elements such as isolated and over-grown pathways, poor visibility, traffic intrusion (noise, fumes and vibration), inadequate lighting, poor maintenance and an apparent disconnect between the facilities and services older people need to access and the provided infrastructure.

Figures 78 and 79 show two views of the same section of pathway adjacent to the ring road. As can be seen, the path is narrow, isolated, poorly maintained, uneven and poorly lit. Pedestrians using the path would not be at risk of involvement in a traffic collision, but may have other safety concerns which might make them reluctant to use the path. The overall effect this might have on their exposure to traffic risk will be discussed further in Chapter 8.

Fig 78; View of pedestrian route adjacent to the ring road

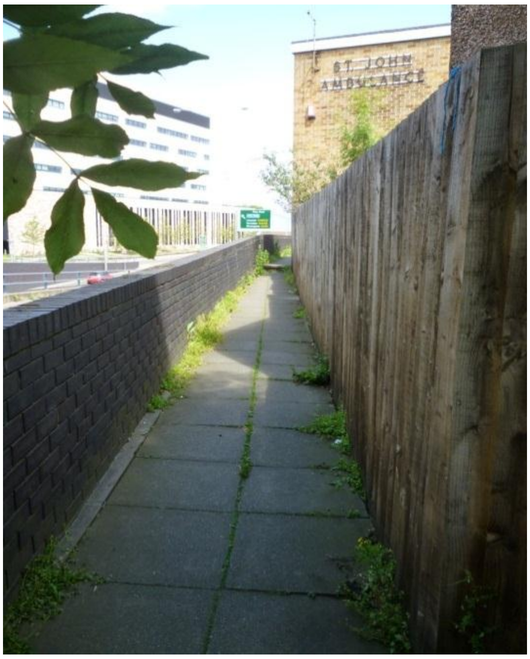

Fig 79; View of pedestrian route adjacent to the ring road

Another factor which may affect people's perceptions of their personal safety when walking is the degree to which they can see what is ahead, and whether there are other people using the infrastructure. There are many examples of locations in the central zone where forward visibility is limited.

Figures 80 and 81 show typical examples.

Fig 80; View of pedestrian/cycle infrastructure with limited view into subway

Fig 81; View of pedestrian/cycle infrastructure with limited view into subway

Poor lighting is also a frequently occurring issue. As has been demonstrated chapter 2, it affects older people's perceptions of personal safety when walking, but it can also increase the risk of trip/slip accidents. Figures 82 and 83 below show examples of the lighting issues which are present in some of the pedestrian subways and under-passes in the central zone.

Fig 82; Poorly lit crossing point close to Albany Road

Fig 83; Poorly lit crossing point close to Radford Road

Pedestrian access to public transport services is not a major issue for most of the infrastructure in the central zone. This can be partly explained by the grade separation of motorised and non-motorised traffic around the ring road (meaning walk access to bus services is limited) but also by the proximity of most of this infrastructure to the main interchanges in the City Centre where potential passengers would have a greater choice of services, access to better information, and facilities such as shelter and seating. A noteable exception to this is Warwick Road, close to the Railway Station, which is outside the ring road and is served by pedestrian routes and bus services from the City Centre, suburbs and from other nearby towns such as Warwick and Kenilworth.

A number of barriers to safe mobility for older pedestrians using the train station and bus services to and from the station were identified.

Figure 84, below shows the location of a bus stop on Warwick Road for passengers from the South of the City, Kenilworth and Warwick to access the main railway station. A signalised crossing point can be seen in the distance, though using this requires passengers to walk some distance away from the station.

Fig 84; Relative positions of signalised crossing and bus stop serving railway station

Figure 85, below shows the location of the bus stop and crossing, with station access indicated by the pedestrian sign on the left of the picture. As can be seen, for bus passengers arriving from the south of the city, a significant detour is required in order to use the safe crossing point.

Fig 85; Relative positions of signalised crossing, bus stop and railway station access

Observations at this location suggest that most pedestrians alighting from buses and travelling to the station elect to cross the carriageway somewhere between the bus stop and the station entrance, rather than using the signalised crossing. Figure 86, below, shows the width of the carriageway to be crossed. Whilst there is a central reservation, making it safer for older pedestrians who can cross each half of the carriageway separately, the proximity of the crossing point to the roundabout makes crossing more complex, by adding to the number of directions from which traffic may be approaching, and meaning that traffic flow is more continuous than would be the case with a signalised junction.

Additional factors contribute to the unpredictability of traffic flow at this location. These include; the high number of bus services which use the bus stops, meaning stop/start traffic and other vehicles trying to pass the buses; the presence of a large secondary school between the bus stop and signalised crossing, meaning high volumes of parked vehicles, cars crossing the footway at certain times of day during term time, and heavy demand generated by a large retail park accessed from the roundabout shown in figure 86, leading to queuing vehicles at peak times.

Fig 86; Carriageway between railway station and bus stop, showing position of roundabout

Once across the carriageway, the shortest route for pedestrians to access the station is via a flight of steps, as shown in figure 87. The alternative route is shown in figure 88.

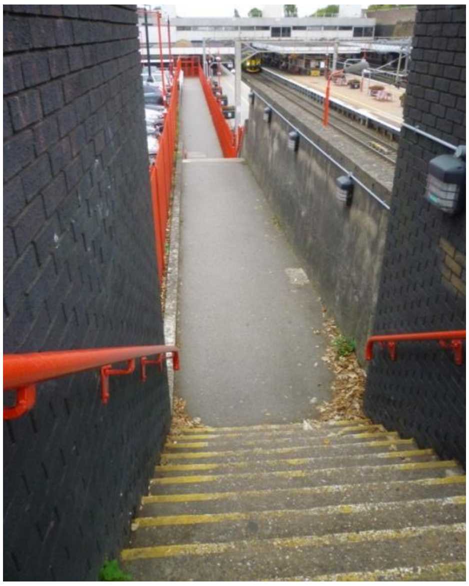

Fig 87; Station access from Warwick Road

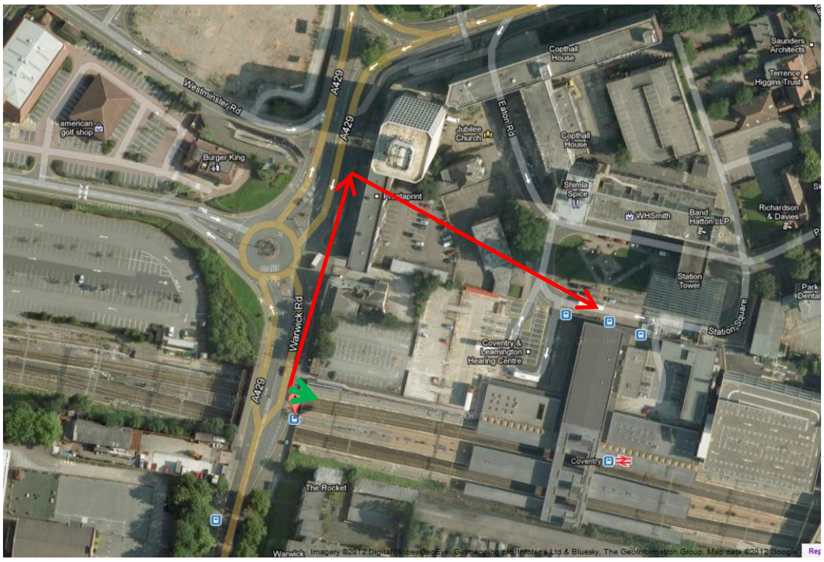

Fig 88; Station access showing location of steps and alternative route.

Source: Google maps.

→

Location of steps depicted in figure 81

→

Alternative (accessible) route

As can be appreciated, the level route indicated by the red arrows is significantly longer than the route via the steps. One solution to this would be to provide lifts from the road level to the platform level.

One factor which might be expected to lead to better provision of pedestrian facilities in the central zone is the amount of land available for dedicated pedestrian infrastructure. Several examples were found of locations where there was ample land for high quality, dedicated pedestrian (and cycle) infrastructure. However, in many cases poor design or maintenance meant that the best use was not made of the land.

Fig 89, below shows a location between the central railway station and the Memorial Park. This road is popularly used by people accessing the station from the south of the city (including by students from Warwick University), and is beyond the end of a cycle path which covers part of the route to the university and Kenilworth. As can be seen from the picture, there is ample land available here, which could be used to provide better pedestrian and cycle facilities between the station, park and university, linking with the existing cycle path which is sign-posted to the city centre not to the station. As it currently stands, many cyclists use the footpaths. These are narrow and uneven in places in any case, and are certainly not ideal as a shared pedestrian/cycle facility. However, the fact that cyclists use the footpaths suggests unwillingness amongst some to use the main carriageway. The explanation for this might lie in factors such as the narrow lanes, high traffic flows and poor road maintenance. As has been stated, cycling accounts for very few journeys made by older road users. However, improved cycling provision could benefit them by reducing the incidence of cyclists using the footpaths, even if it did not encourage large numbers of older road users to switch to cycling as a mode choice.

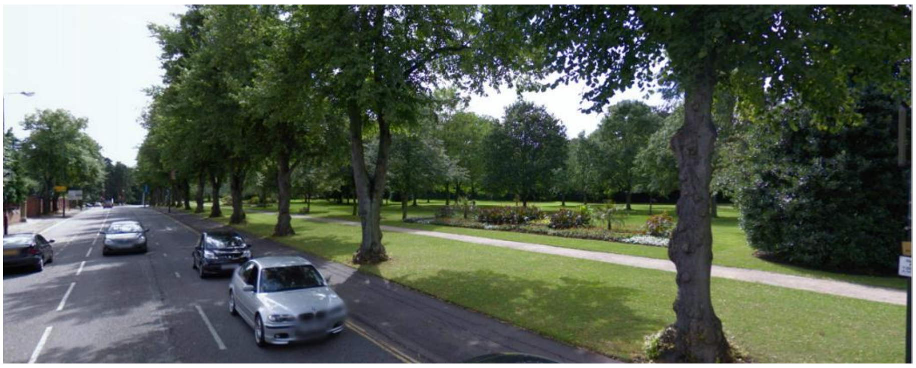

Fig 89; Warwick Rd, showing availability of land

In contrast, figures 90 and 91, below show what can be achieved when the pedestrianised areas are well planned and adequately maintained.

Fig 90; Pedestrian walkway close to Parkside

Fig 91; Pedestrian walkway from City Centre to railway station

In contrast, figures 92 and 93 show locations in the central zone where ample land has been turned over to pedestrians and cyclists, but has arguably not been used in the best way. Whilst the wide spaces are not unpleasant, and have several advantages (they are well-lit and open), they could be improved: The design encourages cyclists to travel at speed, and the sheltered spaces are often used by large groups such as teenagers, which may be intimidating to older pedestrians.

Fig 92; Pedestrian walkway close to the railway station

Fig 93; Pedestrian walkway close to Queens Rd

7.5.6 Central Zone - Conclusions

The results of the audit suggest that the infrastructure in the central zone caters better for the mobility of drivers and the safety of pedestrians than it does for driver safety and pedestrian mobility. The reasons for this can be summarised as follows;

- **Older driver mobility is high.** Traffic movement around the ring road is facilitated by grade separation of pedestrians and cyclists, lack of bus traffic (and thus of bus stops), and junction design which does not require traffic to stop at junctions or to move from stationary. This means that traffic flow is likely to be relatively smooth and fast-flowing, facilitating mobility of vehicular traffic.
- **Older pedestrian safety is high**. The grade separation of pedestrian and vehicular traffic also means that pedestrians are well protected from accident risk, especially when crossing the road, which has been shown to present a

particular risk to older pedestrians. Dedicated crossings of a variety of types (subways, bridges and signalised crossings) are found frequently in the central zone, meaning that pedestrians do not often need to cross moving traffic and thus make complex judgements about the speed and distance of vehicles or cross several lanes of traffic. However, when grade separated or signalised junctions are not provided, road crossings often are complex and/or risky.

- **Older driver safety is low.** The design of the ring road means that drivers are required to make complex judgements in small time windows. Junctions are close together and traffic speeds are relatively high, meaning that drivers have to make frequent decisions. In many cases, in order to negotiate the junctions it is necessary to look for traffic approaching from several directions at once, which is not easy for road users whose peripheral vision is declining, or who have limited movement in the head and neck.

- **Older pedestrian mobility is low.** In order to use dedicated pedestrian infrastructure, it is often necessary for pedestrians to make long detours. The provided infrastructure is frequently not located where it is most needed, or is otherwise inadequate as a result of issues with design, maintenance, lighting or other problems.

7.6 Results - South Zone

7.6.1 Introduction – South Zone

The South Zone incorporates three major Links; Kenpas Highway (A45), Kenilworth Road, Earlsdon Avenue

The A45 is the main route around the South and West of the city, linking the city to the M45 (for the M1 and London), the A46 (for Leicester and the M69 and Warwick/Leamington and the M40) and to Birmingham and the M42. The Kenpas Highway section is dual carriageway with a 40mph limit, passing through residential and shopping streets, and with a number of junctions and pedestrian crossing facilities. It passes close to one of the City's main parks, which hosts events throughout the year, including the City's main act of Remembrance each November, a festival of motoring, and various other cultural and leisure activities.

The Kenilworth Rd is a wide, leafy road with low density housing set well back from the road. It has a 40mph speed limit for most of its length, including where it passes a primary school, but has a 30mph limit close to the city centre, where it widens to two lanes approaching Coventry Station.

The key places in the South Zone are Quinton Parade, Kenpas Highway Shops and Earlsdon High Street. Quinton Parade is a row of shops, set back from the Daventry

Road, with a service road to the shop frontages providing parking bays. Additional parking is available on the road itself. The pavements are wide, but are used in places by displays of stock. The shops are varied, and include food shops, hardware stores, takeaways, charity shops and newsagents. The shops face a large park, with churches and associated activities (play groups, for example) nearby. Daventry Road itself has a 30 mph speed limit, and is a popular residential area where houses generally have off-street parking.

Kenpas Highway is a smaller shopping area than either Quinton Parade or Earlsdon High Street. It has a small amount of parking on a service road off the A45, with the A45 itself being subject to a 40mph speed limit. Whilst there is a smaller range of shops here (a general store, takeaways, chemist and hairdressing salon), the streets around provide a large range of popular activities for the over 60s, including a library, medical centre, park and churches. Kenpas Highway also has bus stops from which services run to the City Centre and Warwick University in one direction and to University Hospital in the other. The A45 carries a range of traffic, including large lorries, and is especially busy when there is major disruption on the surrounding strategic road network, particularly the M6.

Earlsdon High Street is the busiest shopping street of the Places in the South Zone. It has a range of shops including an antique centre, florists, delicatessens, gift shops, restaurants, convenience stores and other independent food stores such as a butcher and grocers. It also has a local library and church, both of which hold special interest events such as reading groups, weight loss groups and concerts.

7.6.2 South Zone – safe mobility for older drivers

The infrastructure in the south zone is predominantly less complex than that found in the central zone. Whilst the A45, as the busiest route in the zone has examples of complex junctions, these occur less frequently than around the ring road. However, compared to the central zone (and especially the ring road) the traffic is less homogenous and predictable, with a mixture of traffic including large goods vehicles, buses, cars and pedestrians, meaning that disruption to traffic flow is more likely. Whilst the ring road is clearly purpose built to maintain throughput of traffic whilst providing pedestrian and cycle facilities, the rest of the assessed infrastructure demonstrates more keenly the compromises that are usually necessary in attempting to meet the different needs of different road user groups.

Figure 94, below shows a junction on the A45. It can be seen that the junction is not particularly complex. The junction is signalised, meaning that there is no need for drivers to judge the speed or distance of on-coming vehicles, there is a pedestrian light phase and pedestrian guard-rail, hence the risk of pedestrians being in the carriageway is lower, and the barred right turn means that there should be no conflicting vehicle movements when the signals are green.

Fig 94; Junction of A45/Wainbody Avenue

However, the impact of the infrastructure design on driver mobility is less positive. The barred turns limit access to the shops which can be seen on the left of the picture. In addition, for traffic wishing to make the right turns, the only alternative involves a detour incorporating several additional junctions, which at busy times of the day would impose a significant time delay as well as increasing drivers' exposure to risk. The detour is shown in fig 95, below.

Fig 95; Impact of barred turns

There is evidence that the lack of provision for right turning vehicles at this junction does cause a problem for drivers: Significant numbers of vehicles turn left into the junction in order to make a three-point turn and then travel straight across the junction. This causes an issue for pedestrians, as turning vehicles use the dropped kerb to mount the pavement in order to make the turn easier.

7.6.3 South zone – safe mobility for pedestrians

Appendix G summarises the main findings of the assessment of Places, south zone.

Kenpas Highway was assessed from its intersection with the Kenilworth Rd at the northwest end of the segment, to the Leamington Rd at the southern end. Whilst the shops are concentrated at the northern (Kenilworth Rd) end, there are additional shops including a popular convenience store at the southern end, as well as access via side roads to two doctor's surgeries, a church and a post office.

The following figures (96 - 98) give an idea of the general traffic conditions and infrastructure provision in the immediate vicinity of the Kenpas Highway shops. As can be seen, the infrastructure is designed with throughput of motorised traffic prioritised. The carriageway is wide, with separation of opposing traffic flows and median strip guard rail, as well as "visi-rail" at pedestrian crossing points. Despite the proximity of housing and shops to the main carriageway, there is a 40mph speed limit, and heavy and mixed traffic flows.

Fig 96; Kenpas Highway showing design features

Fig 97; Kenpas Highway showing large goods vehicle traffic

Fig 98; Kenpas Highway showing traffic and guard rail

Three crossing points are provided in the study area, all of which are south of the main shopping parade. This means that from the northern end of the Kenpas Highway Place, pedestrians must make a detour of approximately 1km each way if they wish to use the nearest crossing facility. In addition, it then becomes necessary to cross a number of side roads. The phasing of the lights at the Kenilworth Rd intersection means that there is no point in the cycle when all traffic is stationary.

This, coupled with the wide carriageway (5 lanes of traffic in total) and lack of pedestrian refuges makes it very difficult for older pedestrians to cross at this point (figure 99). As was stated in Chapter 2, wider roads with undivided carriageways present a particular safety issue for older pedestrians. The location of bus stops for services to the city centre and hospital would make this a desirable place to cross for anyone wishing to access those services.

Fig 99; Traffic at the junction of Kenilworth Road and Kenpas Highway

In addition to the crossing pictured in figure 96, there is a further at grade crossing (figure 100) and a pedestrian subway (figure 101)

Fig 100; Kenpas Highway, at-grade crossing

Fig 101 Kenpas Highway, subway

This gives an indication of the likely difficulty an older pedestrian would encounter if trying to cross the road here to access public transport, or in order to get to or from the shops. In the case of the subway, some older road pedestrians (and indeed other categories of pedestrian) would be reluctant to use it because of concerns about personal safety. In this case users would have to decide between the risk they felt was posed by crossing the carriageway and the risk they felt was posed by using the subway.

Fig 102, below, shows the narrow and overgrown condition of the footway at this point, which could present a slip hazard to older pedestrians, particularly in the autumn. In addition, the proximity of pedestrians to the traffic can be appreciated; this could be quite unpleasant, with visual intrusion, noise and poor air quality, all contributing to a less than ideal pedestrian environment.

Fig 102; Narrow overgrown footway in south zone

Pavement condition was poor throughout the study area, but was particularly poor at the northern end, closest to the shopping parade.

Problems included footpaths blocked by trees and roadside furniture such as signage and lighting posts, gullies running the length of the pavement, broken tarmac and uneven slabs. Figures 103 and 104 give an indication of the problems with pavement condition.

Fig 103; Example of poor pavement condition

Fig 104; Example of poor pavement condition

As can be seen in figure 104, above**,** a cycle path is marked out on the footpath itself, this is a factor which hinders the mobility of older road users, who stated in focus groups that they found shared facilities like this intimidating, since they were unclear who had right of way and were afraid of being knocked over. In this case, the cycle way is marked on the part of the footpath which is periodically blocked with trees, which would cause cyclists to weave across the footpath around the obstructions. This would be likely to exacerbate feelings of insecurity amongst older pedestrians. Whilst older cyclists have been excluded from the analysis, for reasons which are set out in Chapter 1, it is worth noting that this particular example of cycle provision is unlikely to be very user-friendly, due to the obstacles, and lack of clarity for both cyclists and pedestrians about who has right of way on which parts of the footpath. The location of this infrastructure, in close proximity to two secondary schools, means that at certain times of day, the footway/cycle path is used by higher numbers of cyclists. As can be appreciated from figure 105, below, availability of space within which to create quality pedestrian and cycle provision would not appear to be the key factor at this location.

Fig 105; Cyclist using the shared pedestrian/cycle facility

Fig 106; Tactile surface

Figure 106 shows an example of tactile surfacing crossing the footpath. This is intended to guide the visually impaired to the safe crossing place to the right of the photograph. However, in combination with the uneven surface which can be seen on the left of the picture, it can represent a trip hazard and was disliked by some focus group participants who felt that it was uncomfortable and difficult to walk on for those with mobility issues such as arthritis.

Quinton Parade is a row of shops on the Daventry Rd, which was assessed from its junction with Quinton Road to its junction with Queen Isabella's Avenue. Whilst the majority of the shops are concentrated on the North side of Daventry Road, there is a small row of shops, a park, and church on the south side. The shops are set back from the main carriageway on both sides of the Daventry Road, but in both cases there are service roads and parking provision immediately adjacent to the shops.

This can be seen in figure 107, below, where the service road and parking is to the left of the picture, and the Daventry road itself is on the right.

Fig 107; View of Daventry Road showing parking provision and service road

Pavement condition was good throughout this location, with surfaces mainly tarmac or slabbing, which appeared to be well-maintained and smooth. Whilst some shops were utilising pavements for stock display, this did not cause an obstruction as the pavements were wide.

The pavement immediately fronting the shops was also relatively clear of obstructions from roadside furniture such as sign posts and trees. However, the pavement between the Daventry Road and the surface road was less wide, and contained more obstructions, as can be seen in figure 108, below.

Fig 108; Pavement obstructions Daventry Road

There is no dedicated cycle provision at this location.

There are three dedicated crossings, the location of all being close to the junction of Quinton Rd and Daventry Rd would be convenient for pedestrians crossing between the shops on the north and south sides of Daventry Road. Daventry Road itself is served by a signalised crossing, with zebra crossings on Quinton Rd and Quinton Park. However, the surface condition of the crossing on Quinton Rd is extremely poor, as can be seen by figure 109.

Fig 109; Poor pavement condition at Quinton Rd crossing

This would clearly present a trip hazard to crossing pedestrians. In addition, there is evidence of previous crashes at this location (figure 110). Aside from any safety issue this might suggest, the condition of the guard rail here could be a cause for concern for anyone waiting to cross here.

Fig 110; Guard rail damage, Daventry Road

Crossing elsewhere would be made more difficult by parked cars on both the pavement itself and on the roadside (as shown in figures 111 and 112. As can be seen, obstructions of dropped kerbs and footways by vehicles is a major problem at this location. This emphasises the point made in Chapter 2, that the mobility is a highly dynamic concept: Providing infrastructure which meets the needs of older road users is important. However, misuse of infrastructure can easily affect its usability in ways which designers or policy-makers may be unable to predict or indeed to appreciate. There are no pedestrian refuges here either; having to cross both carriageways together has been shown to be more problematic for older pedestrians, especially if their walk speed is low (Oxley et al, 2002).

Figure 111; Parked vehicle obstructing the dropped kerb, Daventry Road

In figure 105, the parked vehicles are blocking a significant proportion of the pavement alongside the Daventry Rd, but are also obstructing the approach to the crossing. As well as making it difficult for pedestrians to use the footpath, it hinders visibility of the crossing for drivers, and of vehicles for crossing pedestrians. As older pedestrians are more likely to suffer deteriorations in their vision and hearing (Brace et al, 2006) anything which impedes their view of on-coming traffic is problematic.

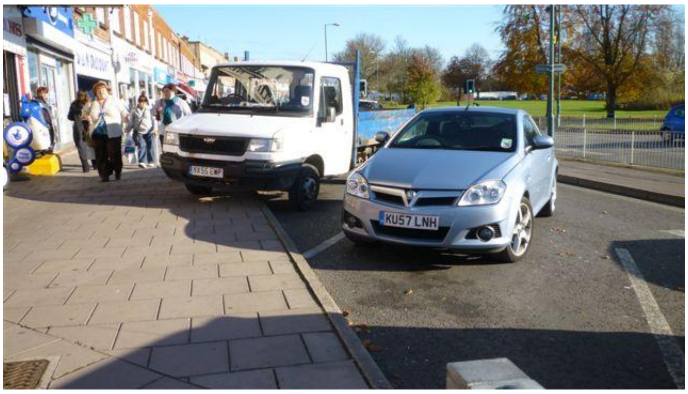

Figure 112; Parked vehicle obstructing the pavement and reducing crossing visibility, Daventry Road

This again stresses the trade-offs between mobility for older drivers (can they get where they need to go and park conveniently and safely once they get there?) and safety and mobility for older pedestrians (are they protected from traffic risk and can they move around the urban area in the way they need to?)

7.6.4 South zone – Conclusions

Data collected in the south zone suggest that the balance between safety and mobility and between drivers and pedestrians is less clear-cut here than in the central zone. There is a clear difference between the locations within the south zone which border the strategic infrastructure of the A45, where traffic flows are high and pedestrian safety and mobility may be compromised as a result. The local roads serving Quinton Parade and Earlsdon High Street do not carry the high traffic flows seen on the A45/Kenpas Highway. As a result, junctions do not need to have such high capacity and decision-making is less complex. In addition, both the speed limit and average vehicle speeds are lower, giving drivers more time to perceive and respond to cues. However, parking is problematic, and traffic flows are complicated by vehicles looking for spaces, manoeuvring in and out of them, and by pedestrians crossing. This is different from the situation in the vicinity of the A45, where parking is, in many cases, banned. A similar contrast is apparent in the degree to which pedestrian mobility is facilitated. Around Quinton Park and Earlsdon High St, pedestrian mobility is well catered for in infrastructure design, with wide pavements, convenient dedicated crossings and a lack of barriers such as guard rail, but is hampered by inconsiderate parking. Pedestrian safety is promoted through (relatively) low speed limits, narrow carriageways and the presence of parked vehicles on kerb sides, though it should be borne in mind that parked vehicles only improve safety for *adult* pedestrians, whilst increasing risk for child pedestrians (Dumbaugh, 2008). Along the A45, the same is not true; the speed limit is 40mph, and whilst footpaths are wide, they are shared with cyclists. Crossing is difficult other than at dedicated crossings, which are not ideally designed or situated.

In the case of the Kenpas Highway it is anticipated that a separate performance indicator would show that vehicle mobility has been prioritised at the expense of pedestrian mobility. However, due to the large gaps between crossing provision, the lack of signalised crossings and the lack of pedestrian refuges, it is also anticipated that the score for pedestrian safety will be low. The driver safety score is also expected to be relatively poor due to the complicated traffic flow and the need to yield to oncoming traffic at junctions. However, when aggregate scores are calculated for the zone as a whole, the overall scores are harder to predict due to the different scores calculated for the different locations.

7.7 East Zone

7.7.1 East Zone - Introduction

The key Links in the East Zone are Walsgrave Road, Binley Road and the A444. Walsgrave Rd is one the City’s key arterial links, carrying traffic from the City Centre in an East – North East direction, towards strategic roads such as the M6 and M69.

It also links the rest of the city to the main hospital (University Hospital Coventry and Warwickshire), as well as providing access to a number of retail and leisure activities on the eastern edge of the city, including a multi-screen cinema, a number of large supermarkets and hotels, gyms and restaurants, all of which were highlighted by the focus group participants as being important places for them to visit. The road itself is mostly single carriageway, with a 30mph limit, and it passes through key shopping and residential areas (including Ball Hill, which is discussed in more detail below). As a result it is, in places, an area with high pedestrian traffic flows, and a number of crossing points and junctions.

Binley Road also carries traffic heading east out of the city. At its junction with the Walsgrave Road it is several lanes wide with a broad median strip with flower beds and pedestrian guard rail. Whilst it is a 30mph limit, the design speed appears to be higher, with the result that traffic appears to be fast-flowing at this point. Beyond its junction with the A444 Binley Road narrows to one lane, with housing mostly set back from the road. Whilst Binley Road is mostly single carriageway with a 30mph limit, beyond the Empress Buildings shops (described in more detail below) it widens to two lanes, with buildings set further from the road, and a 40mph limit.
Traffic is predominantly local traffic, as the Walsgrave Road (to the north) or A444 to the West provide more convenient access to the trunk road network. However, Binley Road is used to some extent by emergency vehicles travelling to and from University Hospital.

The A444 in Coventry was constructed in the late 1990s, as a dual carriageway linking the City Centre and the North of the City to the M6, and towns such as Nuneaton and Burton upon Trent. Since the opening of the road, a number of important traffic-generating developments have been constructed along it, including supermarkets and clothes shops, a casino, and the Ricoh Arena, which hosts Coventry City Football Club home games, major rock and pop concerts, and which also incorporates a gym and hotel. Currently public transport access to these facilities is limited; whilst the Coventry - Nuneaton rail line passes close to the route of the road, there is currently no station serving Coventry's northern suburbs. For a fuller discussion of the issues around public transport access to the Ricoh Arena and its associated developments, see Rackliff et al (2008). The A444 thus represents an important link for people wishing to access these shopping and leisure facilities, or who wish to travel to the North via the M6 or A444.

The Places in the East Zone are Ball Hill, Empress Buildings and The Forum.

Ball Hill is to the East of the City Centre, with shops on either side of the Walsgrave Road. It has a 30mph limit, and whilst on-street parking is limited, there are some on-street spaces and car parks on the streets leading off the main shopping street. The road itself is busy, being extensively used by buses, as well as by emergency vehicles travelling to and from University Hospital Coventry and Warwickshire. The pavements are wide, but are used by shop-keepers for displaying stock.   The shops are varied, but include banks, clothing and shoe shops, electrical shops, charity shops and small supermarkets.

Empress Buildings is a compact shopping area adjacent to the Binley Road to the East of the City Centre. It has a large off-street parking area, and has a range of shops including two large food stores, takeaways, a grocers, florist and building society. There is an optician and doctor's surgery nearby, and bus stops for services to the City Centre in one direction, and to University Hospital in the other.

7.7.2 East zone – safe mobility for drivers

As with the south zone, the east zone has some contrasting areas.   The Walsgrave Road, Binley Road and London Road all carry heavy and varied traffic. Whilst Binley Road and London Road are wide dual carriageways with a 40mph limit for at least part of the route, the Walsgrave Road is predominantly single carriageway with a 30mph limit. However, all would appear to impose a high workload on the driver through the need to make frequent, complex decisions in an environment complicated by the presence of detailed, often degraded signage and factors such as bus stops, emergency vehicles and parking disturbing traffic flow.

Fig 113, below shows the approach to the junction of the Walsgrave Road and Binley Road.

Fig 113; Approach to the Binley Rd/Walsgrave Rd junction

As can be seen, the carriageway is wide, with a choice of 4 lanes, with a choice of 3 lanes for traffic going straight across the junction. The lane selection here has implications at the next junction (shown in figure 114, below). The proximity of the junctions makes the selection of a wrong lane choice difficult to correct. In addition, the bus stop, visible to the left of fig 113 also complicates the traffic flow.

Fig 114; Junction of Binley Rd and Gulson Rd

In terms of driver mobility, both Binley Road and the Walsgrave Road have a number of parking restrictions and barred turns. Figures 115 and 116 below, show barred turns on the Walsgrave Road. It is assumed these relate to the Air Quality Management Area referred to earlier. Whilst the rationale for the barred turn depicted in figure 115, is likely to be the prevention of traffic queues forming behind right turning vehicles waiting for a suitable gap in the traffic, in the case of fig 116, the reasoning is unclear. This turn was mentioned by focus group participants who found it to be inconvenient and illogical. Many felt that it was widely ignored, probably as a consequence of drivers failing to understand the purpose behind it.

Fig 115; Barred right turn on Walsgrave Rd

Fig 116; Barred left turn on Walsgrave Rd

7.7.3 East zone – safe mobility for pedestrians

Overall the findings with regard to safe mobility for pedestrians were less mixed than in the south zone. Whereas the south zone contained locations where the trade-offs between throughput of motorised traffic and the needs of pedestrians were less keenly felt, in all of the key locations of the east zone there was an obvious conflict between the needs of the two groups. This is because of the strategic importance of the key routes (Binley Road, Walsgrave Road and London Road) as routes into and out of the city and access to the main hospital and their function as popular and busy shopping streets. It is in precisely these kind of locations where the decisions about which road users should have their needs prioritised are the most difficult.

In the case of pedestrian safety, all of the key locations have signalised pedestrian crossing provision, though the distance between them and the difficulty of crossing elsewhere was something which was raised by focus group participants and may affect pedestrian mobility. Figure 117, below gives an indication of traffic conditions on the Walsgrave Road. As can be seen from the picture, whilst the road is neither wide nor fast-moving, traffic volumes are high and the conspicuity of pedestrians is likely to be poor as a consequence of the chaotic conditions. There is no separation of infrastructure at any of the key locations. Some locations *do* have a median strip to aid road crossing and some do not. In the example below it is clear that whilst median strips have been shown to reduce pedestrian accidents (Zegeer and Bushill, 2011), waiting at one would not be particularly pleasant at this location due to the heavy traffic, large goods vehicles and relatively narrow carriageway.

Fig 117; Traffic conditions on Walsgrave Rd

In addition, both Binley Road and Walsgrave Road are extensively used by buses and emergency vehicles, as both are key routes to the hospital.

In terms of pedestrian mobility, pavement condition was poor throughout the study area, with lots of different surface treatments even in short sections, and interfaces between different surfacing poorly executed. Surface such as cobbles are difficult for those with mobility problems caused by, for example, arthritis, to negotiate, and uneven paving presents a clear trip hazard for all users, not just older pedestrians. For much of the study area, rainwater gullies cross the footpath, again presenting a trip hazard. The pavement is also obstructed by stock displays, café seating and roadside furniture such as bins, lamp posts and signage.

Figures 118 – 121 illustrate some of the problems identified.

Fig 118 Poor pavement condition, Walsgrave Rd (1)

Fig 119; Poor pavement condition, Walsgrave Rd (2)

Fig 120; Poor pavement condition, Walsgrave Rd (3)

Fig 121; Pavement condition, Walsgrave Rd (1)

As can be seen in fig 122, below, in some cases there is a distinct camber to the footpath, which would cause a problem for anyone with poor balance. Figure 121, above shows that in some cases much of the footpath is taken up with stock displays.

Fig 122; Pavement condition, Walsgrave Rd (2)

No cycle provision was identified at Walsgrave Road or London Road, but Binley Road had a cycle lane on the carriageway. Given the obstructions present on the footpath cyclists at Walsgrave Road would tend to use the road, though no cyclists were observed either in the carriageway or on the footpath during the audit. From the perspective of older pedestrians, this is the best solution, as sharing space with cyclists is not seen as ideal (Titheridge and Soloman, 2007).

In terms of access to public transport, problems with the ease of making return journeys were less apparent in this zone than in the south zone. This is because there was less extensive use of guard rail and separation of infrastructure, meaning that crossing the road to the stop on the outward or return journey was less of an issue. However, in the case of Walsgrave Road, a “Primelines” bus priority scheme had funded modifications to the stops which included the raised kerbs seen in figure 123, below. The idea of these kerbs is that buses can pull right up in order to allow ease of access; those with mobility limitations, prams or wheelchairs can board the bus without needing to negotiate a large step. However, for passengers who need to cross the road to join or leave the bus, this large step up necessitated by the kerb could be a trip hazard.

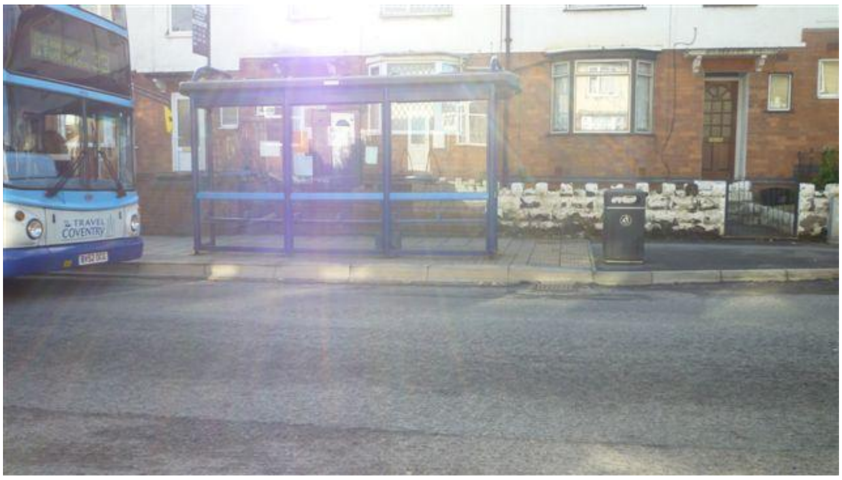

Fig 123, Raised bus kerb on Walsgrave Rd

7.7.4 East Zone Conclusions

Data collected in the east zone suggest that the balance between safety and mobility and between drivers and pedestrians is also problematic in this zone. All of the main routes have key retail and leisure activities located alongside them, and the main shopping area within the zone (Ball Hill) is located on a key arterial route out of the city (Walsgrave Road). None of the routes in the east zone carries the traffic seen on the A45, and the speed limits close to houses and shops are generally 30mph, not the 40mph seen around the ring road and A45 in the central and south zones respectively. As a result, junctions have lower capacity, and are thus less complicated, and both driver decision-making and pedestrian crossing behaviour are less complex and risky. However, parking is occasionally problematic on both the Binley Road and Walsgrave Road (it is banned on London Rd), and traffic flows are complicated by vehicles looking for spaces and manoeuvring. There is a contrast between the way pedestrian mobility is catered for around the wider, faster roads closer to the centre (for example, at the junction of the Walsgrave Road and Binley Road), where pedestrian guard rail, shared pedestrian/cycle facilities and long detours to cross are more common, and mobility on the stretches of road with significant retail activity. In these locations, guard rail and shared facilities are less common.

It is anticipated that the east zone will perform reasonably well for driver safety and mobility, as a consequence of the relative lack of complex junctions, and the widespread provision of on-street parking. In terms of pedestrian mobility, pavement condition was a major concern.

7.8 Discussion

Results show that there are barriers to safe mobility for both older drivers and older pedestrians in all of the zones audited.

No zone had areas of consistent good practice, however, more examples of infrastructure designed for pedestrians were found in the Central Zone than in others. This may be because this zone encompasses locations more likely to be encountered by visitors, or to be used in publicity and tourism material. Other explanations include the importance of the locations as pedestrian routes, or the importance of the location to the City's economy, making it desirable that those who might spend money in the city can access the facilities they wish to use, and that they find the environment pleasant to be in and easy to navigate around. Figure 124, below shows the main pedestrian route from the Railway Station to the City Centre.

Fig 124; Pedestrian route between railway station and main shopping centre

As well as being an attractively landscaped and well-lit environment, the route between the shopping centre and railway station is marked by a continuous blue line, seen in the centre of the picture. This contrasts with other locations audited, where the route was poorly signed and/or discontinuous, and where the environment is dark, over-grown and generally unattractive.

Figure 125 shows the area around a pedestrian route close to the ring road on the north of the city centre.


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Fig 125; Pedestrian route between Radford and city centre

Whilst the popularity of the route may be a factor in dictating the amount invested in it (and thus influencing the extent to which it meets the needs of users), there were both links and places which were extensively used, but which did not meet the needs of users well. In the case of Links, these were often places where vehicle traffic was heavy, and/or the demand for parking provision was high, resulting in large, complex junctions, unpredictable traffic flow, and conditions complicated by the presence of vehicles which were either waiting for spaces, or were parked dangerously or inconsiderately.

In the case of places, several locations were identified where there was a clear need for infrastructure to meet the needs of pedestrians, but where the provision was poor. Examples of this included in the area around the main railway station and close to the main Coventry University buildings on the edge of the City Centre.

There are a number of potential explanations for this. In some cases, infrastructure design is limited by what can be achieved within the constraints of what is there already. In most cases in the central zone, space is not an issue and good design, better maintenance or small modifications to infrastructure or traffic conditions (eg lower speed limit) would improve safe mobility.

7.9 Conclusions

This chapter has presented an audit of infrastructure in the case study city. The results of this audit suggest that safe mobility for older road users (whether as pedestrians or drivers) is not well catered for. The factors leading to this are, in the case of older drivers; complex junctions, poor information, presence of time pressure at junctions, and the presence of complicating factors such as bus lanes, pedestrian crossings and poor visibility. In the case of older pedestrians, the factors which present a barrier to safe mobility are poor footpath condition, poorly signed or discontinuous routes, poorly designed shared pedestrian/cycle infrastructure, obstructions to footways and poor crossing provision.

Different zones within the city have been compared to see what other factors may impact on the extent to which safe mobility is facilitated. In the case of older pedestrians, there were some instances where mobility was compromised in order to promote safety. These were cases such as the A45 in the south zone, where use of the dedicated crossings required a significant retour and extensive guard rail prevented older pedestrians from crossing elsewhere. However, there were also instances where infrastructure was poor for both safety AND mobility. This was because in many cases the “safe” route for pedestrians was so poorly designed, located or signed that it was widely ignored. In the case of older drivers, the presence of large complex roundabouts may indicate some degree of trade-off between safety for the “average” driver, and safety for older drivers and pedestrians. This is because, as has been stated previously, roundabouts are known to be safer than other junction types for most drivers, but they present additional difficulties for older road users, whether they are drivers or pedestrians.

What the results from this chapter indicate are that a quantitative method of assessing safety and mobility for older drivers and older pedestrians would be useful in further exploring he trade-offs between the different user groups and the different policy objectives. Performance indicators which measure the extent to which safety and mobility for older drivers and older pedestrians have been provided for could help to identify policy priorities and quantify the benefits to different user groups of a different balance between these sometimes competing objectives. Chapter 8 presents the performance indicators calculated using the infrastructure audit data. The indicators are discussed in turn, with conclusions drawn about how the calculated indicators reflect the situation for older road users, how they should be interpreted and used, and what contribution they might make to policy design and monitoring.

CHAPTER 8: PERFORMANCE INDICATORS FOR SAFE MOBILITY FOR OLDER ROAD USERS IN URBAN AREAS

8.1 Introduction

This chapter expands on the data collected via the audit of infrastructure presented in Chapter 7, and the user data collected via the user groups described in Chapter 6 to derive a set of composite performance indicators for safe mobility for older road users in urban areas. The areas of the case study city which were assessed during the audit of infrastructure are rated according to the degree to which they facilitate safe mobility for older road users. The trade-offs that have been made between pedestrians and drivers and safety and mobility for different user groups are analysed through the calculation of a set of composite performance indicators for safe mobility for drivers and pedestrians in urban areas.

The indicators focus on those areas where the conflict between different user groups or different needs is most apparent, and aim to -

- Provide a means by which the conflict between the need to protect older road users whilst at the same time promoting their continued independent mobility can be explored;
- Provide a means by which to evaluate the validity of using performance indicators in this context;
- To re-evaluate past road safety initiatives, and identify any significant differences in the conclusions suggested by this approach, as opposed to those suggested by traditional approaches to road safety monitoring;
- To construct a framework within which Performance Indicators of this type could form part of the future monitoring of road safety policy ;

Previous chapters have outlined in detail the main safety and mobility issues which older road users face in urban areas. This chapter will look at how performance indicators can be used to describe the prevalence of those issues and provide an alternative way of assessing the success of measures to improve urban infrastructure.

8.2 Performance Indicators for Safe Mobility

A number of Performance Indicators are proposed. For both drivers and pedestrians there will be two sets of indicators; one set for safety, and one set for mobility. These measures will then be compared, in order to establish what trade-offs have been made between safety and mobility, and what trade-offs have been made between safety and mobility for different road user types, for example, between drivers and pedestrians, or between pedestrian safety and pedestrian mobility.

The Safety Performance Indicators will focus on those factors which have been shown by existing work to present a risk to older road users. In the case of drivers this includes, infrastructure which imposes a high workload. In the case of pedestrians, factors such as number of lanes to be crossed and the presence or otherwise of dedicated crossing provision are relevant factors.

The Mobility Performance Indicators will focus on factors which have been shown to present a challenge to the mobility of older road users. In the case of drivers this includes infrastructure where parking is problematic. In the case of pedestrians, factors such as time penalties (for example whilst waiting to cross traffic) and distance penalties (where the pedestrian desire-line deviates from the available pedestrian route) are the relevant factors.

Figures 7 to 22, presented in Chapter 4 set out in detail the rationale for the proposed indicators, establishing their links to existing studies which assess the role of infrastructure in promoting safety and mobility, and justifying the design adopted.

8.3 Composite Performance Indicators

The possibility of presenting indicators at several levels of detail is another useful feature of performance indicators. By manipulating the level of detail at which the indicator is presented, results can be geared to different users such as local government officials, practitioners and the scientific community. In the case of politicians, “headline” figures can be presented, which combine many layers of detail in order to provide a single over-arching measure. When data are combined in this way, the resulting measure is known as a “Composite Indicator”.

The results obtained in the study will be presented at three levels of detail. In the first section, the values obtained for the simple indicators are presented and analysed. In the second section, composite indicators for each of the four domains (driver safety, pedestrian safety, driver mobility, pedestrian mobility) are presented and analysed. In the final section, the trade-offs between safety and mobility and between drivers and pedestrians are explored, with conclusions drawn about the policy implications of this conflict.

Presenting the performance indicators at these different levels of detail facilitates an understanding of which specific issues contribute to the overall scores and thus helps to identify the key issues that must be addressed in order to improve performance.

8.4 Results – Safety Performance Indicators for drivers

8.4.1 Introduction

As was explained in Chapter 4, there are 3 safety performance indicators for drivers. These are Mental Workload, Junction Workload and Physical Workload.

In most cases, the calculated performance indicator scores are represented by spider graphs. The normalisation process described in the methodology chapter ensures that all indicators regardless of the units of measurement of the component variables or degree of composition have a value between 1 and 10. This makes spider graphs a useful way of presenting the results: Scores for each of the component measures appear on each of the arms of the graph, with poor performance represented by lines close to the origin, and good performance by lines away from the origin. For example, in the case of the indicator for mental workload (drivers), the four dimensions are decision speed, decision complexity, decision frequency and traffic complexity. These measures appear on each of 4 axis, and the relative performance of each zone on each measure can then be seen at a glance

In all cases, graphs show only *relative* performance: The zone furthest from the origin is the best performing of the three zones, and the one closest to the origin is the poorest performing *of these three zones.* As has been explained, performance indicator values are useful for comparing relative performance, but their absolute values are less meaningful. The addition of other comparison areas could potentially change the picture presented.

Where a performance indicator measure captures fewer than three dimensions (for example, mobility performance indicator (drivers) which has only time penalty and utility penalty as inputs), results are presented as bar graphs, with smaller bars representing poorer performance.

8.4.2 Mental Workload

The Mental Workload measure is a subjective measure of workload, as discussed in chapter 2 and advocated by Fuller (2005). Under this methodology, rather than being assessed using a physiological measure such as performance on a secondary task, workload is assessed using engineering measures such as number of traffic signs, number of junctions or traffic complexity.

The mental workload measure has four components; decision frequency, which assesses the number of interactions with the infrastructure (following signage or signals) that must be made and in what time period; decision complexity, which assesses the numbers of items of information that must be processed and number of choices made for each interaction; decision speed, which assesses the time available; traffic complexity, which looks at the number of factors disturbing flow.

Figure 126, below, shows the results of the safety performance indicator calculation for each of the component parts of the mental workload measure. As can be seen, the south zone performs best overall, with the east zone the poorest performing zone.

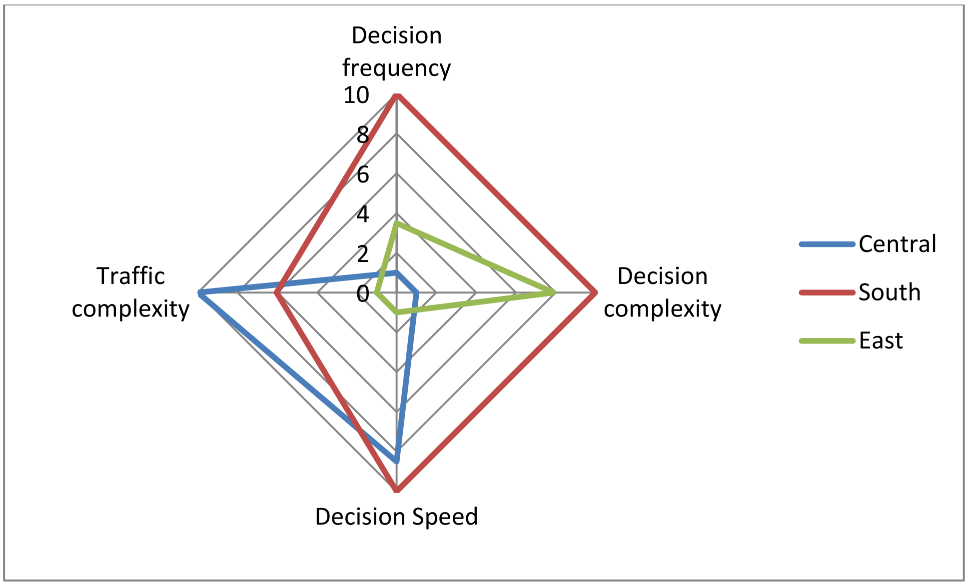

Figure 126; Results of safety performance indicator calculation for mental workload.

The factors which contribute to this outcome are;

- In the central zone, travel time between junctions is short and complex decision-making is required. This is shown in the top left hand portion of the diagram where the line depicting the performance of the south zone is close to the origin. However, lack of complicating factors such as pedestrians and cyclists mean traffic complexity is low (as shown on the left hand side by the line distant from the origin). Perception/reaction times are very short for drivers using the Ring Road. However, this is balanced by longer perception/reaction times in the rest of the central zone, an effect which can only be appreciated when looking at the raw data. When looking at the overall picture, as shown by the spider diagram, performance in the central zone overall is better than in the east zone.
- The south zone is the best performing overall on this measure. Travel time between junctions is highest of all the zones and decision-making is relatively straight forward. This is shown by the position of the line representing the performance of the south zone, which is furthest from the origin on most measures. However, traffic is more complex in the south zone than the east.
- The east zone is the most poorly performing. This can be explained by the need for rapid decision-making, and by the complex traffic environments of the Walsgrave and Binley Roads. These are probably the locations where the competing needs of road users with very different characteristics are most evident, with both roads serving as important arterial routes whilst also accommodating popular shopping areas. Traffic flow is complicated by a high number of factors including buses, parked cars, pedestrian crossings and emergency vehicles.

8.4.3 Junction workload

Junction workload assesses the complexity of the junctions, in order to identify what proportion of the junctions within a zone impose a high workload on the driver. The contributing factors are the number of elements of information the driver must attend to, the time available in which to do so, and any complicating factors such as poor quality signage and traffic signals.

Figure 127, below, shows the results of the safety performance indicator calculation for each of the component parts of the junction workload measure.

As can be seen, the central zone is the most poorly performing overall, with the south zone performing marginally better than the east.

The factors contributing to this outcome are;

- The exceptionally complex junctions found in the ring road; junction speed limits are high, signage is frequent and complicated, most junctions have several lane choices, and there are obstructed and degraded signs at or approaching many junctions. In addition, few junctions are signalised, meaning drivers must make complex judgements about the speed and distance of other traffic.
- The south zone has the highest proportion of 40mph junctions. However, unlike the central zone (where many junctions require drivers to merge in moving traffic) a relatively high proportion of junctions is signalised, meaning complex judgements about speed and distance are less frequently required.
- The east zone performs most poorly for the amount of information drivers must process but performs well in the other domains.

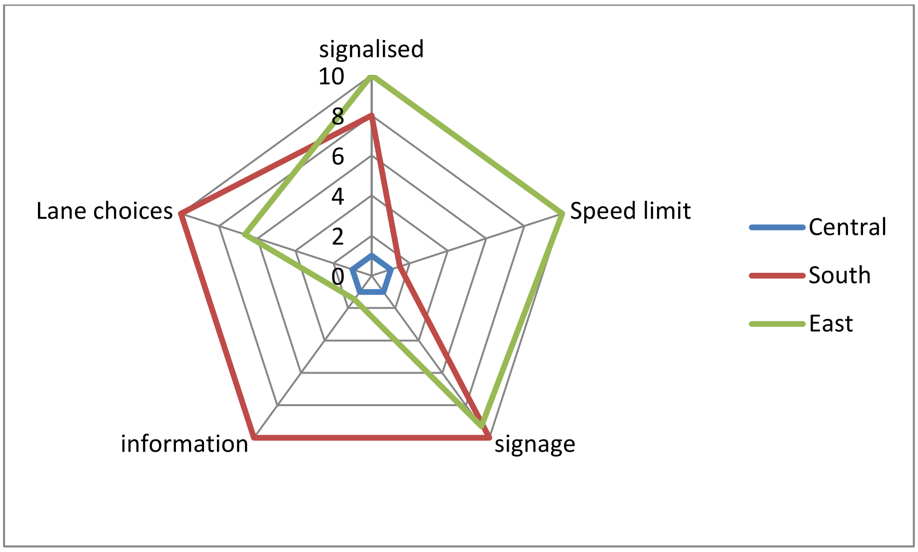

Figure 127; Results of safety performance indicator calculation for junction workload

8.4.4 Physical workload

Physical workload describes the degree to which the assessed infrastructure fails to take account of the physical limitations faced by older drivers, such as restricted head and neck movements. The physical workload indicator has three components: the proportion of junctions at which a movement from stop is normally required; the number of junctions at which drivers are required to simultaneously judge traffic from more than one direction; the degree to which drivers must yield to traffic which is approaching from a direction other than straight ahead or 90 degrees left or right. Included in this, for example, would be the majority of junctions on the ring road, where drivers must merge between vehicles approaching from almost directly behind.

Figure 128, below, shows the results of the safety performance indicator calculation for each of the component parts of the physical workload measure. As can be seen, the central zone performs best overall, with the south zone the poorest performing zone. The factors which contribute to this outcome are;

- The fact that in the central zone, negotiating the junctions usually means observing only traffic on the right (when joining the ring road) or left (when travelling along it or leaving). This is in contrast to some of the more complex junctions elsewhere in the city, where drivers must observe traffic (including pedestrians) from several directions.
- The central zone is, however, the most poorly performing on the Angle of Intersection measure. As has been stated, the majority of the ring road junctions require drivers to make observations through 180 degrees as they merge between traffic both in front of and behind them. As discussed in chapter 2, this is extremely problematic for older drivers, due to deteriorations in muscle condition and a reduction of peripheral vision.
- The east and south zones are more similar in terms of the profile of the infrastructure. The south zone is the most poorly performing. However it is possible that were user-derived weightings applied to the indicators (as described in Chapter 3) the angle of intersection would be weighted more highly than the other components of this measure. Tight angle of intersection was an issue highlighted by the feasibility study described in Chapter 5, and in the focus groups, discussed in Chapter 6.

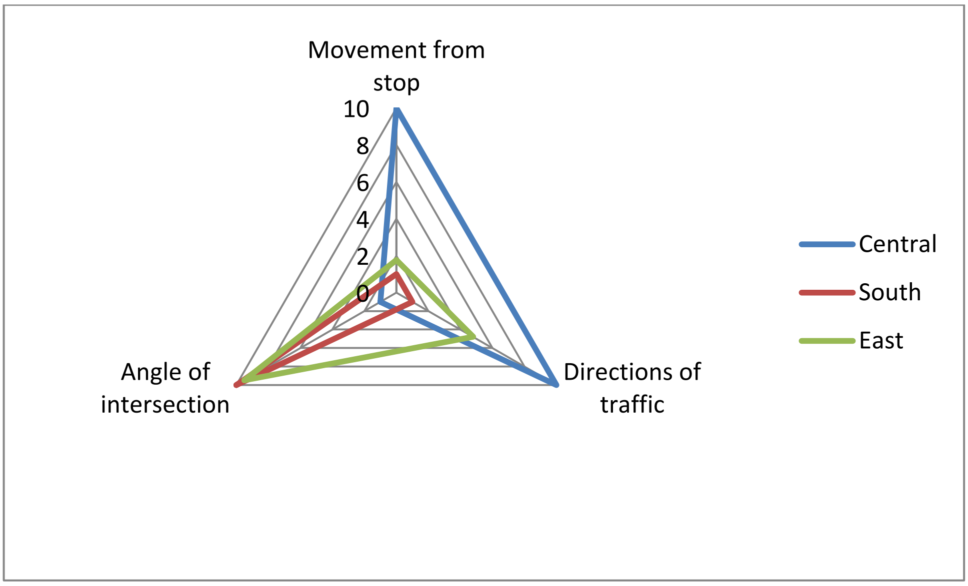

Figure 128; Results of safety performance indicator calculation for physical workload

8.4.5 Zone performance – driver safety

Figure 129, below shows the areas that should be a priority for policy-makers wishing to improve the degree to which infrastructure in the case study area protects older drivers from risk.

The key points to note are;

- The central zone is the most poorly performing on the junction workload measure, due to the complex nature of the decision-making required to navigate the junctions, the high speed limit across the junctions, and the need to merge. This imposes a high workload on older drivers, but also makes it harder for them to adopt coping strategies such as lowering speed or increasing gap acceptance.

- The south zone performs most poorly on the physical workload measure. On average, traffic is approaching from several directions and a movement from stop is more normally required.
- The east zone performs most poorly on the mental workload measure. Traffic flow is complicated by many factors such as traffic with very different characteristics sharing road space and the need for rapid, complex decision-making.

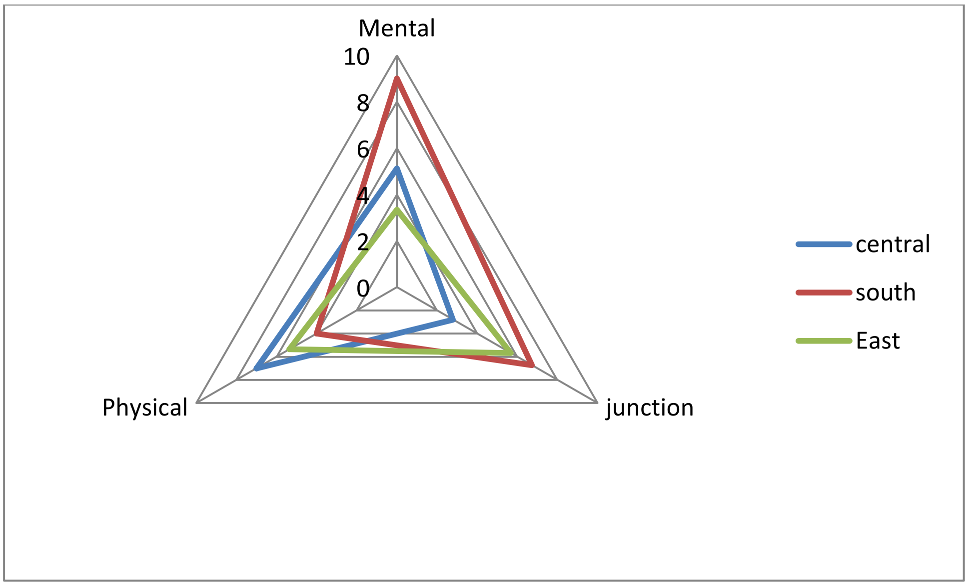

Figure 129; Results of safety performance indicator calculation for drivers

Table 26 below, summarises the key findings of the Safety performance Indicator for Drivers, and the main priority areas for action.

Table 26; Safety Performance Indicator (drivers) summary

Zone	Performance Indicator	Key conclusion	Explanation	Implications for Design	Feasibility
Central	Mental workload	Mental workload moderately high.	Ring road requires complex decision-making. Travel time between junctions is short. Lack of complicating factors such as pedestrians, cyclists and traffic signals helps to compensate. Ring road has the shortest perception /reaction scores, but this is balanced by long P/R in rest of zone.	**Lower speed limit** on ring road would reduce mental workload by lengthening travel time between junctions and increasing P/R times. **Grade separation** helps to limit workload by ensuring traffic with different characteristics doesn't share infrastructure.	Low – current limit poorly observed and not enforced High where infrastructure exists. Less practicable as retro-fit solution
	Junction Workload	**Junction workload High**	Junction speed limits are high. Signage is frequent with many items of information. Much of the ring road has several lane choices. Some signs are obstructed or degraded.	**Lower speed limits** at ring road junctions, or **Better enforcement** of current limit. **Simplification and upgrading of signage** and lane markings	Low – current limit poorly observed. Moderate – there is space for cameras. High – relatively cheap, uncontroversial measure
	Physical Workload	Physical workload Low	Workload is low due to limited directions of on-coming traffic. Angle of intersection problematic on ring road	None **Lower speeds** to increase available time	Poor, as previously noted.

Zone	Performance Indicator	Key conclusion	Explanation	Implications for Design	Feasibility
South	Mental workload	Mental workload low	• Decision-making relatively straight forward. • Travel time between junctions is highest of the zones • South zone best performing zone on this measure.	None	N/A
	Junction Workload	Junction workload low	• Zone has relatively high proportion of 40mph limits, in part due to Kenpas Highway and Kenilworth Rds • Proportion of signalised junctions is also relatively high, possibly as a reflection of lesser importance of maximising traffic flow compared to the other zones	None	N/A
	Physical Workload	**Physical workload high**	• Physical workload high due to need to simultaneously observe traffic from several directions.	Introduction of pedestrian-only phases at lights. Separate lights phase for turning traffic	High – would also help pedestrian safety

Zone	Performance Indicator	Key conclusion	Explanation	Implications for Design	Feasibility
East	Mental workload	**Mental workload highest**	• East Zone scores poorest on decision speed and traffic complexity. • The complex traffic environments of Walsgrave Rd and Binley Rd are problematic. • Traffic flow is complicated by a high number of factors including buses, parked cars, pedestrian crossings and emergency vehicles.	**Lower speed limit** to increase decision speed. **Reduce traffic complexity** – the "Primelines" initiative (see 6.7.2) has already attempted this	Low – Due to congestion and emergency vehicles. Low - "Primelines" initiative (see 6.7.2) has already attempted this
	Junction Workload	**Junction workload high**	• Highest proportion of signalised junctions • Poorest score for amount of information • Lowest percentage of 40mph limit.	**Simplification and upgrading of signage** and lane markings	High – relatively inexpensive and un - controversial
	Physical Workload	Workload Moderate		None	N/A

8.5 Results – Safety Performance indicators for pedestrians

8.5.1 Introduction

As was explained in Chapter 2, the main safety risk to pedestrians comes from crossing the road, hence the indicators for pedestrian safety are related to different aspects of road crossing. There are two indicators; crossing difficulty, and crossing risk. As is the case with all calculated indicators, a low score represents poorer performance, with a position closer to the origin on the presented graphs being poorer performance, and positions further from the origin being better performance.

8.5.2 Crossing difficulty

The safety performance indicator measures the incidence of factors which increase the difficulty for pedestrians who need to cross the road. The relevant factors, as determined by the literature review in conjunction with the user data are the presence or otherwise of grade separation of pedestrians and motorised traffic, the facilities available to help pedestrians (for example, dedicated crossings, median strips) and the number of traffic lanes to be crossed.

Figure 130, below shows the results of the performance indicator calculation for each of the component parts of the crossing difficulty measure.

As can be seen, the central zone is the best performing overall, with the east zone performing the least well on every aspect of the indicator.

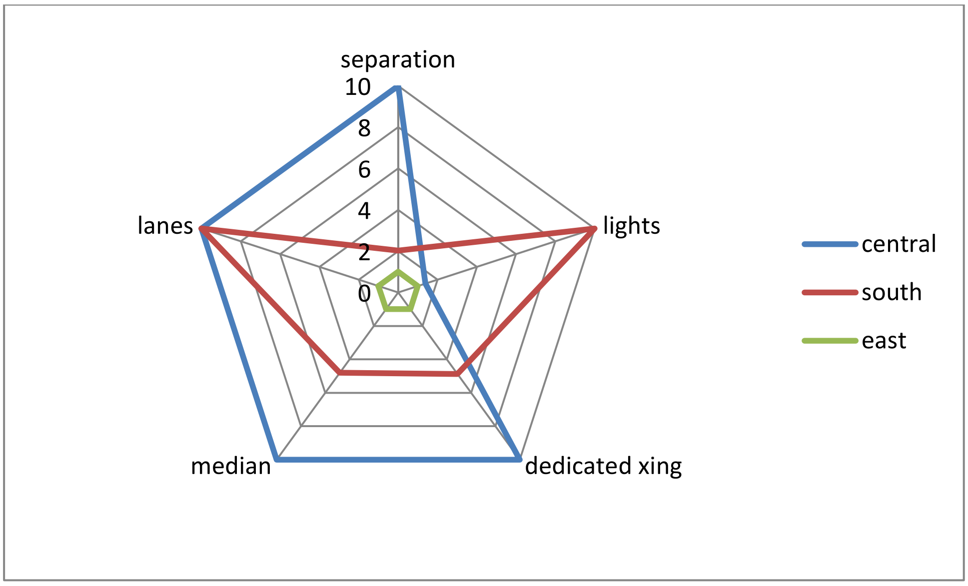

Figure 130; Results of safety performance indicator calculation for crossing difficulty

The factors contributing to this outcome are;

- The extensive separation of infrastructure in the central zone, meaning that in large parts of this zone, pedestrians can cross easily. However, where there are at-grade crossings, many do not have a dedicated pedestrian phase, which increases difficulty for older pedestrians, who find it more difficult to judge the speed and distance of on-coming traffic.
- The south zone has little separation of infrastructure, despite the fact that the junction workload indicator results suggest that this zone has the highest number of junctions with a 40mph limit. This could be very problematic for older pedestrians, who have been shown by existing literature to have greater

difficulty judging speed and distance, but who are also likely to have a slower walk-pace, meaning they will take longer to cross and hence need a larger gap between vehicles in order to cross safely. The south zone also has only a moderate number of crossing places with a median strip.

- The east zone is the most poorly performing. Not only did it perform most poorly overall, but it also scored the most poorly on each individual component measure. There were no grade-separated crossings within the study area, fewer examples of dedicated crossings than in other zones, a lower incidence of median strips, higher average numbers of traffic lanes and fewer junctions with a pedestrian-only phase.

8.5.3 Crossing Risk

The safety performance indicator for crossing risk focuses on factors which increase the risk for pedestrians of suffering injury or death. They are based on results from the literature analysis, as well as from the user data. The key factors are traffic speed, the degree to which on-street parking is permitted (as parked vehicles have been shown to offer some protection to older pedestrians) and the presence in the traffic flow of large or fast-moving vehicles such as goods vehicles, buses or emergency vehicles.

Figure 131, below, shows the results of the safety performance indicator calculation for each of the component parts of the crossing risk measure.

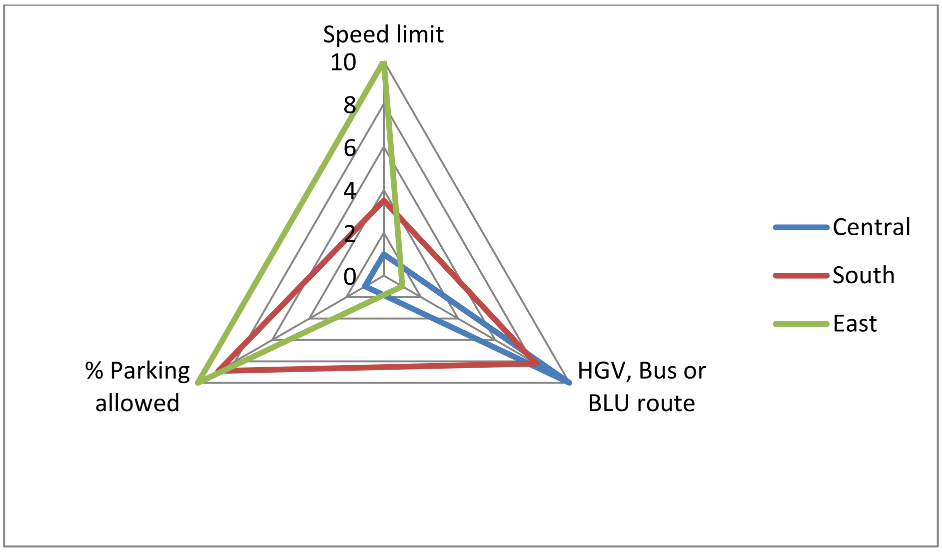

Figure 131; Results of safety performance indicator calculation for crossing risk

As can be seen, the Central zone is the most poorly performing overall, with the east zone performing marginally better than the south. The key reasons for this are as follows;

- In the central zone, speed limits are high and there is little on-street parking. At those junctions where at-grade crossing is required, this is riskier for pedestrians. Where the central zone scores well is in the homogeneity of traffic, meaning that there is less risk from large or fast-moving vehicles.
- The south zone has a lower incidence of 40mph limits than the central zone, but higher than the east. Considered separately, the shopping area around Kenpas Highway (which has a 40mph limit, limited on-street parking and a high proportion of goods vehicles, buses and emergency vehicles) would score very poorly. The shopping areas of Earlsdon and Quinton Parade

would score well, both having a 30mph limit, on-street parking and little through traffic.

- As can be seen, the east zone performs best on this measure, with the shopping areas around Ball Hill (on the Walsgrave Rd) and Empress Buildings (on the Binley Rd) both having 30mph limits and on-street parking. The proximity of the east zone infrastructure to the City's main hospital does mean that both locations are heavily used by buses and emergency vehicles.

8.5.4 Zone performance – Pedestrian safety

Figure 132, below shows the areas that should be a priority for policy-makers wishing to improve the degree to which infrastructure in the case study area protects older pedestrians from harm.

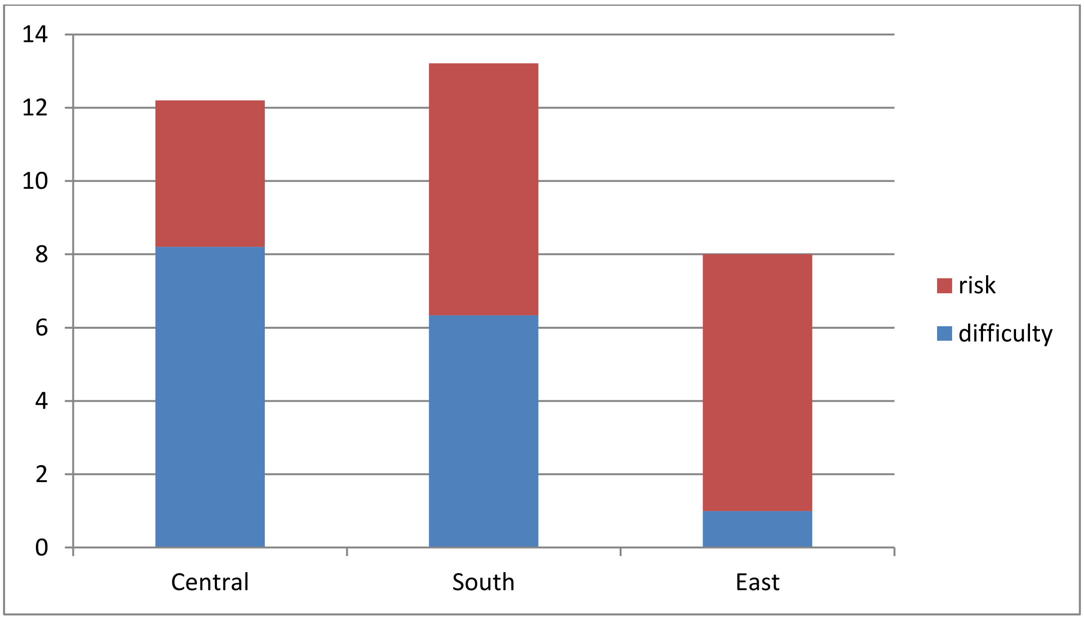

Figure 132; Results of safety performance indicator calculation for pedestrians

As can be seen, performance is worst in the east zone, with crossing difficulty the priority area for action. For those locations in the central zone which do not have grade separation, crossing risk is the priority area for action.

Table 27, below summarise the results of the performance indicators calculation for pedestrian safety.

Table 27; Safety Performance Indicator (pedestrians) summary

Zone	Performance Indicator	Key conclusion	Explanation	Implications for Design	Feasibility
Central	Crossing difficulty	Crossing Difficulty Low	• Extensive grade separation. However, where at-grade crossings exist they could be improved.	Inclusion of pedestrian-only phase in at-grade crossings	High, though not a priority.
	Crossing Risk	**Crossing risk high where at-grade**	• Junction speed • Lack of on-street parking	Lower speed limit for at-grade crossings. Relaxation of parking regulations	High. Low – relaxation of parking would have consequence for other user groups.

Zone	Performance Indicator	Key conclusion	Explanation	Implications for Design	Feasibility
South	Crossing difficulty	Moderate	• Poorest performance relates to degree of grade separation, lack of dedicated crossing phase and lack of median strip	Inclusion of pedestrian-only lights phase and increased use of median strip.	High, cost permitting.
	Crossing risk	Moderate (though high around Kenpas Highway)	• Poorest performance relates to high proportion of 40mph junctions.	Reduction in speed limit, especially important at Kenpas Highway, where shops, bus stops and other facilitates generate demand	Current limit not enforced or well-observed.

Zone	Performance Indicator	Key conclusion	Explanation	Implications for Design	Feasibility
East	Crossing Difficulty	**Crossing Difficulty High**	• Lack of grade-separated crossings • High number of traffic lanes • Few dedicated crossings or median strips • Few pedestrian-only lights phases	Increase in grade-separated crossings Implementation of medians; also reduces number of lanes to be crossed. Increase in dedicated crossings Increase in pedestrian-only lights phases	Low - has implications for mobility High Low High
	Crossing risk	Crossing Risk Low	• Lower speed limits • On-street parking	None.	

8.6 Results - Mobility Performance Indicators for drivers

8.6.2 Introduction

As was stated in Chapter 2, the issues affecting the mobility of older drivers are poorly researched and currently not well-understood. In the past this has been due to research into mobility being focussed on groups without access to a car, as they were seen as being one of the key mobility-limited groups. However, the question of mobility for older drivers is likely to become increasingly important, with future generations of older road user more likely to own a car and wanting to use it (Brace et al, 2006, King, 2000). Lack of existing literature complicates the issue of determining the key variables affecting older driver mobility. As a consequence, the mobility performance indicators are acknowledged to be highly experimental. However, on the basis of participant comments resulting from the focus groups, time penalty (evidence that motorised traffic is slowed to facilitate pedestrian movement) and utility penalty (evidence that movement of motorised traffic is restricted to accommodate other road users) were selected as indicators. As with all of the presented indicators, values were normalised using the formula set out in Chapter 4.

As previously, a low score represents poorer performance, with a position closer to the origin on the presented graphs being poorer performance, and positions further from the origin being better performance.

8.6.3 Time penalty

The time penalty measure provides an indication of the degree to which car journeys in the urban area are slowed down in order to facilitate pedestrian movement or pedestrian safety. Three variables are used: The speed limit, the percentage of dedicated pedestrian crossings within the study zone, and any instances of features designed to slow traffic, such as chicanes, cushions, or camera enforcement of the speed limit.

Figure 133, below shows the results of the performance indicator calculation for each of the component parts of the time penalty measure.

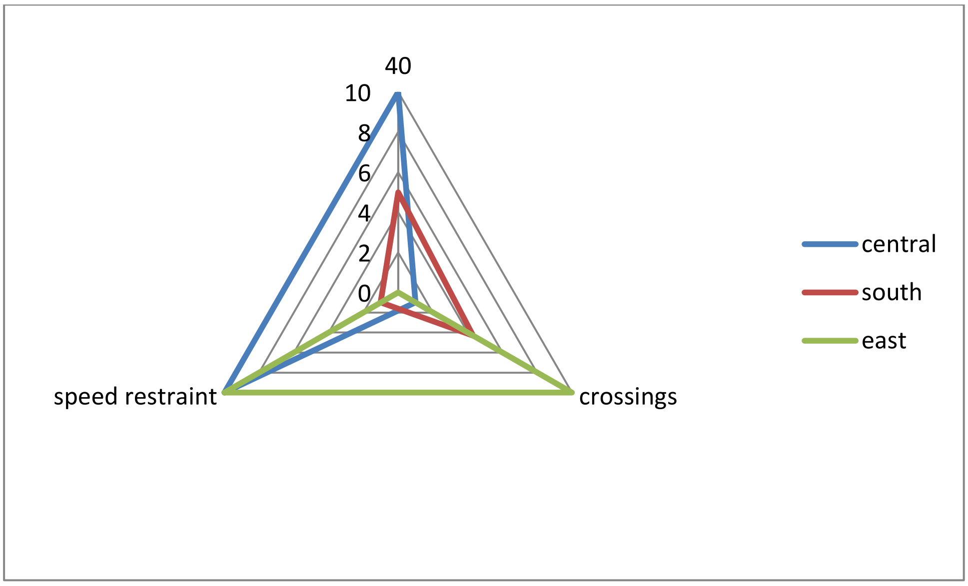

Figure 133; Results of mobility performance indicator calculation for time penalty

As can be seen, the south zone performs least well on this measure, with the central and east zones performing comparably well overall. The main driver mobility issues are;

- There are very few examples in the case study locations of physical speed restraint measures being used. Only the south zone had any at all (one speed camera) on the A45/Kenpas Highway.
- A relatively high number of junctions (even in the more poorly performing locations) have 40mph speed limits. Given that all of the case study locations were chosen because they have important services and facilities for both car drivers *and* pedestrians, it is perhaps surprising that there are not lower limits and higher levels of enforcement.

8.6.4 Utility penalty

The utility penalty describes the degree to which movement of motorised traffic is facilitated in the urban area. Features such as pedestrian-only infrastructure, banned turns and parking restrictions are recorded, in order to identify instances where vehicle movement is not facilitated.

Figure 134, below shows the results of the performance indicator calculation for each of the component parts of the utility penalty measure.

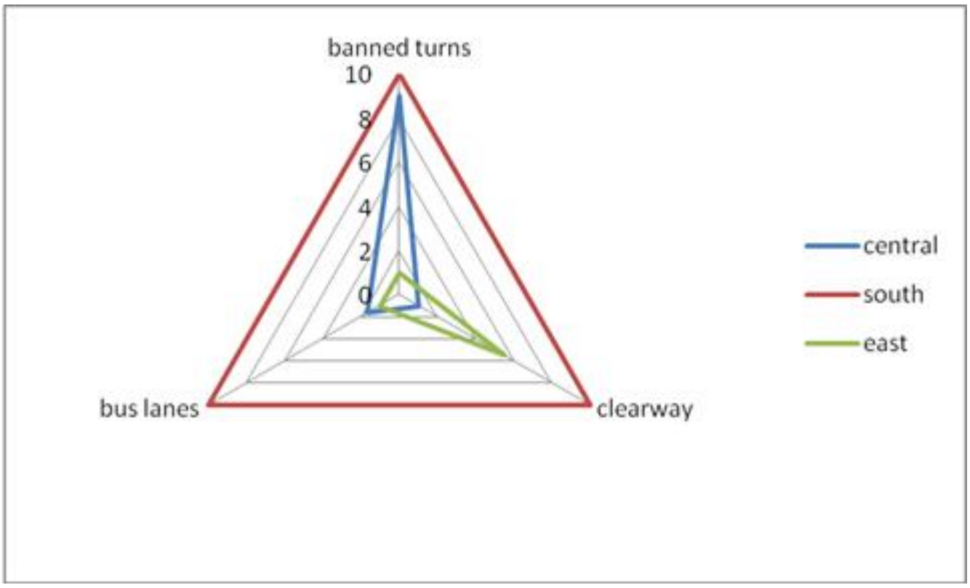

Figure 134; Results of mobility performance indicator calculation for utility penalty

As can be seen, the south zone performs best on all of the component parts of the measure, suggesting that driver mobility is catered for better in this zone than in either of the others. The key factors which contribute to this outcome are;

- Extensive provision in the east zone of dedicated bus infrastructure. This is likely to be related to the use of Walsgrave Rd as the key bus route to the City's main hospital.
- The implementation on Walsgrave Rd of a "Red Route" as part of an air quality improvement initiative. This has reduced parking provision and also involved the implementation of banned turns at key junctions in order to improve traffic flow.

- The only domain in which the east zone was not the most poorly-performing is the incidence of urban clearways. Almost the entire central location infrastructure is a designated clearway.
- The central zone also performs relatively poorly on the bus-only infrastructure measure. This is linked to the separation of pedestrian and motorised traffic in the ring road location: One difficulty of grade separation is how to then provide easy access to bus services for pedestrians. In this case it is done through the provision of bus-only routes which skirt closer to the pedestrianized zones than other motorised traffic is able to get. This is a curb on older driver mobility.

8.6.5 Zone performance – driver mobility

Figure 135, below shows the areas that should be a priority for policy-makers wishing to improve the degree to which infrastructure in the case study area facilitates mobility for older drivers.

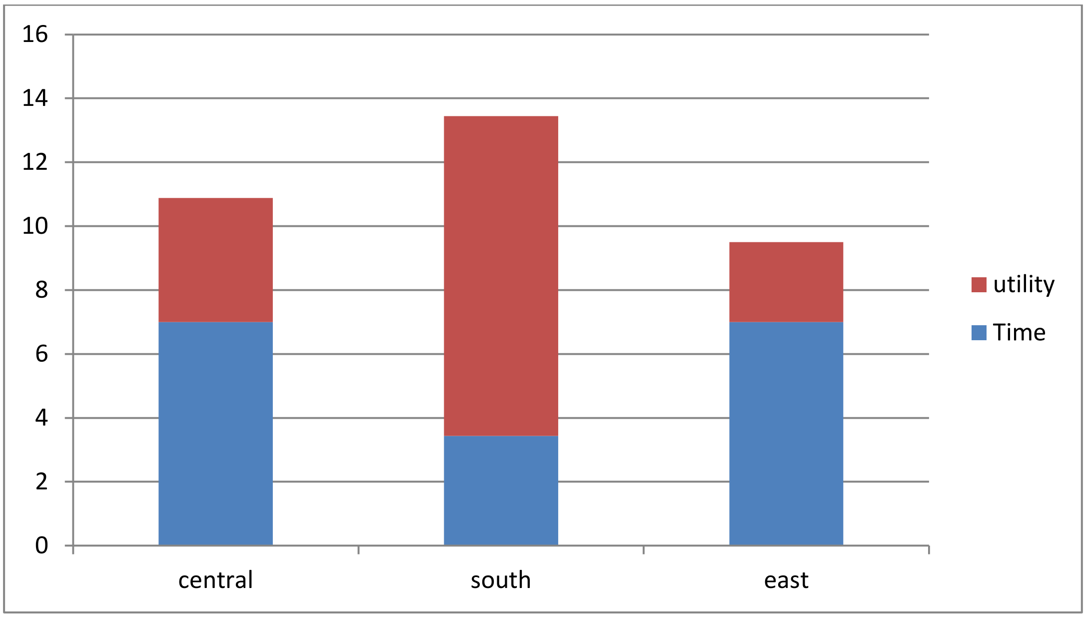

Figure 135; Results of mobility performance indicator calculation for drivers

As can be seen, the south zone performs best overall, though it performs less well on the time penalty measure than the other zones. The East zone is the most poorly performing overall, and performs particularly poorly on the utility measure, largely as a result of the "Red route" infrastructure on the Walsgrave Rd.

Table 28, below summarise the key results from the mobility performance indicator (drivers) calculations.

Table 28; Mobility Performance Indicator (drivers) summary

Zone	Performance Indicator	Key conclusion	Explanation	Implications for Design	Feasibility
Central	Time penalty	Time penalty performance good.	• Majority of junctions have 40mph limit • No physical speed restraint • Most junctions are grade-separated, meaning where at-grade crossings exist they are often signalised.	None	N/A
	Utility penalty	**Utility performance poor**	• High percentage of urban clearways • High proportion of bus-only infrastructure	Relax parking restrictions Relax vehicle movement restrictions	Low – restricted car mobility in central zone may be important for pedestrians and to promote public transport.

Zone	Performance Indicator	Key conclusion	Explanation	Implications for Design	Feasibility
South	Time penalty	**Time performance poor**	• Only zone with any physical speed restraint measures		
	Utility penalty	Utility performance good	• Little bus-only infrastructure	None	N/A

Zone	Performance Indicator	Key conclusion	Explanation	Implications for Design	Feasibility
East	Time penalty	Good	• Few signalised crossings • Few pedestrian-only lights phases	None	N/A
	Utility penalty	**Poor**	• High proportion of banned turns • Bus-only infrastructure		Possibility of changes low – infrastructure design results from air quality and "Primelines" initiative.

8.7 Results - Mobility Performance Indicators for pedestrians

8.7.2 Introduction

The issues which affect pedestrian mobility are better documented than those affecting driver mobility. As was explained in Chapter 3, there are 5 indicators for pedestrian mobility, all selected on the basis of the existing literature and the results of the focus group activity. There are distance penalty, time penalty, effort penalty, utility penalty and public transport access. As previously, a low score represents poorer performance, with a position closer to the origin on the presented graphs being poorer performance, and positions further from the origin being better performance.

8.7.3 Distance Penalty

The Distance Penalty reflects the increased walk necessitated by poorly located crossings, clear divergence between the safe pedestrian route and the pedestrian desire-line (for example, as evidenced by patchy grass or other damage to landscaping), and poorly signed pedestrian facilities or discontinuous walkways. A distance penalty has been calculated for all infrastructure with dedicated crossing provision, as it has been assumed that where this exists it has been deemed risky for pedestrians to cross elsewhere.

In all cases, distance penalties have been calculated by reference to the facilities and services which exist at a location. For example, where a bus stop is located on one side of the road and shops or other services are located on the other, the distance penalty is measured from the bus stop to the shops. Where many potential distance penalties exist at one location (for example, at the ring road, where several different activities and services could be accessed using many different walking routes) several measures are taken and average penalties are used.

Figure 136, below, shows the results of the mobility performance indicator calculation for each of the component parts of the distance penalty measure.

As can be seen, the central zone is the most poorly performing overall, with the east zone performing marginally better than the south. Given that the central zone is arguably the one where pedestrian traffic could be expected to be highest, and considering the domination of that zone by purpose-built dedicated pedestrian infrastructure, it is disappointing that this zone does not cater better for pedestrian mobility.

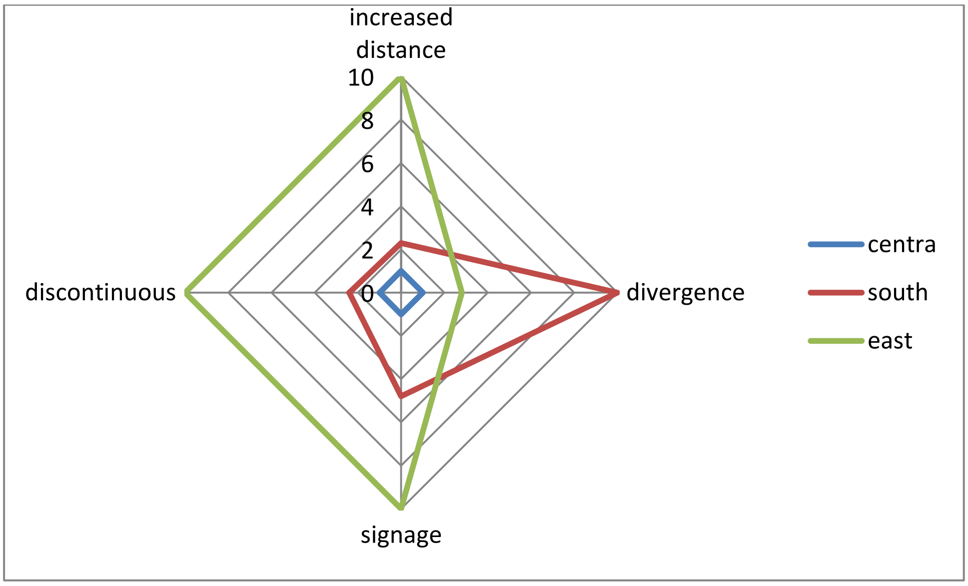

Figure 136; Results of mobility performance indicator calculation for distance penalty

The factors contributing to this outcome are;

- Frequent, lengthy divergence in the central zone between the pedestrian desire-line and the safe pedestrian route.

- Poor signage of the pedestrian route in the central zone, despite the fact that the pedestrian route is often not immediately obvious, due to it being separate from the (often better signed) route for motorised traffic.
- Infrastructure in the south zone – and in particular the Kenpas Highway location – is designed in such a way as to necessitate lengthy detours in order for pedestrians to cross the road. In some cases, accessing the dedicated pedestrian crossings in this zone meant crossing additional side roads without dedicated provision, thus increasing exposure of older pedestrians to risk at these locations and reducing both safety and mobility.
- Overall the east zone performs best on this measure, performing best on three of the four measures, but less well on the divergence of the safe pedestrian route from the desire-line.

8.7.4 Time Penalty

The Time Penalty is calculated by timing the wait to cross the road, from placing the call (at signalised crossings) to the traffic stopping. For comparison, at locations with no dedicated provision, an average wait time for a suitable gap in the traffic is also calculated. This will be useful in assessing the trade-offs between driver mobility and pedestrian mobility. As before, in locations with several signalised crossings and several potential pedestrian routes, an average measure is taken.

Figure 137, below, shows the results of the mobility performance indicator calculation for the Time Penalty measure.

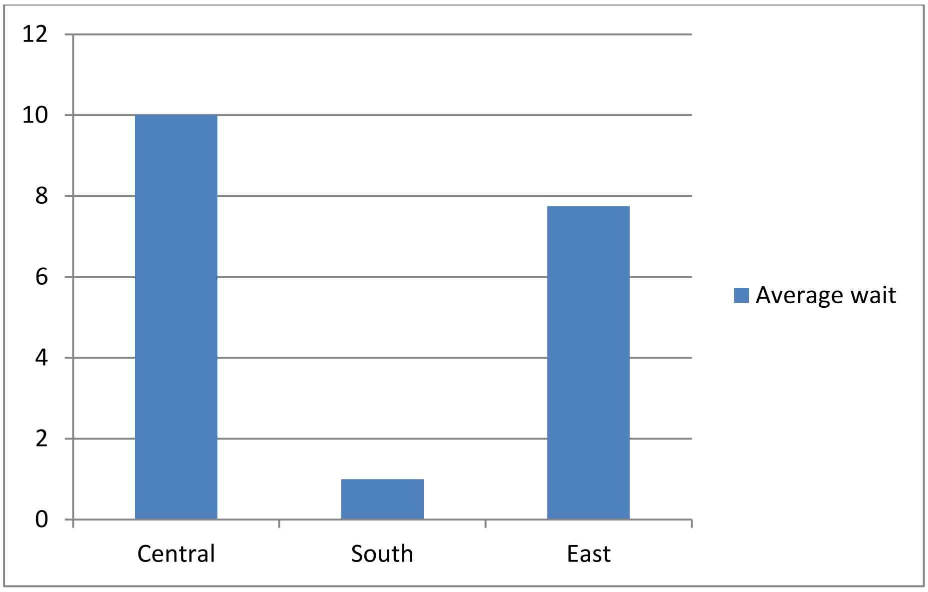

Figure 137; Results of mobility performance indicator calculation for time penalty

As can be seen, the south zone is by far the most poorly performing, with the central the best performing zone. The factors behind this include;

- Lack of a dedicated pedestrian crossing phase at many junctions in the south zone, meaning that pedestrians frequently have to cross junction arms in two phases.
- Extensive separation of infrastructure in the central zone, meaning that the busiest road sections are not crossed at grade. This allows for higher pedestrian priority at crossings, as the busier routes do not have the same pressure to compromise between the needs of pedestrians and the needs of motorised traffic.

8.7.5 Effort Penalty

The Effort Penalty is calculated for locations where there is grade separation of pedestrians and motorised traffic which means that the safe pedestrian route involves a significant change of level such as bridge or ramp. It comprises the average number of steps (where steps are provided) or the average ramp length (where only a ramp exists).

Figure 138, below, shows the results of the mobility performance indicator calculation for the effort penalty measure.

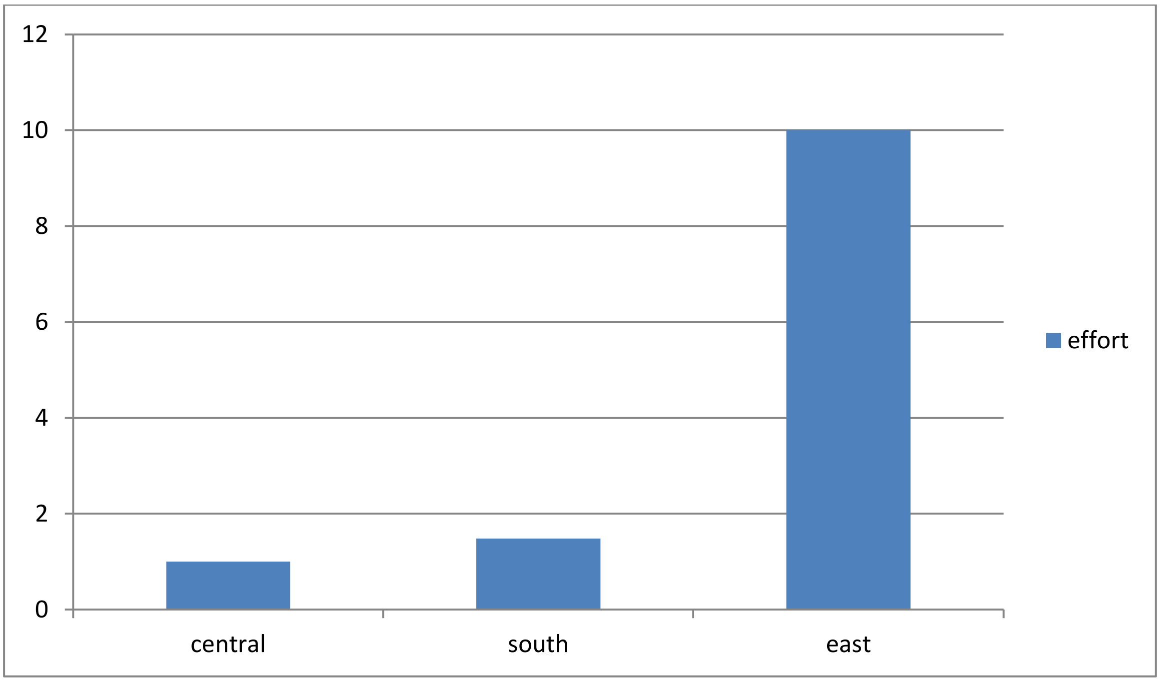

Figure 138; Results of mobility performance indicator calculation for effort penalty

As can be seen, the central zone is the worst performing, with the east zone the best. This can be explained by the extensive separation of motorised and pedestrian traffic in the central zone, and the fact that there are no grade separated crossings in the east zone.

8.7.6 Utility Penalty

The utility penalty is a subjective measure which records the presence of factors which the literature review and focus groups highlighted as having a negative impact on older users' perceptions of an area, and thus their willingness to undertake pedestrian journeys in those areas. The utility penalty is calculated by scoring each incidence of the following negative factors: Road noise; poor lighting; unattractive infrastructure (for example, intrusive signage, high guard rails); uneven pavements; presence of shared cycle and pedestrian facilities; incidence of pavement obstructions such as signage, parked vehicles, shop displays and bollards.

Figure 139, below, shows the results of the mobility performance indicator calculation for each of the component parts of the Utility Penalty measure.

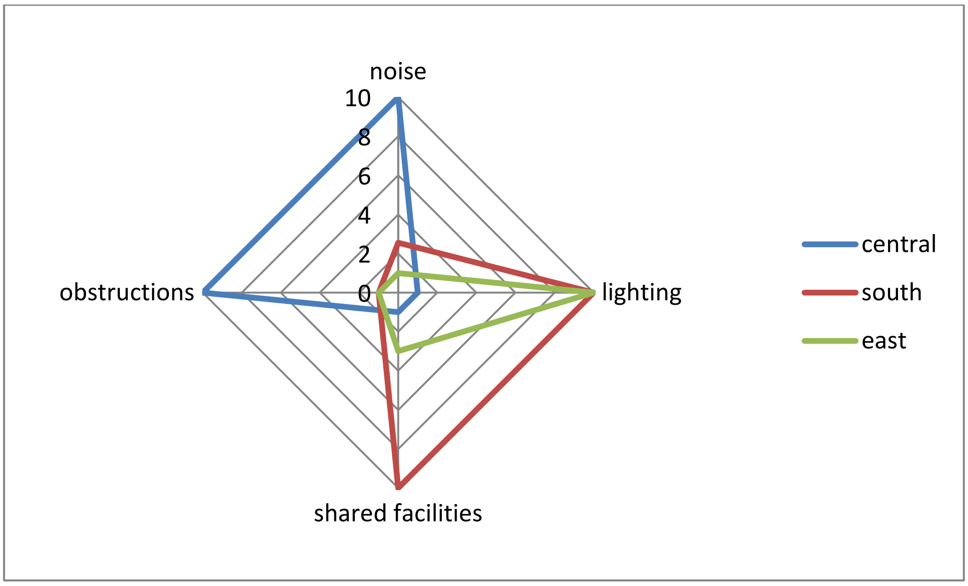

Figure 139; Results of mobility performance indicator calculation for utility penalty

As can be seen, the east zone is the worst performing zone for utility. The factors which explain this include;

- Separation of motorised and non-motorised traffic in the central zone, which means pavement obstructions and intrusion from traffic are less prevalent. However, lighting issues are much more common in the central zone as a consequence of the widespread use of poorly-lit subways and underpasses.
- There is a low incidence of shared facilities and poor lighting in the south zone, though in many cases this reflects a lack of cycle infrastructure, rather than the presence of dedicated, separate cycle infrastructure.
- The east zone does not have a high incidence of locations with poor lighting, though again this reflects the lack of grade-separated pedestrian provision in the east zone. The east zone performs poorly on noise and pavement

obstructions, again reflecting the conflict between the Binley and Walsgrave Roads' functions as arterial routes for traffic and popular shopping areas.

8.7.7 Public transport penalty

The Public Transport penalty is a measure of how easily pedestrians can access the public transport services in a location. As has been stated, many of the issues older people face in using public transport relate to their journey to/from the bus stop. This measure aims to capture the extent to which the limitations of older users have been taken into consideration in the location and design of public transport services, and the degree to which their needs *as pedestrians* walking to and from bus stops and train stations are met. The measure has two components: The first measures the incidence of locations where access to public transport is not on one level (for example because of high kerbs or steps). The second measures the incidence of locations where return journeys cannot be made with equal ease (for example, because the "to town" and "from town" stops are on opposite sides of major road junctions).

Figure 140, below, shows the results of the mobility performance indicator calculation for each of the component parts of the public transport penalty measure.

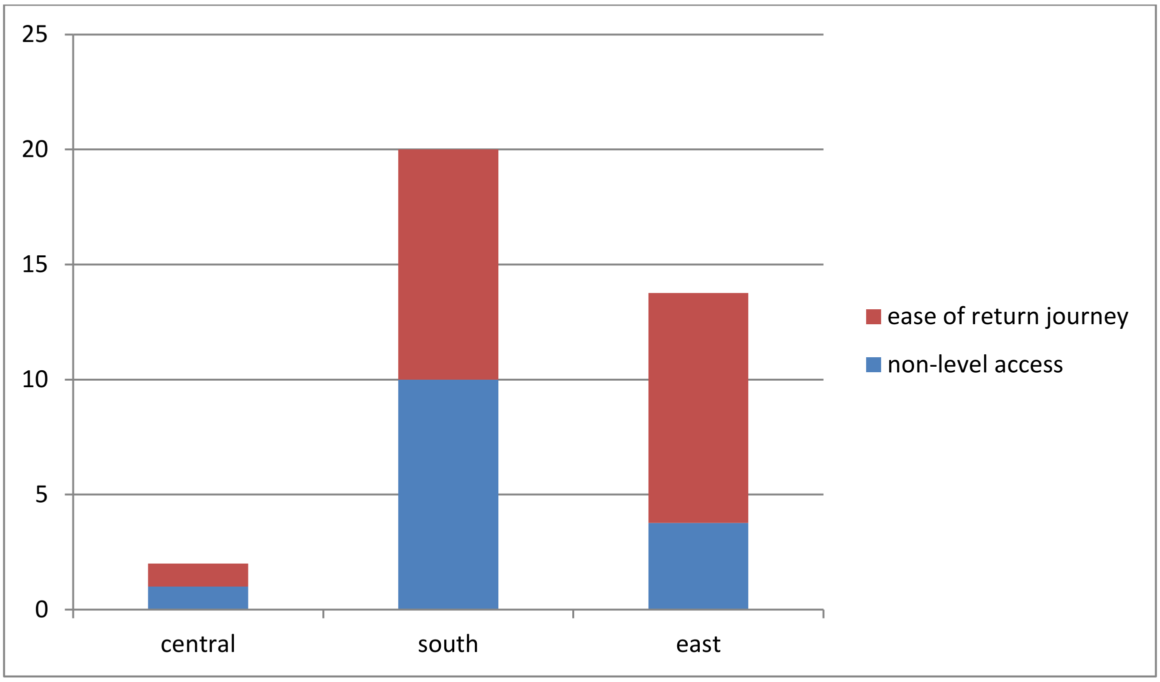

Figure 140; Results of mobility performance indicator calculation for public transport penalty

As can be seen, the central zone is the most poorly performing on both measures, which is disappointing given that it is the hub for most of the bus services and is also the location of the main railway station. The south zone is the best performing. However, the performance indicator measures are all relative measures: They describe the performance of each zone by comparison to the other zones. In the case of this measure, ALL of the zones had public transport services which were sited in such a way as to make return journeys problematic. In the case of the best performing zone, 66% of bus stops were located in such a way as to make return journeys problematic. In the worst performing zone, 80% of bus stops did not facilitate return journeys. The main problem was “to town” and “from town” bus stops being located on opposite sides of wide carriageways or busy junctions, with no pedestrian provision to facilitate access.

8.7.8 Zone performance – pedestrian mobility

Figure 141, below shows the results of the composite performance indicators calculation for pedestrian mobility. The key results are;

- The central zone performs best for time delay and utility. This is because, in the case of time delay, the majority of at-grade crossings are sited on less trafficked routes. The busier routes (constituting the majority in the ring road location) have grade separated crossings. As a consequence, time delays for pedestrians waiting at at-grade crossings are less significant than on other locations where the balance between facilitating movement of motorised and non-motorised traffic is more problematic. In the case of the utility measure, whilst there ARE locations in and around the ring road where the pedestrian environment is unattractive, there are also many examples of locations which are attractively landscaped. In any case, for the majority of the ring road, pedestrian infrastructure is located away from intrusion from traffic such as noise and fumes.
- The south zone performs best on the public transport measure. However, as has already been stated, performance indicators are *relative* measures. Over 60% of the public transport facilities in the south zone had access problems. The south zone performs most poorly on the effort penalty measure, though there are also issues with utility resulting from noise intrusion caused by the traffic, and a high incidence of obstructions to the footpaths.

- As expected, the east zone performs best on pedestrian mobility measures. This is as a consequence of a lack of separated infrastructure, thus minimising distance and effort penalties. As with the south zone, the relatively low performance for utility reflects issues with traffic noise and footpath obstructions.

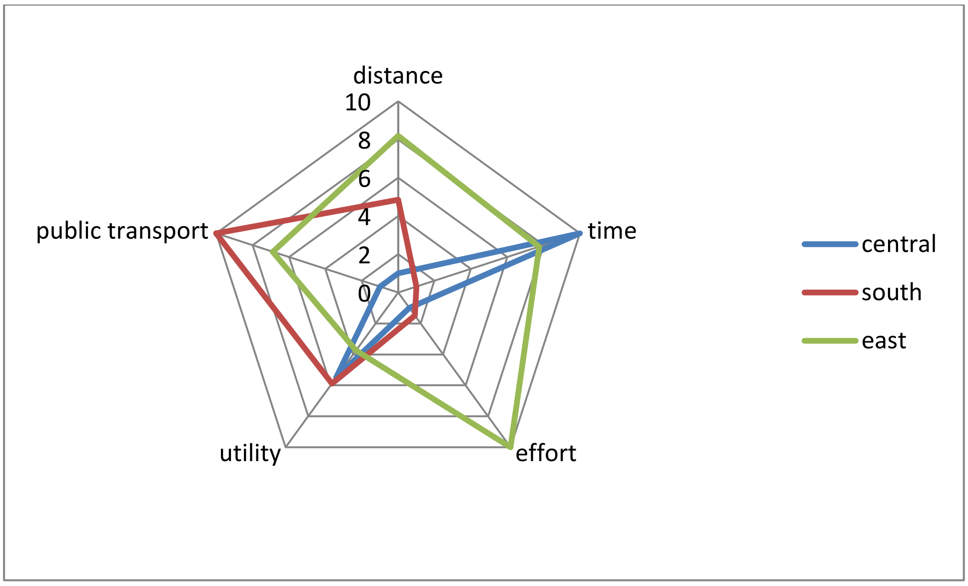

Figure 141; Results of mobility performance indicator calculations

Table 29, below, summarises the main results of the performance indicator calculation for pedestrian mobility.

Table 29; Mobility performance indicator (pedestrians) summary

Zone	Performance Indicator	Key conclusion	Explanation	Implications for Design	Feasibility
Central	Distance penalty	**Distance performance poor**	• Frequently lengthy divergence between desire-line and safe route • Poor signage of routes	Re-think of pedestrian routes, looking at where demand is and how it is provided for Improved signage	High High
	Time penalty	Time performance good	• Fewer locations where crossing is at-grade	None	N/A
	Effort penalty	**Effort performance poor**	• Extensive separation of infrastructure, meaning that stairs/ramps are frequently required for road crossing	Increased use of at-grade crossings Use of lifts for key infrastructure (for example, at railway station)	Moderate – some grade separated crossings have already been replaced with at-grade. Moderate -
	Utility penalty	Utility performance moderate	• Few obstructions to footpaths and intrusion from traffic rare • Extensive use of shared facilities and many locations with poor lighting	None Shared facilities could be improved, especially with signage. Better lighting already	High

				being implemented.	
	Public transport	**Public transport performance poor**	- Return journeys frequently problematic	Re-think of relative positions of transport infrastructure such as bus stops and pedestrian provision such as crossings.	High if done on a small scale at most problematic/ most used locations.
			- Access to services frequently not level	Accessibility design-guidelines extended to cover bus stops as well as major infrastructure such as stations.	Low, unless investment in public transport is to be substantially increased.

Zone	**Performance Indicator**	**Key conclusion**	**Explanation**	**Implications for Design**	**Feasibility**
South	Distance penalty	**Distance performance poor**	• Lengthy detours required for road crossing	Better designed pedestrian provision, better geared to pedestrian needs rather than traffic flow considerations	High, if it is deemed to be a policy priority. Low if traffic throughput is the aim.
	Time penalty	**Time performance poor**	• Lack of dedicated crossing phase in signals		
	Effort penalty	Effort performance moderate	• Only one grade separated crossing in zone	None	N/A
	Utility penalty	Utility performance moderate	• Some examples of pavement obstructions and traffic intrusion, but lighting good and few shared facilities	None	N/A
	Public transport	Public Transport performance good	• Performance better in this zone than central or east. However, majority of bus stops have issues with ease of return journey	None	N/A

Zone	Performance Indicator	Key conclusion	Explanation	Implications for Design	Feasibility
East	Distance penalty	Distance performance good	• Lack of dedicated pedestrian infrastructure and features such as guard rail mean that pedestrians can take shortest route. • However, there is sometimes divergence between desire-line and safe route	None	N/A
	Time penalty	Time performance moderate	• Lower speed limits mean pedestrians find it easier to cross between traffic rather than waiting.	None	N/A
	Effort penalty	Effort penalty good	• Little separation of infrastructure means a change of level for road crossing not required	None	N/A
	Utility penalty	**Utility performance poor**	• Footpath obstructions, intrusion and shared facilities all relatively common	General improvements to the environment required.	High
	Public transport	Public transport performance moderate	• Non-level access a bigger problem than ease of return journeys, though all zones had problematic infrastructure	None	N/A

8.8 Exploring the Trade-offs

As can be appreciated, when considering the design implications of poor performance as measured by performance indicators, some proposed remedial measures will improve performance for one road user group or in one dimension, but at the expense of poorer performance elsewhere. For example, lowering speed limits will increase the time available for drivers to make decision (improved driver safety) but will increase journey times (reduced driver mobility). Providing grade separated crossings will minimise the delay to drivers caused by pedestrians, but at the expense of reduced pedestrian mobility, as longer detours are required to cross.

Calculation of performance indicators allows for these types of trade-off to be analysed. Comparing the composite performance indicators facilitates analysis of where the balance has been struck in different zones between driver safety, pedestrian safety, driver mobility and pedestrian mobility. Various trade-offs between the competing needs of different user groups are possible. For example,

- Between driver safety and driver mobility: For example, higher speeds lead to increased decision frequency and decision speed (poorer safety performance), but increase traffic throughput (improved mobility performance)
- Between driver mobility and pedestrian safety: For example, pedestrian-only lights phases and dedicated crossings reduce driver mobility but improve pedestrian safety by reducing crossing difficulty.
- Between pedestrian safety and pedestrian mobility: Presence of grade separation improves pedestrian safety by reducing crossing difficulty, but reduces pedestrian mobility by increasing distance penalties.

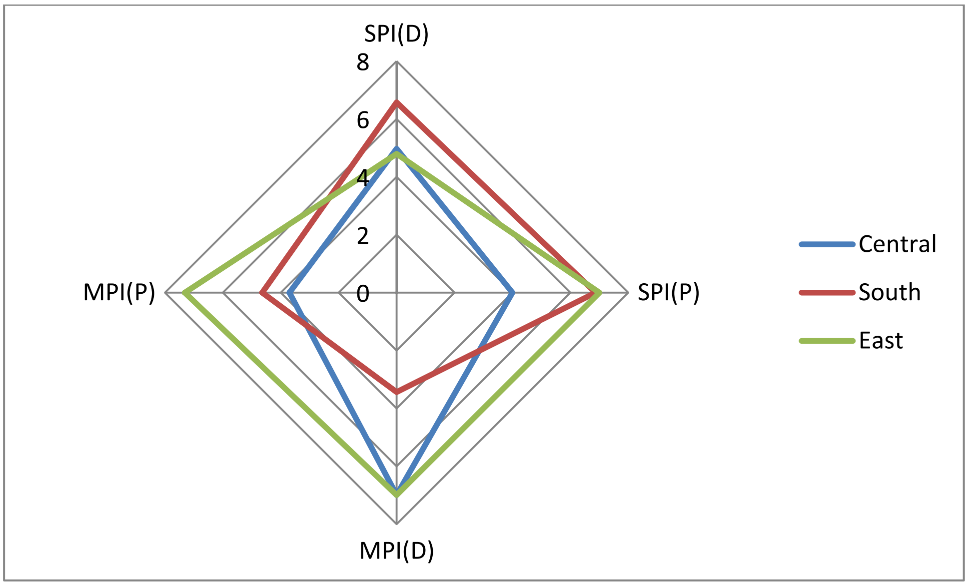

Fig 142; Safety and mobility performance indicators for pedestrians and drivers

Figure 142, above, shows the performance for each of the three zones on each of the four performance indicator domains.

The key features to note are;

- The central zone performs best on mobility for drivers. This is unsurprising given the purpose-built nature of much of the infrastructure in the central zone, which was designed to facilitate throughput of motorised traffic. The trade-off is with driver safety (as the complex junctions and relatively high speed limit result in high driver workload), pedestrian mobility (long detours and subways/over-bridges are often necessary features of road crossing) and pedestrian safety (in areas which do not have grade separation, the central zone features relatively high speed limits, and urban clearways)

- The south zone performs best for driver safety and pedestrian safety. This is as a consequence of relatively high travel times between junctions, and a high proportion of signalised junctions meaning drivers are not required to make rapid, complex decisions about the speed and distance of other traffic. In the case of the south zone, the compromise made is with pedestrian mobility and driver mobility. Pedestrian crossing facilities are poorly designed or located, often necessitating lengthy detours, long waits or a change of level. In addition, obstructions to the footpaths and intrusion from traffic are frequently-occurring issues, even in the less busy areas around Quinton Parade and Earlsdon. For drivers, there is a high number of banned turns and a higher incidence of physical speed restraint measures than in the other zones.
- The east zone performs least well on driver safety, as a consequence of the need for rapid decision-making, and the complex traffic conditions of Walsgrave Rd and Binley Rd, where cars, buses, bicycles and emergency vehicles all share road space. The east zone performs noticeably better than the other two zones for pedestrian mobility, due to lack of factors curbing pedestrian movement (guard rail, grade-separated crossings for example), meaning that long detours and divergence between the desire-line and the safe crossing route were not commonly found.

Whilst all of the locations assessed were selected on the basis that they either -

1) had services and facilities which older users would be likely to want to access, or

2) had been specifically mentioned by focus group participants,

the degree to which older people DO use the infrastructure (whether as drivers or pedestrians) is impossible to know, due to a lack of detailed, disaggregate exposure data. This makes it impossible to judge the impact of poor infrastructure on user behaviour, and in turn, makes it difficult to judge the benefits of improving poorly-performing infrastructure. Chapter 8 aim to provide evidence regarding the degree to which older road users alter their travel behaviour on the basis of the infrastructure they encounter.

The results seem to show that contrary to what one might expect, the trade-off between safety and mobility is not a straightforward one: The Ring Road has very good levels of pedestrian safety. The explanation for this lies in the grade separation of motorised and non-motorised traffic, which means that on the one hand, pedestrians are well protected from conflict with motorised traffic, but on the other, are often required to take significant detours when walking between locations on either side of the Ring Road. In addition, grade separation also influences the inclusion of some additional features which affect mobility, such as changes of level (steps and ramps to access subways), shared pedestrian and cycle facility and poor lighting.

However, the Kenpas Highway, Station and Walsgrave Rd areas score relatively poorly on both measures. It could be argued that these are the areas where the need to balance the competing requirements of pedestrians and motorised traffic is greatest, and that at these locations it is not being well-managed. As has been stated in earlier sections, the Kenpas Highway is a busy traffic route, which was previously part of the trunk road network. The factors which contribute to its low pedestrian safety score are; the high speed limit (40mph), high number of traffic lanes, vehicle mix (which includes high numbers of HVGs as well as buses and emergency vehicles) the lack of pedestrian-only phases in traffic light sequences, and frequent obstructions to visibility caused by trees and signage. However, a number of barriers to pedestrian mobility are also found at this location. These include; long detours to access safe crossing points, shared pedestrian/cycle facilities, pavement obstructions, and traffic noise, fumes and general intrusion.

The station and Walsgrave Rd areas score very similarly for pedestrian safety, but the Walsgrave Rd has the better score for pedestrian mobility. There are some issues here with pavement condition, and with the phasing of the lights (these were also identified by focus group participants). However, despite this area being the subject of a lengthy consultation, and the focus of an existing academic study of the problem of balancing competing demands from pedestrian and motorised traffic (Jones, 2010) there are clearly still issues here which have not been addressed.

The poor pedestrian mobility score for the Station area is particularly disappointing, given that one might expect this to be a location at which public transport and pedestrian access might be prioritised. The key factors here are the long detour to the safe crossing point, the steep access to the station itself (again with long detour if accessing via the steps is not possible), and intrusion from traffic. There is also a lack of well thought-through cycle provision, coupled with high traffic flows and narrow lanes, meaning that cyclists can frequently be observed using the pavements. However, this is a location at which traffic frequently queues, meaning that measures to restrict driver mobility in favour of pedestrian safety or mobility are unlikely to be considered.

Quinton Parade scores best for pedestrian mobility. This is due to the fact that traffic the throughput of motorised traffic is not a priority at this location. The main mobility issues stem from problems with parking, rather than problems with road crossing or other traffic-related issues such as noise or fumes.

8.9 Discussion and conclusions

All of the zones have examples of infrastructure where the competing needs of different road user groups were clearly difficult to reconcile. These were;

- Central Zone: The area immediately adjacent to the ring road; the area adjacent to the railway station.
- South Zone: Kenpas Highway and Kenilworth Rd
- East Zone: Walsgrave Rd and Binley Rd

In each of these locations, the need to maintain the throughput of motorised traffic whilst at the same time facilitating the movement of pedestrians and local traffic was difficult to reconcile. In the case of the area adjacent to the railway station for example, traffic regularly queues to enter and leave the city via this route, yet at the same time, pedestrians need to cross to access bus and rail services, and other nearby facilities including a school and retail park generate additional vehicle and pedestrian traffic. In the south zone, the Kenpas Highway provides access to local shops as well as facilities such as schools, churches and leisure activities. At the same time it provides a convenient diversionary route when there are incidents causing congestion on the M6, meaning that allowing through traffic to keep moving may be a desirable objective. In the east zone, the Walsgrave and Binley roads have a high concentration of local facilities, but at the same time are key arterial routes into and out of the city, and are also the main routes used for access to the city’s hospital.

In many cases the infrastructure designed to maintain throughput of traffic (for example, the “red routes” and associated banned turns on the Walsgrave Rd) present a barrier to the mobility of drivers. In other areas, the infrastructure designed to improve safety, for example, the pedestrian crossings and guard rails on the Kenpas Highway are a clear barrier to pedestrian mobility.

Performance indicators do provide a framework within which these issues can be explored. However, the key questions of firstly where the balance between providing for the needs of different road user groups should lie, and secondly, what level of investment should be made in meeting these needs remain.

One of the key aims of this chapter was to present performance indicators capable of facilitating analysis of the trade-offs between safety and mobility, and between drivers and pedestrians. The indicators themselves are experimental, with further development necessary to address some of the limitations, in particular –

- The question of how to apply weightings which accurately reflect the relative importance of the different performance indicator components in affecting behaviour.
- The issue of how best to approach driver mobility, given that mobility for older drivers has been identified as an issue, but little research currently exists into the key factors which affect it.

However, the presented indicators DO allow for better integration of separate, but related policy aims.

Ewing and Dumbaugh (2009) suggest that safety and mobility are competing aims in urban environments. The results presented here suggest that to some extent this is true, with many of the proposed measures for improving the infrastructure for one group (drivers or pedestrians) or in pursuance of one policy aim (safety or mobility) frequently compromising performance elsewhere. This is a consequence of the need to balance competing needs in urban areas.

It is not within the scope of this study to draw conclusions about where the correct balance lies between the competing needs of different road users in urban areas. However, the use of performance indicators allows the necessary trade-offs to be made much more explicit. Once a framework exists for measuring and monitoring the broader impacts of urban infrastructure design, a better understanding of the interactions between design, travel behaviour, safety and mobility can be built. This in turn makes it possible for policy-makers to incorporate a wider range of information into decision-making and policy.

CHAPTER 9: VALIDATING PERFORMANCE INDICATORS AS A POLICY TOOL

9.1 Introduction

This chapter looks at the accident data for the case study city, in order to identify fatal accidents in which an older pedestrian or driver was involved. These identified accidents are then compared to the results of the performance indicator analysis, in order to establish;

- The validity of using the calculated performance indicators in the road safety context;
- The relevance of the specific indicators proposed;

The success of past initiatives to improve safety in the case study areas are then assessed by reference to both the performance indicator measures *and* accident and casualty data, in order to identify any significant differences between the two approaches. Relevant policy recommendations are then made in the light of the research findings.

Historically, policy makers have used counts of accidents and/or injuries to monitor improvements in road safety. This has been done at both national level, where the first target – to reduce casualties by one third by 2000 was set in 1987, and at European level, where a target for a 50% reduction in casualties was set in 2003.

Whilst the UK government abandoned "over-arching national targets"[5] in 2011, the annual fatality total remains the "headline" indicator of road safety performance. In 2010, this figure was the lowest ever recorded in Great Britain, at 1850. However, it is possible that this total was affected by subtle changes in road users' exposure to traffic risk caused by, amongst other things, periods of exceptional winter weather, during which people made fewer journeys, and challenging economic circumstances, meaning fewer people traveling for work, and people less able to afford leisure trips. The subsequent increase seen in 2011, to 1,901 (the first increase since 2003) shows that continuing falls in fatality totals cannot be taken for granted (DfT, 2012). The role of exposure is key to understanding and interpreting outcomes data: Without knowing how far people are going, what modes they are using, how many trips they make or how much time they spend in traffic, it is impossible to fully understand whether changes in the absolute number of accidents represent an improvement in safety or reflect a reduction in exposure.

9.2 Secondary data sources

Aggregate national data for accidents and injuries is available from the Department for Transport (for data pertaining to Great Britain) and from the CARE database, for United Kingdom data (ec.europe.eu). This data is also publicly available in several interactive and electronic formats, including from the UK Department for Transport's own website (www.dft.gov.uk) and the BBC (http://www.bbc.co.uk/news/uk-15975720). The source of the data is the same in each case; it is derived from

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[5] Strategic framework for road safety, DfT, 2011)

"Stats 19" data, as described in Chapter 2. As will become clear when this data is analysed, one major limitation of using outcomes based data for a specific issue such as the safety of older road users in urban areas is the availability of data. Fatal accidents are, fortunately, relatively rare events. When one looks at the level of a specific city, and then for a particular road user type, such as older road users, data points become extremely limited, and scientifically robust conclusions more difficult to draw.

For exposure data, the main source is the National Travel Survey, a survey of household travel patterns which has been running since 1988, the aim of which is to track long term changes in travel habits (www.dft.gov.uk) This is also available via the Department for Transport website, along with the methodological details of data collection, sampling methodologies and "headline" figures. One major limitation of travel survey data is the lack of detailed disaggregation which is possible. According to Thomas et al (2005) in order for meaningful comparisons of risk rates to be made (whether between countries, regions or road users)

"continuous exposure measurements of different road user categories in different modes and different road environments would be required and could provide detailed exposure estimates to the degree of disaggregation of the respective accidents data…"

As has been highlighted in section 1.3, this lack of detailed exposure estimates is one of the factors which makes analysis of a broader range of data (such as the performance indicators proposed) a potentially useful approach. In locations where pedestrian mobility is restricted, for example, through the use of guard rail, or because traffic flows and speeds are so high that walking is problematic for mobility-restricted users, low accident numbers may reflect lower exposure to risk, rather than higher levels of safety.

The following sections present some of the available secondary data, assessing what can be learnt from them about the safety of older road users in urban areas and comparing the results of this analysis to the conclusions drawn from Performance Indicator analysis.

9.3 Analysis of accident and casualty data

Using the accident data publicly available on-line, accidents where road users over the age of 65 were killed either as drivers or pedestrians were identified. Accidents where the older road user casualty was a vehicle passenger are not included in the analysis, as in these cases, the older road user is not considered to be an "active road user". In other words, they are not directly interacting with the road infrastructure. Accidents are considered separately according to whether the older road user was a driver or pedestrian, and are then further classified according to whether they occurred in one of the case study zones or not. Any accidents where there were inconsistencies which could not be resolved in the accident record were also excluded, along with any others where the known circumstances suggested the accidents were not relevant to the issues under consideration here.

Excluded accidents are described in table 30, below.

Table 30; excluded accidents

Accident Date	**Location**	**Casualties**	**Reason for exclusion**
22nd October 2004	A444 Foleshill Rd	Male aged 80	Accident location and vehicle type unclear.
29th October 2006	Junction of A429 and unclassified Rd (Coat of Arms Bridge)	Female driver aged 80 (serious injury)	From widespread reporting in local media, the driver of the other vehicle involved (a 23 year old male) is known to have been at fault for the accident, having pulled out of a minor road into the path of the 80 year old driver.

For those accidents that were inside a case study zone, comparisons were drawn between the conclusions suggested by the calculated performance indicators and those suggested by the accident circumstances. The accident locations within and outside of the case study zones were then compared, in order to identify any infrastructure features which may have contributed to the accident but which were not incorporated into the audit.

9.3.1 Results - drivers

Analysis of the available data suggests that between 1999 and 2010 there were 4 accidents in Coventry between 1999 and 2010 in which drivers aged over 65 were killed or seriously injured. Table 31, below, summarises the main features of these accidents. The following sections then describe the infrastructure features which are apparent in the areas around the accident locations.

Table 31; main accident features – older drivers

Accident identifier	Date	Driver details	Casualties	Infrastructure description	Zone
D1	16th February 2000	Male aged 82 (fatality)	Car driver (single vehicle accident)	Abbots Lane. Unclassified road	Outside zone
D2	24th August 2004	Male driver aged 90 (fatality)	Car driver only (single vehicle accident)	Junction of The Chesils and Quinton Park Rd	Periphery of south zone
D3	29th July 2007	Female driver aged 72 (injured)	PTW rider (fatal) Car passenger (serious injury)	Stoke Green, close to Junction of A428 Binley Rd	Inside East zone

Figure 143 (below) shows the location of accident D1.

Figure 143; Location of accident D1.

Abbotts Lane is a quiet road, close to the ring road. It has a mix of residential and business properties and is subject to a 30mph limit. As can be seen from figure 143, it has some on-street parking and some stretches where this is banned.

It has none of the characteristics highlighted by the literature as being problematic for older drivers, such as busy junctions, high, mixed traffic flow, poor sightlines or the presence of obscured, illegible or complex information,

Figure 144 (below) shows the location of accident D2. This accident involved a vehicle pulling from the side road visible on the right to the main road. The main features to note include;

- Lack of signals
- Necessity to yield
- Movement from stop

Figure 144; Location of accident D2

In this case the speed limit is 30mph, however, the road geometry reduces the conspicuity of on-coming traffic, as well as reducing the visibility of traffic pulling out of the side road. This is exacerbated by the parked cars around the area of the shops. However, as was the case with accident D1, this location has few of the features which are known to present a problem to older drivers.

Figure 145, below, shows the location of accident D3.

Figure 145; Location of accident D3

As can be seen, this is also a relatively quiet road, with a 30mph limit, bordering housing, a park and with a school and a number of small businesses such as a funeral directors and opticians close by. As with the two previous cases, this location has none of the features highlighted by the literature as being problematic for older drivers.

9.3.2 Results – pedestrians

Analysis of the available data suggests that between 1999 and 2010 there were 9 accidents in Coventry in which pedestrians over 65 were killed or seriously injured. Table 32, below summarises the main features of these accidents. The following sections describe the infrastructure features which are apparent in the areas.

Table 32; main accident features – older pedestrians

Accident identifier	Date	Casualty details	Infrastructure description	Zone
P1	12th December 2006	Female aged 78	Junction of A4414 Holyhead Rd and Kingsbury Rd.	Outside zone
P2	3rd March 2009	Male aged 86	Junction of A4414 and Lammas Rd	Outside zone
P3	19th April 2006	Female aged 89. Female aged 88 seriously injured	Junction of unclassified Radford Rd and Bede Rd	Outside zone
P4	30th November 2004	Male aged 83	Butts Rd	Inside central zone
P5	28th November 2000	Male aged 89	Junction of A45 Kenpas Highway and unclassified Wainbody Avenue	Inside south zone
P6	22nd January 2005	Female aged 82	A4082 London Rd	Outside zone
P7	10th June 2010	Male aged 70+	A4600 Walsgrave Rd	Inside east zone
P8	18th September 2008	Male aged 83	A4600 Walsgrave Rd	Inside east zone
P9	7th December 2001	Male aged 84	A4600 Ansty Rd	Inside east zone
P10	23rd February 2004	Female aged 72 seriously injured Female aged 62 also killed.	A4600 Ansty Rd	Outside zone

Figures 146 to 148 (below) show the A4414, which is the location of Accidents P1 and P2. The A4414 is a main route for traffic travelling north-west towards

Birmingham and the M42, or arriving from that direction. As can be seen, the locations have a number of features which present a barrier to safe mobility for pedestrians.

Both P1 and P2 occurred at junctions, which are known to be more problematic for older pedestrians.

Fig 146; Accident P1 - A4414, at its junction with Kingsbury Rd

In the case of P1, there is no separation of pedestrian and vehicle infrastructure, no dedicated crossing provision at the junction and no pedestrian phase in the lights on any of the four arms of the junction. The junction is wide and obstacle-free, which is likely to influence vehicle speeds. However, there are pedestrian refuges, which have been shown to be a factor in reducing crossing risk for older pedestrians. The A4414 is single lane only at this point, with Kingsbury Rd widening to two lanes at the signals, but being single lane only prior to that. According to the literature, this is safer for pedestrians than wide carriageways with many traffic lanes to cross.

From the mobility point of view, the lack of guard rail and dedicated pedestrian infrastructure mean that long detours are not necessary for pedestrians who wish to cross the road. However, there is some shared pedestrian/cycle infrastructure and access to public transport is not ideal, with the bus stops for services towards the City Centre being located on the other side of the junction from services from the centre. This location has planning permission for a “Local” branch of a large supermarket chain, on the building plot shown in fig 145, which will have implications for both motorised and pedestrian traffic, as well as for parking provision. If vehicle traffic generated by the new store is high, this will have implications for the complexity of the road crossing task here.

Fig 147; Accident P1 - A4414, location of new supermarket

Fig 148; Accident P2 - A4414 at its junction with Lammas Road

The location of P2 is immediately adjacent to a large shopping centre with a variety of businesses including a supermarket and restaurant. The separation of motorised and non-motorised traffic through the use of pedestrian guard rail and dedicated crossing provision reduces conflict. However, as has been shown, it increases the distances pedestrians need to walk in order to cross the road. A high number of traffic lanes, as seen here, has been shown to be strongly associated with a greater likelihood of pedestrian accidents and injuries. In addition, as can be seen, both the main carriageway and the junction providing access to the retail park are wide, a factor which is also associated with over-representation of older pedestrians in accident rates. The infrastructure here is a clearway: Parked cars have been shown to be a factor in increasing safety for older pedestrians, where they appear to provide “friction” which helps to slow traffic and mitigate the effects of accidents.

The photograph shown in figure 147 was taken during extensive resurfacing works to the carriageway. As a consequence, the dedicated crossings were closed and pedestrian activity was severely curbed by the use of cones, barriers and tapes. In the foreground of figure 149 it is possible to see that pedestrian access to the crossing is prevented by barriers fixed to the traffic signal posts.

Figure 149, below, gives some idea of the additional walk for pedestrians needing to cross the road during the remedial works. Whilst this was a temporary situation, for older pedestrians wishing to use the shops, this additional distance could well be the difference between feeling able to make the journey, and feeling unable to. This is especially true of shopping trips, where consideration may also need to be given to the ease with which purchases can be carried home. PACTS (2012) has recently suggested that an audit for older people's needs should be a key part of road safety audits in the future. This example suggests that there may be a case for incorporating it into the regulations governing traffic management at road works.

Fig 149; Accident P2 - A4414 at its junction with Lammas Road

Figures 150 and 151 (below) show the location of accident P3.

Fig 150; Accident P3 – Junction of Radford Rd and Bede Rd

Fig 151; Accident P3 – Junction of Radford Rd and Bede Rd

This location also has a number of businesses which might make it a location older road users (amongst others) might wish to visit. They include a supermarket, newsagent, cake shop and betting shop. In addition, there are other leisure facilities such as a social club and Bingo hall. As with P2, this location has dedicated crossing provision, pedestrian guard rail and no parking. Unlike P2, however, it has a relatively narrow carriageway with only two lanes of traffic and a 30mph speed limit. Pavement condition is poor, with obstacles such as vehicles and clutter including signage, both permanent road signs and temporary signs advertising local businesses.

The location of accident P4 (pictured in figures 153 and 154 below) is the first of the accidents to have occurred in a case study zone. The location is close to the City Centre. It has some retail and other businesses but also has residential developments (as can be seen from the flats on the left and right of figure 153). Pedestrian activity might be expected to be high at this location, as a consequence of its proximity to the City Centre, the businesses and housing it contains, but also its popularity with students. This is due to a college (immediately behind the spot from which the picture in figure 153 was taken) a nearby student housing development, and its proximity to Earlsdon, a suburb of the city with a lively bar and restaurant scene.

As can be seen from the picture, there is separation of motorised and non-motorised traffic, with pedestrian guard rail and dedicated crossing provision. However, the carriageway is wide with a high number of traffic lanes and evidence of deviation between the pedestrian desire line and the safe pedestrian route.

Fig 152; Accident P4 – Butts Rd

Fig 153; Accident P4 – Butts Rd

Figure 154, below, shows the location of accident P5.

Fig 154; Accident P5 – Junction of A45 Kenpas Highway and Wainbody Avenue

As with the majority of the pedestrian accident locations, there is some dedicated pedestrian provision and pedestrian guard rail. The speed limit at this location is 40pmh. The carriageway is wide, with two traffic lanes in each direction, and no parked cars, though there is a central pedestrian refuge, meaning the road can be crossed in two halves. As can be seen, the location serves a row of local shops, and also has bus stops for services to and from the City Centre.

Figure 155, below, shows the location of accident P6.

Fig 155; Accident P6 – London Rd

It is similar to P5, having a 40mph limit, two traffic lanes, dedicated pedestrian crossing provision and no parking. There is also pedestrian guard rail, and the location has bus stops for services in each direction: On the far carriageway the bus stop can be seen to the left of the red car, on the near carriageway it is to the left of the spot from which the picture was taken. Again, the location is convenient for a number of activities and services which older people might wish to access. On the far side of the road there is a small row of local shops and a church (visible on the left of the picture), Out of the picture on the near side of the road there is a supermarket.

Figure 156, below, shows the Walsgrave Rd, the location for accidents p7 and P8. As can be seen, traffic conditions are heavy, but the road has a 30mph limit, there is one lane of traffic in each direction, and on-street parking is permitted. There is a dedicated pedestrian crossing, but no guard rail and no separation of infrastructure. Walsgrave Rd is a busy shopping area, which also has stops for bus services towards the City Centre in one direction, and to the City's main hospital in the other.

Fig 156; P7 and P8 Walsgrave Rd

Figures 157 – 159, below, show the Ansty Rd, the location of accidents P9 and P10.

Fig 157; Accident P9 – Ansty Rd

Fig 158; Accident P9 – Ansty Rd

Fig 159; Accident P10 – Ansty Rd

As can be seen, the Ansty Rd has wide carriageways, several traffic lanes and no parking. It is a 40pmh limit, and other than at the junction (the location of accident P10), it has no pedestrian guard rail or dedicated crossing provision. It is close to the main hospital, which although screened from the road by trees, is located to the left of Fig 158. This means it is frequently used by emergency vehicles. There is evidence in fig 158 that pedestrians would wish to cross here: Aside from the pedestrian pictured, the grass on the central reservation is worn in places, suggesting that people frequently walk across it.

9.3.3 Discussion of accident and casualty data

There are a number of limitations of using accident and casualty data in this way, most of which have already been alluded to, and which can be summarised as follows;

- There are too few data points for robust statistical analysis to be possible. In the case of drivers aged 65+ there were only 4 fatal accidents between 1999 and 2010 in Coventry, and for pedestrians there were only 10. This is why a case study approach has been necessary.
- In order to collect even the (relatively few) accident cases examined here it has been necessary to take data over a relatively long period of time. It is likely that many changes will have taken place over this period, including changes in traffic flows, vehicle types and changes to the road layout. Even during the period over which this study was undertaken significant changes were made to road layouts, the most important of these included the introduction of a "Shared Space" scheme (discussed in more detail in section 8.7), the pedestrianisation of Broadgate, previously one of the City's main bus interchanges, and the closure of some grade separated crossings in the Central zone and their replacement with at-grade crossings.
- It is not possible from the data alone to ascertain who was to blame for the accident, hence accidents may be included on the basis of the age of the casualties, not on the basis of the age of the road user whose behaviour led to the accident. This may not be appropriate if the aim is to assess the effect of infrastructure features on the safety of older road users.

- Accident and casualty data are known to be incomplete, and the degree of incompleteness varies by road user type. This phenomenon has previously been discussed in detail in chapter 3.

However, despite these limitations, some features of the accidents involving casualties over 65 are worth noting:

As was already suggested by the literature, the analysis of accident statistics appears to confirm that the risk to older road users is far greater when they are pedestrians than when they are drivers. Whilst lack of available data concerning exposure to risk makes it difficult to draw robust conclusions about the relative risk levels, this would suggest that -

1) The safety of older pedestrians should be a policy priority. On balance, measures which prioritise pedestrian safety over driver mobility would be advantageous for older road users.
2) Measures to enable older people to continue to drive later into old age (for example, through additional training, health screening or other support) would, on average reduce their exposure to risk compared to measures aimed at supporting them in giving up driving whilst at the same time maintaining independent mobility via other modes.

In terms of the assessed infrastructure at the accident locations, the following conclusions can be drawn;

1) The locations of the accidents involving older drivers do not present many of the features highlighted by the literature as being problematic for older drivers. All of the accidents occurred on quiet side streets, not at complex urban junctions.
2) The locations of the pedestrian accidents had many more of the features associated with risk, such as wide lanes, high speed limits and a lack of on-street parking. However, in many cases, they also presented features which should have helped to protect older pedestrians, such as guard rail and signalised crossing provision.

One of the advantages of Performance Indicators is that they can provide an objective set of measures by which to assess safety which do not require detailed exposure data to be available. By combining the two sets of information – the accident data and the performance indicators, it is hoped that a more complete picture of safe mobility can be built, and, leading on from that, more appropriate policies can be designed.

9.4 Validation of performance indicators using accident records and proxy exposure data

One of the main limitations of performance indicators is the difficulty of validating the calculated measures. Identifying methods of demonstrating the precise nature of the relationship between the calculated measure and the safety or mobility problem is complicated by a lack of necessary data, specifically –

- Detailed disaggregate exposure data, which makes it difficult to determine the effect of barriers to mobility on trips made.
- Large numbers of accidents in which older drivers were at fault, making robust statistical analysis of the relationship between older users' difficulties in traffic and accident involvement difficult.

The National Travel Survey (NTS) collects detailed information on how far people travel, which modes they use, and how frequently they make trips. However, this data cannot be disaggregated to the level of an individual city, much less to different zones within a city. The NTS does, however, suggest a general reduction in walking journeys, with, 2010 seeing the lowest level of walking trips ever recorded by the survey. It also suggests a general decline in bus patronage outside London, with an associated rise in car journeys. This provides some evidence in support of the argument that declining numbers of pedestrian accidents could be caused in part by falls in the popularity of walking.

An additional difficulty of using accident or casualty rates to assess the safety of older road users is that it is not always possible to link the known difficulties outlined in detail in Chapter 2 (for example, loss of peripheral vision, increased reaction times) with increased accident involvement. One suggested explanation for this is the coping strategies described in section 2.7, which could be another factor in reducing older users' exposure to risk: Where older users are not comfortable with the infrastructure, they change route, mode or some other journey characteristic, which reduces their exposure and partially explains lower accident rates.

The following sub-sections (9.4.1 to 9.4.5) combine the available data – performance indicators, accident records, and the collected user data – in order to explore *validation* of the performance indicator scores for the chosen locations through use of the accident and user-data for the same locations. This will be done by comparing actual outcomes (in terms of accident case studies and user-data) with Performance Indicator scores. By doing this it will be possible to draw conclusions about how well the calculated performance indicators scores describe the extent to which safe mobility has been successfully promoted in the case study city. Section 9.4.1 summarises the evidence for each of the three zones, and for the accident locations which were outside the assessed zones.

9.4.1 Central Zone

Table 33 summarises the findings for the central zone

Table 33; Summary findings central zone

Performance Indicator Scores				Accident record		User data
Driver safety	**Pedestrian safety**	**Driver mobility**	**Pedestrian mobility**	**Older drivers**	**Older pedestrians**	
Poor	Good for Ring Road location, less good elsewhere	Good	Poor	No fatalities	P4	No direct evidence relating to this location. Many users report not feeling comfortable using the ring road, either as a driver or pedestrian.

Despite a poor score for driver safety, the central zone has no older driver fatalities. There are a number of possible explanations for this, including

- Older drivers adapt their driving style when using the infrastructure;
- Older drivers avoid the infrastructure;
- Because of chance, accidents have not occurred, despite the infrastructure being risky for older drivers;
- The indicator is flawed and does not reflect the actual level of risk posed to older drivers.

The one pedestrian fatality occurred close to, but not directly within the infrastructure of the ring road. As has been pointed out, at these locations, crossings are often at grade (as was the case here), though carriageways are still wide, and vehicle speeds high. Whilst the central zone performed well overall for pedestrian safety, the location at which this accident occurred would have scored poorly. However, as a consequence of long detours, clear divergence between the desire line and the pedestrian route, guard rail and traffic intrusion, it would also have scored poorly for pedestrian mobility. This suggests that pedestrian activity here may be low, as pedestrians avoid the infrastructure which does not cater well for their needs.

9.4.2 South Zone

Table 34, below, summarises the findings for the south zone.

Table 34; Summary findings south zone

Performance Indicator Scores				**Accident record**		**User data**
Driver safety	**Pedestrian safety**	**Driver mobility**	**Pedestrian mobility**	**Older drivers**	**Older pedestrians**	
Good	Good	Poor	Poor	D2	P5	No direct evidence relating to driver accident location. Some evidence about the location of pedestrian accident

The location of accident D2 has few of the features known to present a hazard to older drivers and was not mentioned by focus group participants as causing problems. Whilst it is difficult to reconcile the performance indicator score with the instance of a fatal accident here, it is likely that more conventional analysis of the accident would encounter similar difficulties: There are no obvious risk factors present at the location. The speed limit is 30mph and the road is not busy. It is also not known whether the older driver was responsible for the accident, and whether a younger driver might have survived the impact.

The location of accident P5 was mentioned by focus group participants as being somewhere they avoided, partly as a result of difficulties with road crossing. The pedestrian safety score is good, as a result of the grade separated crossing facilities. However, this raises the question of whether pedestrians crossing at-grade at locations where grade separated facilities exist are at greater risk. The speed limit is 40mph, the carriageway wide, there are no parked cars and there is extensive use of guard rail. All of these factors contribute to drivers' perceptions of what constitutes a safe speed. Moreover, focus group participants felt that through traffic was unambiguously the priority here, meaning that factors such as crossing timings, location, and design reflected this imperative, rather than the needs of pedestrians.

9.4.3 East Zone

Table 35, below, summarises the findings for the east zone.

Table 35; Summary findings east zone

Performance Indicator Scores				**Accident record**		**User data**
Driver safety	**Pedestrian safety**	**Driver mobility**	**Pedestrian mobility**	**Older drivers**	**Older pedestrians**	
Poor	Poor for crossing difficulty. Fair overall.	Good	Good	D3	P7, P8, P9	Some direct evidence relating to P7 and P8. No evidence relating to P9 or D3

As can be seen, the east zone performs poorly with respect to the indicator for driver safety. However, as was the case with both the central and south zones, the precise accident location has few of the factors considered to present a high risk to older drivers.

The east zone has more pedestrian fatalities than either of the other zones. It was also the zone which performed best for pedestrian mobility, with few instances of lengthy detours necessitated by grade-separated crossings or guard rail. It did, however, perform poorly for crossing difficulty, as a consequence of lack of median strip and lack of dedicated crossing provision.

9.4.4 Outside Zone

Accidents P1, P2, P3, P6 and P10 occurred outside the study zones, hence do not have calculated performance indicators. However, as can be seen, P1 – P3 and P6 are locations with dedicated crossing provision and guard rail. As a result of these features, these locations would score highly for pedestrian safety, but poorly for pedestrian mobility. In addition, all have a 30mph limit.

As was the case with P4 and P5, in the central and south zones respectively, this again raises the question of the precise relationship between features such as guard rail and dedicated crossing provision and pedestrian safety. It may be the case that such features have unintended negative consequences, such as increasing vehicle speeds or reducing the concentration of pedestrians, who rely on the signals without observing the traffic for themselves.

9.4.5 Conclusions

Trying to validate performance indicator values against accidents and fatalities is a difficult process as a result of –

- Random fluctuations in accident data, and the role of chance in determining crash outcomes (ETSC, 2001)

- The fact that inherently dangerous conditions do not always result in accidents (ETSC, 2001)
- The coping strategies that older drivers are known to employ when they feel at risk (DfT, 2001)
- The unknown, but potentially significant role of exposure.
- The experimental nature of the indicators, which may mean they do not accurately describe the levels of safety at different locations.

The purpose of Performance Indicators is not to “prove” that accident and casualty rates should not be used to asses safety, but is rather to look for additional information which can supplement these measures.

What these case studies suggest is that -

- Dedicated crossing provision and other pedestrian facilities such as guard rail do not prevent pedestrian fatalities, with P2, P3, P4, P6 and P10 all occurring at locations with signalised crossing provision and guard rail.
- At the same time, such infrastructure increases walk distances for pedestrians, reduces the attractiveness of the environment, and in some cases, for some pedestrians, causes them to avoid the infrastructure or use another mode.
- By using performance indicators as well as accident and casualty figures, more information about a location becomes available. This is particularly useful when looking at a specific problem such as the safety of older road

users in urban areas, where otherwise data points are few and statistical analysis problematic.

The highly experimental nature of these performance indicators may affect the degree to which they accurately describe the performance of the assessed infrastructure in terms of safe mobility. However, they do allow for a wider range of information to be incorporated into policy design, and a different perspective to be adopted. Policy objectives which could reasonably be incorporated alongside road safety include –

- Environmental objectives such as improved air quality, reduced congestion, increased use of “benign” modes such as walking and cycling.
- Health objectives, again possibly including improved air quality, but also including increased physical activity levels.
- Economic objectives, such as the viability of local businesses
- Social objectives such as reductions in isolation, reduction of community severance, increases in community spirit

Performance indicators which aimed to capture the impact of road infrastructure design on some of these more nebulous outcomes could be constructed. Thus whilst further development work could improve the reliability of the performance indicators in describing the impact of infrastructure on user behaviour and outcomes, they can certainly be used to draw a wider range of policy issues into policy design.

9.5 Shared Space – A potential solution?

So-called “Shared Spaces” are areas where, rather than being separated by subways, under-passes and guard rail, different types of traffic share the same space. The advantages claimed for such areas are set out in Chapter 2. Shared space works by introducing uncertainty amongst road-users (about who has right of way, about whether pedestrians or cyclists might be in the carriageway) thereby making them more cautious about negotiating their way through the infrastructure. As a consequence, vehicles are expected to slow down and all road users to be more vigilant. Coventry currently has two locations which could be described as Shared Space, where traffic signals and road signs have been removed and there has been a deliberate blurring of the boundaries between the vehicle carriageway and pedestrian footpaths. These are at the junction of The Burgess, Hales Street and Bishop St (shown in fig 160 (before) and fig 161, (after)) and the junction of Fairfax St and Gosford St (fig 162 (before) and 163 (after)), both of which are in the City Centre.

Fig 160; Junction of The Burgess, Hales Street and Bishop St, before creation of shared space scheme

Fig 161;Jjunction of The Burgess, Hales Street and Bishop St, after creation of shared space scheme

Fig 162; Junction of Fairfax St and Gosford St before shared space scheme

Fig 163, Junction of Fairfax St and Gosford St after shared space scheme

Both of these locations are in the city centre, where pedestrian traffic flows are high. Fairfax St is also immediately adjacent to Coventry University and the Herbert Art gallery, meaning that it is crowded with students at certain times of the day and year.

As can be appreciated from the pictures, the transition to a shared space design reduces pedestrian walk distances by allowing them to wander across the junction rather than crossing the arms. Theoretically it also reduces pedestrian wait times, as pedestrians should be able to weave between cars, over which they should have priority. Whilst it might be expected that the design increases journey times for motorised traffic as a consequence of the lower speed limit (30mph before the changes, 20mph after), it has been claimed that by reducing inefficiencies at junctions, it actually lowers journey times for drivers and makes them more predictable.

Whilst this might seem like an ideal solution in busy urban areas, where motorised traffic speeds are likely to be low anyway as a result of congestion, signals and vehicles looking for parking, in reality, both schemes have proved controversial, with the local paper (The Coventry Evening Telegraph) carrying a series of negative articles. (For example, “No U-Turn Over Shared Spaces” Coventry Evening Telegraph, January 12th 2012, “Former Home Secretary Wades into row over Shared Space Junctions” Coventry Evening Telegraph, June 29th 2012). The key objections are that:

1) They are problematic for the disabled, especially those with visual impairments;
2) They are dangerous for all road users.

According to the DfT (2011)

"Shared space is a design approach that seeks to change the way streets operate by reducing the dominance of motor vehicles, primarily through lower speeds and encouraging drivers to behave more accommodatingly towards pedestrians."

However, members of the Coventry Society for the Blind quoted in local papers (for example, Coventry Times, July 5th 2012) believe that drivers do not modify their behaviour in the light of pedestrian priority, leading to unsafe conditions for the visually impaired. In addition, a fatal accident involving an older road user and a bus at the Burgess/Hales St/Bishop St junction in January 2012 has increased the perception amongst some that the Shared Space design is not safe.

"Reducing the dominance" of motor vehicles in urban centres, where older road users are at greatest risk, but are most likely to find the services and facilities they need would appear to be an idea solution to balancing competing needs in urban areas. Proponents of shared space schemes argue that they can meet the needs of pedestrians by increasing safety (lower vehicles speeds) and increasing mobility (allowing pedestrians to walk where they want to walk, not be herded into subways or behind guard rail). At the same time, reduced (and more predictable) journey times mean drivers are not disadvantaged.

Lack of public acceptance for shared space schemes may affect their implementation, though as recently as October 2012 the council announced plans to create more such spaces in Coventry (BBC.co.uk, October 3rd 2012). This reflects quite a change from the approach advocated by the Buchanan Report, and discussed in Chapter 2, which suggested separation of vehicle traffic and pedestrians.

Two of the key conclusions from the validation exercise described in the previous section were that –

- Dedicated crossing provision and other pedestrian facilities such as guard rail do not prevent pedestrian fatalities,
- At the same time, such infrastructure increases walk distances for pedestrians, reduces the attractiveness of the environment, and in some cases, for some pedestrians, causes them to avoid the infrastructure or use another mode.

Shared space is thus a relevant urban infrastructure design concept, as it attempts to reconcile the competing needs of different road user groups (principally motorised and non-motorised traffic) in a very different way from that apparent for much of the other assessed infrastructure: Rather than separating different road user types with dedicated infrastructure such as urban clearways, grade-separated crossings and high design speeds for vehicles, shared space – as the name implies – encourages integration. The calculated performance indicators suggest that separate infrastructure limits pedestrian mobility and there is no evidence from the accident data that it is safer for pedestrians either. Shared Space is a type of infrastructure design which could score well on both safety and mobility, for both motorised and non-motorised traffic. In addition, performance indicators may be an ideal way of monitoring safety and mobility at such infrastructure: Sufficient accident data points for the new layout will not be available for many years, and the new design is likely to have a significant impact on traffic patterns, which will also be difficult to evaluate without detailed disaggregate data, which again is unlikely to be available for some time, if at all.

9.6 Conclusions

This chapter has explored the validity of using the calculated performance indicators in the road safety context. The fact that they can provide additional information to support policy decisions has been established. However, further work could be done to improve the reliability of the specific indicators proposed. Factors which may have affected the relevance of the indicators include –

- The decision to calculate indicators for zones within the city, rather than specific locations. This may have resulted in the composite indicators not providing the most accurate picture of safe mobility for each specific location. For example, whilst the ring road has predominantly grade-separated infrastructure, making it very safe for pedestrians, the area immediately adjacent to the ring road often has at-grade crossings with high traffic speeds, no parked vehicles and wide carriageways. This clearly has very different implications for pedestrian safety.
- The particular variables used: The relationship between the use of guard rail and pedestrian safety, for example, could be explored further. The performance indicator calculations assume guard rail is a good thing for pedestrian safety, but this may not be the case, especially if guard rail is also associated with higher vehicle speeds, reduced pedestrian conspicuity, or other issues.
- The lack of weighting when constructing composite indicators.

The success of past initiatives to improve safety in the case study areas has been assessed by reference to both the performance indicator measures *and* accident and casualty data. Differences are apparent in the conclusions suggested by the two approaches: Areas which perform reasonably well for pedestrian safety have a history of pedestrian accidents, and locations which do not have the features associated with poor driver safety present driver accidents. Possible explanations for this include

- Changes in infrastructure design made since the accidents (and possibly as a consequence of them).
- Flaws in the performance indicators themselves.
- The impact of random fluctuations in accident data, particularly in the light of the relatively few accidents included in the analysis.

However, it is important to bear in mind that the use of performance indicators is intended to complement accident and fatality data, not replace it. Therefore, the two types of data should be assessed together, as has been done here, in order that infrastructure design can facilitate both the safety and the mobility of older road users, not just protect them from traffic risk.

Problems that cannot be identified through analysis of accident or casualty data can be incorporated into performance indicators. These include some of the more nebulous issues such as feelings of personal safety or footpath obstructions (some of which may be highly dynamic, such as vehicles or stock displays). Performance indicators thus allow a broader range of factors to be incorporated into policy design.

CHAPTER 10: SUMMARY, DISCUSSION AND GENERAL CONCLUSIONS

10.1 Introduction

This study aimed to explore the conflict which may exist in complex urban traffic environments between progressing road safety and facilitating continued independent mobility, specifically in the case of older road users. The reason for this focus is the predicted increase in older road users as the population ages, the expectation that future generations will travel further and more frequently than previous generations, and the implications of these changes for policy design (ONS, 2008). The potential to use Performance Indicators to progress road safety, whilst at the same time facilitating continued independent mobility was investigated. The research questions under consideration were –

- What are the main safety and mobility issues which affect older road users in urban areas?
- Does analysis of the issues undertaken using a Performance Indicator approach offer a different perspective, for example by identifying issues that are not apparent when outcomes-based measures of monitored, or by providing more detail about the underlying causes of the problem?
- Would an approach to policy that was based on the calculation of Performance Indicators lead to changes in the design or implementation of urban transport policies?

This section summarises the results of the work. In the following sections, a concise summary of the key safety and mobility issues is presented, followed by a discussion of the main findings in respect of Performance Indicator calculation, validation and use. The implications for policy are then discussed and conclusions drawn.

10.2 The key safety and mobility issues which affect older road users

The key issues identified by this study were

- the likely growing importance of older road users
- the numerous age-related changes which make older road users' needs different from those of other road user groups
- the need to protect older road users from accident and injury risk in traffic
- the need to provide for their continued independent mobility by designing infrastructure which does not hamper their ability to get around

Whilst it is acknowledged that the ageing process affects individuals in different ways and at a different pace, a set of commonly-occurring symptoms can be identified. These symptoms were incorporated into the calculation of the performance indicator measures, in order that the measures reflect the actual difficulties faced by older road users. According to Brace et al (2006), these include stiffening of joints and weak muscles, leading to difficulty in looking; deterioration in hearing and eye-sight; dulling of reflexes and reduced attention span; slowing of sensory performance and increased disruption of working memory. This understanding of the difficulties faced enabled a number of common infrastructure features which older road users find problematic, to be identified. For driver safety, the key factors identified included;

- the amount of information that must be attended to, for example, the number of route and lane choices, presence of signals or pedestrians
- the quality of the information provided, for example, distance at which signage becomes visible, presence of intrusion from vegetation or buildings
- the presence or otherwise of time pressure, for example, the distance within which lane choices must be made, the degree to which drivers can select an appropriate speed as opposed to merging with the flow
- Any physical difficulty with observations, for example, such as that caused by needing to look in front and behind when merging.

Junctions were found to present a particular problem to older drivers. What this study has shown is that these well-documented age-related changes are currently not adequately incorporated into infrastructure design. Numerous examples were found in the case study city of road environments where the driving task required attendance to a large amount of information, the deciphering of degraded or obscured information – often under time-pressure – or the need to look for traffic both in front and behind when manoeuvring.

For pedestrians the key factors which influenced traffic risk were mainly associated with road crossing. High risk features included;

- Wide street crossings

- High number of lanes
- Lack of median strip

Previous work has suggested that it is sometimes difficult to link the factors identified as being problematic for older road users to increased accident involvement. The user data offers a partial explanation for this: Where older road users find the infrastructure particularly problematic (for example, because junctions are complex or road crossing is difficult) they compensate, for example by switching route or mode. This affects the relationship between safety problems and accident involvement in a way that, because of lack of detailed exposure data, is difficult to interpret. This confirms earlier research which suggested that the implementation of coping strategies such as route or mode switch might explain the difficulty of linking problems in traffic to accident involvement. (DfT, 2001). Performance indicators, which do not require detailed exposure data would therefore be a useful way of exploring the relationship between infrastructure design, safety, accident involvement and risk exposure. The degree to which infrastructure helps to protect older users from traffic risk can then be analysed without reference to detailed disaggregate exposure data..

Work on mobility has tended to focus on those without access to a car. However, there is evidence from both the focus groups and case studies of mobility issues which affect drivers. These include lack of adequate parking and the presence of barred turns. Given the likely increase in the importance of car-use amongst older road users, the development of indicators which could measure and monitor the incidence of barriers to mobility for older drivers would be a positive step towards promoting design which facilitates mobility for older drivers.

For pedestrians, the same physical changes occur as have already been outlined in the context of drivers. They have additional implications for the mobility of older pedestrians. A number of factors were found to affect mobility. These included;

- Poor lighting
- Poor footpath condition
- Poorly designed or sign-posted pedestrian routes (including poor crossing provision)

According to the results of this study, the largest barriers tended to be micro-level details such as pavement condition, inadequate crossing facilities and obstacles such as bicycles on pavements or overgrown hedges. This confirms the conclusions reached by Titheridge and Soloman (2007). Indicators which could describe and monitor the incidence of such barriers to mobility would be an important step in promoting the mobility of older road users. This is a step which is also recommended by Metz (2000), who states that continued mobility for older people is an important policy objective, and this importance should be reflected in more systematic measurement and monitoring of the extent to which urban infrastructure design supports older people’s independent mobility.

10.3 Striking the balance between safety and mobility

In most busy urban areas a balance must be struck between the competing needs of different road user groups. One of the most obvious examples of the problem is determination of the appropriate speed limit: It is known that pedestrians have a greater chance of survival if hit at lower speeds (DfT 2006), but the prevailing limit represents a compromise between their safety and other factors such as air quality and the economic imperative to keep traffic flowing.

The study has analysed the extent to which the safety and mobility of different road-user groups are traded off against one another. This trade-off is manifested in infrastructure features such as pedestrian guard rail and grade-separated pedestrian crossings, which allow for higher vehicles speeds (driver mobility), but often require pedestrians to make lengthy detours (pedestrian mobility). What this research shows is that features such as dedicated crossing provision and guard rail do not prevent pedestrian fatalities, with several occurring in the case study city at locations which had these features. At the same time, they increase walk distances and reduce the attractiveness of the environment, both of which have a negative effect on pedestrian mobility. Performance indicators, used in conjunction with accident or casualty figure allow more information to be incorporated into the design of policy. This is particularly useful when looking at a specific problem such as the safety of older road users in urban areas. Not only does it help to address the problem of too few data points being available for detailed statistical analysis, but it also helps to quantify the otherwise more nebulous impacts on mobility and quality of life.

In some of the case study areas, it was not just the anticipated trade-offs between pedestrian safety and mobility and driver safety and mobility that were apparent. Additionally the safety and mobility of local users (whether pedestrians or drivers) were traded for safe mobility for through traffic. This was the case on the A45 Kenpas highway for example, where barred turns and lack of parking limited mobility for local drivers, whilst high speed limits, poor crossing provision and a general lack of quality pedestrian infrastructure reduced safety and mobility for pedestrians.

Ewing and Dumbaugh (2009) suggest that safety and mobility are competing aims in urban environments. The results of this study support this viewpoint to a large extent. It is necessary to balance the competing needs of different user groups in complex urban areas such as Coventry. The decision about which group's needs should be prioritised on which parts of the road network is an important one which falls beyond the scope of this study. However, as the population ages it becomes more important to consider older road users and their continuing need to access shops, health care facilities and leisure activities. In addition, the predicted increase in the number of older road users who own and use a car means that previous work which considered the needs of older people along with other mobility-limited groups primarily without access to or use of a car should be revisited. As has been stated, older users are at greater risk of accident involvement when walking than when they are vehicle occupants. Measures such as designing infrastructure to take account of the performance standards of older adults would be one way of supporting them in continuing to drive for longer. This is one way in which safety and mobility of older drivers could *both* be promoted. Similarly, certain measures to improve the environment for pedestrians and thus promote pedestrian mobility could be implemented without having a negative effect on other categories of road users. These include improved lighting and pedestrian signage, and repairs to damaged and uneven surfaces. Results obtained from both the literature review and the user data show that poor lighting, signage and damaged and uneven surfaces are a barrier to mobility. Results from the audit of infrastructure demonstrate that these are a frequently occurring issue in the case study city.

It is not within the scope of this study to draw conclusions about where the correct balance lies between the competing needs of different road users in urban areas (for example, lowering speed limits to promote pedestrian mobility at the expense of driver mobility, or removing guard rail to promote pedestrian mobility at the expense of pedestrian safety).   However, the calculated performance indicators allow the necessary trade-offs to be made much more explicit. If significant barriers to mobility exist and older users cannot make the journeys they need or want to make, this imposes a cost in terms of the effect on their physical and mental health. This cost has not previously been incorporated into decisions about urban infrastructure design. Once a framework exists for measuring and monitoring the broader impacts of urban infrastructure design, a better understanding of the interactions between design, travel behaviour, safety and mobility can be built. This in turn makes it possible for policy-makers to incorporate a wider range of information into decision-making and policy.

Since all of the case study areas were chosen for the services and facilities they offered to older road users, one could argue that a different balance between road users would be beneficial in these areas.

10.4 The calculated performance indicators

The calculated performance indicators allow comparisons to be made between different case study zones and different locations within zones. In addition, they enable a wider range of information to be used in policy determination: As well as the traditional approach (looking at casualty and accident figures) policy can also be designed using safety and mobility performance indicators. In this way, not only does more data become available, but a wider range of policy options can be incorporated into the analysis, and the interactions between them can be better understood.

The performance indicators presented here are not weighted. In other words, different factors (for example, decision frequency, decision complexity, traffic complexity) are assumed to have an equal impact on road users. It is likely that this is not an accurate reflection of reality. However, there are a number of problems with deriving accurate weightings and applying them to calculated performance indicators. These are discussed in more detail in Chapter 3, but include

- The difficulty of obtaining consistent weightings
- The arbitrary nature of some weighting methods

- The likely correlation between some of the included variables

Thus whilst weighted performance indicators might be *theoretically* better able to reflect the impact on safe mobility of different factors, in reality, the challenges involved in deriving scientifically robust weightings are difficult to overcome. Un-weighted performance indicators have the advantage of simplicity, in both calculation and interpretation, and were therefore felt to be more appropriate in the context of this study.

Designing a suitable method for weighting the indicators is a potential future development of the work. However, an important first step would be to determine the degree of correlation between the variables. For example, wide carriageways, higher speed limits, pedestrian guard rail and grade separated crossings might be features which frequently occur together. Should this be the case, the calculated indicators might also be highly correlated. As was explained in Chapter 3, equal weightings are the best approach where this is thought to be the case. Therefore should the variables used in the calculations be found to be highly correlated, it would be necessary to refine the formulae used in the calculations to address the problem. One way of doing this would be to ensure that any variables found to be correlated were used together in the calculation of single indicators. Once the question of correlation had been addressed, weightings could possibly be obtained by using user data such as Travel Diaries or Case Studies to identify the features which most commonly lead older road users to change their behaviour (for example, driving rather than walking, to avoid subways; taking a different route to avoid a fast-moving roundabout). The problem of safe mobility could then be translated into a hierarchy, consisting of an overall goal such as “improving infrastructure to facilitate safe mobility for older users”, and a number of alternative approaches, of which the one which, on the basis of the user data will make the biggest difference to behaviour can be selected.

As was discussed in Chapter 3, data can be combined to make composite performance indicators, which combine several levels of detail in order to simplify interpretation of the results. The decision to present the results of this study at several different levels of composition was based on the opportunity that provides to see how specific issues contribute to the overall performance. In this way, a detailed picture can be obtained of the strengths and weaknesses in performance of each zone over each dimension (driver safety, pedestrian safety, driver mobility, pedestrian mobility). Policy priorities can be identified quickly by looking at the highest level of composition, but the specific areas to be addressed are highlighted by the more detailed performance indicators.

This allows the information used to construct the indicators to be exploited most efficiently; the detail of the data is not “wasted” by high levels of aggregation, but the simplicity of interpretation is maintained by the presentation of one “headline” performance indicator.

10.5 The validity of using performance indicators in the context of safe urban mobility

Outcomes-based measures of safety such as accident and casualty figures have formed the basis of publicly-announced road safety targets in Britain since 1987. The advantages of using measures such as total fatalities, or total numbers of killed or seriously injured casualties include the relative simplicity of interpretation and the fact that data collection is an established process with well-documented definitions and widespread support. It is fair to question the extent to which performance indicators can improve on the traditional approach.

This study has put forward a number of reasons for the inclusion in policy design and monitoring of performance indicators *alongside* outcomes-based measures. These include;

- The smoothing out of random fluctuations in crash or injury data
- Minimisation of the effects of inaccurate or incomplete reporting of accidents and injuries
- Better identification of unsafe conditions, even in cases where accidents have not occurred
- Incorporation of a wider range of information into policy design and monitoring (ETSC, 2001)

This study has explicitly linked safety and mobility as twin goals of urban infrastructure provision: Older road users are at greater risk from traffic than other road user groups, especially in urban areas, hence they must be protected. However, they *need* to access essential services and facilities, and continued independent mobility is highly beneficial to both their physical and mental health). Infrastructure provision must therefore meet these two very different aims. The analysis presented here shows that there ARE trade-offs to be made between safety and mobility, and between different road user groups. This confirms the description by Ewing and Dumbaugh (2009) of safety and mobility as *“conflicting goals, at least in urban areas”*

Ewing and Dumbaugh argue for a better understanding of the interactions between design, behaviour, safety and mobility. The Performance Indicators presented here are one approach which can help to facilitate this better understanding which previous work has shown to be necessary. Unlike outcomes-based measures such as accidents and casualties, performance indicators can use both safety AND mobility variables, in order to explore the trade-offs between the two objectives. They can also use a common methodology such as infrastructure audit in order to gather comparable and compatible data, such as speed limits and the presence or otherwise of grade separation, of on-street parking etc.

Against these advantages, there are disadvantages to using performance indicators. Arguably the biggest disadvantage is the difficulty of validating the performance indicators. Whilst theoretically there should be a “causal relationship” (ETSC, 2001) between a calculated *safety* performance indicator and crashes, in reality, this relationship is difficult to establish and quantify, thanks to the role of exposure to risk and the difficulty of undertaking robust statistical analysis using relatively few accident cases. This difficulty is apparent in Chapter 9, where data concerning fatally injured older drivers was particularly limited. Other limitations of safety performance indicators include;

- The difficulty of selecting the appropriate elements of the traffic system for which to calculate indicators.
- The potential for lack of objectivity in the selection of performance indicators or method of calculation, in order to serve political, rather than road safety objectives.

Similar problems are encountered when trying to establish a link between mobility performance indicators and the impact of barriers on individuals' mobility: Whilst at the margin, a barrier to mobility might dictate an older person's willingness to undertake a journey, identifying where the tipping point lies between feeling able and unable to make a journey (and thus understanding the precise nature of the relationship between barriers to mobility and travel habits) is extremely problematic. A number of confounding factors contribute to the difficulty of linking barriers to mobility and travel habits. These include;

- The highly dynamic nature of the relationship, which is influenced by changing factors such as an individual's mood, their perceptions of their health and capabilities, or even the weather. Barriers such as long detours or poorly-lit paths may not be the decisive factor on a dry, sunny day, but may suddenly seem insurmountable in mid-winter when levels of natural light are lower and being out of doors is already arguably less pleasant.

- The highly personal nature of the relationship: A barrier which would prove decisive to one older road user would not necessarily also be so to another with a different set of motivations, physical capabilities and attitudes.

In the case of both safety and mobility, the lack of detailed, disaggregate exposure data describing where older road users travel to, the modes and routes they choice (and why), and the time taken is a significant barrier to the calculation of scientifically robust Performance Indicators.

However, it should be borne in mind that analysis of outcomes-based measures also suffers from similar limitations. The lack of exposure data is also a significant issue in the monitoring of accident and casualty figures: Without it, a fall in accidents could be explained by an increase in safety (conditions are inherently less risky) a reduction in mobility (fewer users are exposed to the risk), or a combination (in an unknown ratio) of both. Regression to the mean, explained in detail in Chapter 2 is another factor which can distort analysis of accident data, leading to the wrong conclusions being drawn about the effect of policy on reducing risk.

Thus what is being argued for here is the use of performance indicators as way of *complementing* outcomes-based measures. By using a wider range of data, including safety and mobility performance indicators AND outcomes-based measures, policy design and monitoring can be undertaken from more than one perspective. This helps to minimise the limitations of each individual approach and offers the following advantages –

- Conclusions drawn using one approach can be verified using the other
- Policy determination does not reply on few data points (as demonstrated by the analysis of casualties presented in Chapter 9)
- Road safety policy can be fully integrated with a wide range of other, relevant, policy areas such as health, sustainability and economics.

This makes performance indicators a useful policy tool with which to design and monitor safe urban mobility.

10.6 Performance indicators as a tool to re-evaluate past policy successes

As is well-documented, the number of people killed in Britain as a result of road accidents fell steadily up to 2010, with fatalities that year being the lowest since records began in 1926 (DfT, 2011). This represents a policy success, since the number of fatalities has been the key metric against which road safety is measured. However, the results presented suggest that there may be a mismatch between the “official” problem of accidents, defined as that generated through police accident records, and the “unofficial” one, which includes Unreported accident and Non-injury accidents, but also, more nebulous aspects of the problem, such as enforced restrictions on independent mobility caused by older users’ fears about safety, noise, pollution and congestion.. This supports the work of Tight et al (1998) who also distinguished between the “official” and “unofficial” road safety problem.

A reassessment of past policy successes using a Performance Indicator approach would require more complex data, which may not always be readily available. However, reassessment of past policy using a Performance Indicator approach would be able to quantify any unintended negative consequences, such as reductions in walking and cycling, increases in community severance and health impacts of reduced mobility (for example, increased obesity, increases in the incidence of breathing problems such as asthma). It would also help to make more explicit costs which are currently not well documented, not well-understood, or not adequately linked to road safety, despite being relevant.

When safety is addressed in isolation, investment decisions can be based on the cost of remedial works, set against the anticipated reductions in casualties and/or accidents, and the likely cost of those accidents or casualties. Whilst the costs of road accidents are well-documented – in 2011 the estimated value of prevention of road accidents in Great Britain was 315.6 billion (DfT, 2012) - the more nebulous health impacts of a lack of independent mobility are much harder to quantify.

Rather than monitoring road safety (via accidents and casualties) in isolation, Performance Indicators assess safety and mobility as separate but inter-connected aims. Other policy objectives which could be considered alongside road safety using a performance indicator framework might include other health-related indicators such as premature deaths resulting from poor air quality related to vehicle emissions, physical activity levels such as "active commuting" and the popularity of walking and cycling.

10.7 Discussion of results

The key results of the study can be summarised as follows -

- Using a performance indicator framework, it can be concluded that many locations within the case study city do not cater well for the safe mobility of older road users. This conclusion is supported by the user data, which identifies locations where older users can identify the problems they encounter, and locations which they actively avoid. It is also supported by the

Performance Indicator data, which shows that some locations perform very poorly.

- The reasons for this vary from location to location, but it is most apparent at locations where balancing the conflicting needs of different road users is most difficult. For example, at Walsgrave Rd, where there is a popular shopping area, bus services to the city and hospital, and a main arterial route from the city towards key infrastructure such as the hospital and motorway network. This means that guard rail and grade-separated crossings may not be appropriate (because they limit access to the shops and bus stops), but restrictions on vehicle movements may also not be appropriate (because of the need for emergency services to access the hospital as rapidly as possible in emergencies). Pedestrian-only light phases limit the time available for motorised traffic, and other policy objectives such as increased vehicle throughput to reduce congestion may be deemed to be more important.
- Using only outcomes measures of road safety, in isolation from other indicators does not facilitate a broader understanding of the complex interactions between infrastructure design, travel behaviour, traffic risk and individual mobility. These interactions are currently not well understood, especially in the case of driver mobility. There is evidence both in the literature and from the user data collected for this study that older road users avoid infrastructure where they are not confident or feel at risk. Low accident numbers can be indicative of a situation where traffic risk is low, or where the exposure of a particular group of users to the risk is low. Performance

indicators can address this problem by providing more information, as has been demonstrated by this study.

- To some extent, safety and mobility are competing policy ends. However, new thinking such as the creation of “Shared Spaces”, which force road users with different characteristics to share road space, may help to provide the right balance between the two, doing so by creating uncertainty about right of way, and forcing different categories of road users to integrate. This may provide an optimal solution to balancing safety and mobility, at least in central urban areas where pedestrian activity is high and vehicle speeds are already low.
- The presented user data shows that some infrastructure which is introduced to protect users from traffic risk does indeed alter route or mode choice, and that these behavioural changes may provide a partial explanation for subsequent falls in accident or casualty rates, as exposure rates fall for those users in those areas.

These results support existing work in the field: ETSC (2001) argued that accident and casualty data have known limitations, and should be supplemented with a wider range of information. Wegman (2003) argues for a more proactive way of monitoring road safety, which does not depend on accidents occurring for policy to be determined. The calculated Performance Indicators provide a framework which allows for more proactive monitoring of safety, and for the use of a wider range of information to be used.

The focus on older road users reflects the concern that many have expressed about their likely increasing importance as a group (Oxley et al, 1997, Hakamies Blomqvist et al, 2003), whilst the decision to focus on infrastructure results from the work of Sabey and Taylor (1980) who suggest that modifications to the road environment provide more immediate and more cost-effective solutions to safety issues than efforts to effect behaviour change. This study demonstrates a way of identifying infrastructure which currently does not meet the needs of older road users, and the measures that should be taken to improve it. Such modifications to infrastructure are likely to be more cost-effective and provide more immediate results than measures such as additional training for older drivers, as explained by Sabey and Taylor (1980)

Maintaining safe mobility for older road users has been shown to be important by a number of previous studies (Maratolli et al 1997, Glass et al, 1999). However, existing studies have suggested that mobility is a concept that is poorly researched, not well understood, and not properly integrated into policy (Dumbaugh, 2008). One explanation for this may lie in the difficulty of integrating mobility into accident and casualty reduction policies. Previous studies have explored the possibility that at least some of the success in reducing traffic fatalities over recent decades may be explained by reductions in exposure for certain road user groups (Davis 1996). The results of this study provide further evidence that this may be the case for vulnerable road user groups such as older pedestrians, or for certain infrastructure types, by showing that they *do* have issues with certain locations along the network, and that some actively avoid certain locations. . This study also demonstrates a way in which mobility *can* be better integrated into policy, and can be monitored alongside other policy objectives such as road safety, using a compatible methodology.

The results are important because they propose a framework within which some of these issues can be explored further. Road safety audit is a well-documented methodology which can be applied in the context of both safety and mobility, in order to understand mobility better, and to integrate it into road safety policy design. Infrastructure design has been shown to affect, not only road safety, but a broader range of related policy objectives. Providing for the continued independent mobility of older road users has been shown to be important for health, therefore it is essential that some way be found of measuring and monitoring it.

10.8 Implications for policy

The results of this study show that monitoring accident and casualty figures in isolation from other indicators does not provide a full picture of the impact of road infrastructure design on safe mobility for older road users.

When assessing a very specific issue, such as this, too few data points are available from casualty data for statistically robust analysis. In addition, some of the broader implications of policy (such as reductions in walking) do not become apparent.
Existing mobility indicators do not focus specifically on the problems faced by older road users, tending to include them within other disadvantaged groups such as parents with pushchairs, wheelchair users or those without access to a car. This means that the question of safe mobility for older divers has tended to be ignored.

However, policies which discourage older people from driving would, on average increase their exposure to traffic risk.

King (2004) states that

“The road environment can be changed to make it easier for drivers to continue driving longer, and for older pedestrians to walk safely”

This study has identified some of the features which make it more difficult and less safe for older road users to remain independently mobile. It has also highlighted some of the consequences of a lack of independent mobility for older people.
A monitoring framework which took a broader view than just accident and casualty monitoring could help to promote continued safe mobility and thus reduce some of the negative consequences highlighted. Key policy recommendations which follow on from this study include;

- The use of a wider range of information in the design of road safety policy, in order to that the broader implication of road safety measures can be assessed.
- Further research into the mobility problems faced by older drivers, as they are likely to become an increasingly important group.
- A rigorous debate into the appropriate balance between safety and mobility for different road user groups in urban areas, following on from which it may be necessary for that balance to be changed, with more resources dedicated

to facilitating continued independent mobility for older road users, and improved infrastructure for users of more “benign modes” such as walking and public transport.

In many cases the decisions about which group or objective should be prioritised is a political one. Some may argue that in the central zones of cities, where shops, train stations and other facilities are located, pedestrian safety and mobility should be prioritised ahead of driver mobility. However, for cities such as Coventry, with good transport links and other popular shopping centres nearby, this runs the risk of affecting the viability of local businesses, as some consumers choose other centres where they feel driving and parking are easier.

10.9 Study limitations

One of the key limitations relates to the selection of over 65s as being “Older road users”. As was stated in the introduction, this was done in order to be consistent with the definitions adopted by commonly-used accident databases. However, ageing is a process which affects individuals in very different ways; whilst some over 65s may well have experienced age-related changes which affect their ability to successfully negotiate traffic (whether as drivers or pedestrians), others will be as capable as younger people. In terms of their safety, the higher injury and fatality rate of older drivers is largely the result of their greater physical frailty, not greater accident involvement (Davidse, 2008).

A number of key limitations have been associated with Performance Indicators as a measure. These include –

- The difficulty of establishing the precise nature of the relationship between the calculated indicators and safety or mobility
- The difficulty of weighting the indicators so that the relative importance of different influences on safety and mobility can be reflected in the score
- The possibility that they invite simplistic conclusions, or can be subject to political interference (for example, in the selection of performance indicators or in the calculation process)
- The fact that different calculation methods will give different results.

In addition, the indicators presented here are highly experimental. As a result, it could also be argued that these particular indicators may not capture the right information (this may be particularly true of the driver mobility performance indicator). This study has attempted to explore the relationship between the calculated indicators and safety and mobility by comparing with accident data (to validate the safety indicators) and by incorporating user data (to validate the mobility indicators). Both of these approaches are subject to some limitations. In the case of safety Performance Indicators, the known limitations are –

- The limitations of accident data itself. These have been explained previously, but include missing and incomplete data and the very small number of accident cases (especially in the case of older drivers). In addition, in the accident data presented here, it was not known whether the older road user was responsible for the accident, only that they were fatally injured. Were it possible to look only at accidents where an older road user made an error which resulted in an accident or casualty the data might suggest different conclusions.

- The difficulty of using accident or fatality numbers without detailed disaggregated exposure data.

In the case of the mobility Performance Indicators, the limitations of the user dater include –

- The small number of cases
- The selection of participants, most of whom did not have particular physical limitations. This may have led them to identify different locations or features from those which would have been identified by participants who had more significant mobility issues.

The decision not to weight the indicators is one which affects the relationship between the calculated indicators and safety or mobility, as features which have a greater or lesser impact on safety or mobility should, theoretically contribute more to the overall scores. The advantage of using un-weighted indicators is their relative simplicity (both in calculation and interpretation), however, it is unlikely that the variables incorporated into the calculations do have the same impact on older people's safety and mobility. It would be useful to explore ways of understanding which factors do have the biggest impact on safe mobility and which of the dimensions (safety and mobility, drivers and pedestrians) users value most highly. This could then be used to derive a method for weighting the indicators. It would then be possible to design policy responses which reflected the importance placed on different features by users. The lack of weighting is a serious limitation of the calculated Performance Indicators, and one which further developments of the indicators would seek to address.

The selection of Coventry as a case study city also gives rise to some limitations: As has been stated, Performance Indicators are relative measures of performance. Whilst some locations have been identified as performing poorly or performing well using this methodology, in reality, that performance is only relative to the other zones included in the study. What is not known is whether Coventry is typical of similar UK cities or not. Being able to compare the scores from more than one city would not only aid an understanding of the current "state of the art" in infrastructure design for safe mobility, it would also help to identify areas of best practice, which could then form the basis of policy recommendations. Comparison with cities in other countries could also help to identify novel approaches to the problem of reconciling competing user demands in complex urban areas. In addition, the extension of the methodology to other areas would enable a greater number of accident cases and case studies to be incorporated. Whilst these would, to some extent, be subject to the same limitations outlined here, it would offer the possibility of including a larger number of cases, thus helping to address the issue of too few data points being available.

10.10 Conclusions

The presented indicators suggest that more could be done to promote safe mobility for older road users in urban areas, and that Performance Indicators is an approach which offers potential in measuring and monitoring it. The data from users themselves supports both the importance to older users of safe mobility, but also the contention that it is currently not well provided for in some locations. The importance of maintaining continued independent safe mobility for older people has been established, against the background of the likely increasing importance of this group as the population ages.

The main safety and mobility issues which affect older road users in urban areas are poor infrastructure design which does not adequately protect them from risk in traffic or does so only at the expense of hindering their mobility. This research presents numerous examples of infrastructure which older users themselves found problematic, either because they found it stressful and difficult to drive around, or inconvenient and intimidating to walk round. In general, both safety and mobility issues were worst where the competing demands on road space were highest.

Analysis of the issues undertaken using a Performance Indicator approach offers a different perspective on the problem. Accident numbers were low across both categories (those involving older drivers and those involving older pedestrians), making scientifically robust conclusions difficult, even when using 10 years' worth of data. However, even in areas seemingly designed for higher safe speeds (for example, with dedicated pedestrian infrastructure, grade separation of motorised and non-motorised traffic flow) there were still fatal accidents. There was also evidence that exposure to risk of older road users at these locations was relatively low (i.e. many older road users actively avoided the locations), and barriers to mobility were high. Thus by adopting a Performance Indicator approach it is possible to use a wider range of information when making policy design, implementation and monitoring decisions, and thereby gain a different perspective on the issues.

Future work should look at ways of refining the indicators so that they better reflect the actual impact on safe mobility of the features encountered. This could be done by;

- Looking in more depth at the issue of driver mobility
- Weighting the indicators
- Refining the variables used in the calculations, so that there is likely to be less correlation between them (for example, factors such as number of lanes, speed limit, presence of guard rail are likely to be correlated to some degree)
- Calculating indicators for specific locations, rather than zones, so that the final indicator values are not confused by the incorporation of locations with different characteristics.
- More scientific data collection, for example, using GPS or in-vehicle data recorders to gather more accurate data about factors such as driver reaction times, driver workload, travel times or physical infrastructure features.

The analysis could also be extended by the inclusion of a broader range of indicators, for example, reflecting factors such as air quality.

It is considered that this thesis has addressed the stated objectives, which were

- To define the key safety and mobility issues that affect older road users in urban areas.
- To explore the conflict that sometimes arises between the need to implement safety measures to protect vulnerable road users, and the desirability of promoting continued independent mobility for such groups.
- Based on the issues defined, to calculate and validate a series of appropriate and relevant Performance Indicators for the safe mobility of older road users in urban areas.
- To evaluate the validity of using Performance Indicators in the road safety context, and the relevance of the specific indicators proposed
- To measure the success of past initiatives by reference to those Performance Indicators, and identify any significant differences between the conclusions suggested by the two different types of measure.

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Appendix A – Questionnaire Returns

Ergonomics and Safety Research Institute
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Tel. 01509 226900 Fax: 01509 29600
E-mail: l.k.rackliff@lboro.ac.uk www.lboro.ac.uk

Loughborough University

We are trying to identify particular types of road design that older drivers find problematic. Please could you assist us by filling in this form.

Age 60+ Gender: Male/[✓ Female] (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): TOLL BAR ROUNDABOUT.

Road name (s): FROM BAGINTON VILLAGE ONTO THE JUNCTION.

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

Many large lorries – from airport + industrial estate converging onto 2 roundabouts only metres apart. Very intimidating for car – visibility for oncoming traffic very restricted.

F

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Traffic lights on 3 of the junctions on the island could be expanded to at least 4 – to accommodate this heavy traffic.

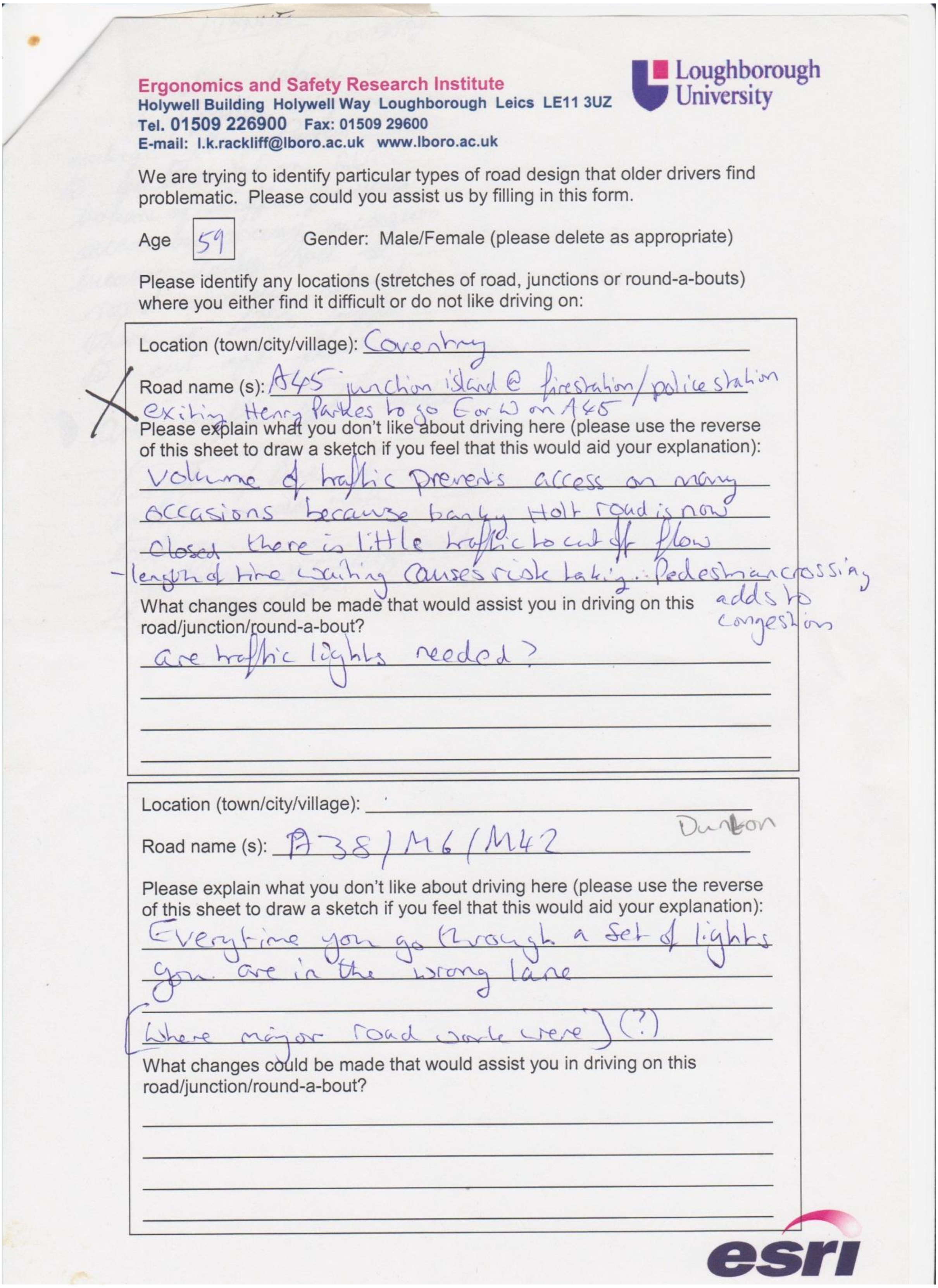
Location (town/city/village): ____________________

Road name (s): ____________________

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

esri



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Age 59 Gender: Male/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): Coventry

X Road name (s): A45 junction island @ firestation/police station exiting Henry Parkes to go E or W on A45

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

volume of traffic prevents access on many accasions because banky Holt road is now closed there is little traffic to cut off flow - length of time waiting causes risk taking. Pedestrian crossing adds to congestion

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

are traffic lights needed?

Location (town/city/village):

Road name (s): A38/M6/M42 Dunton

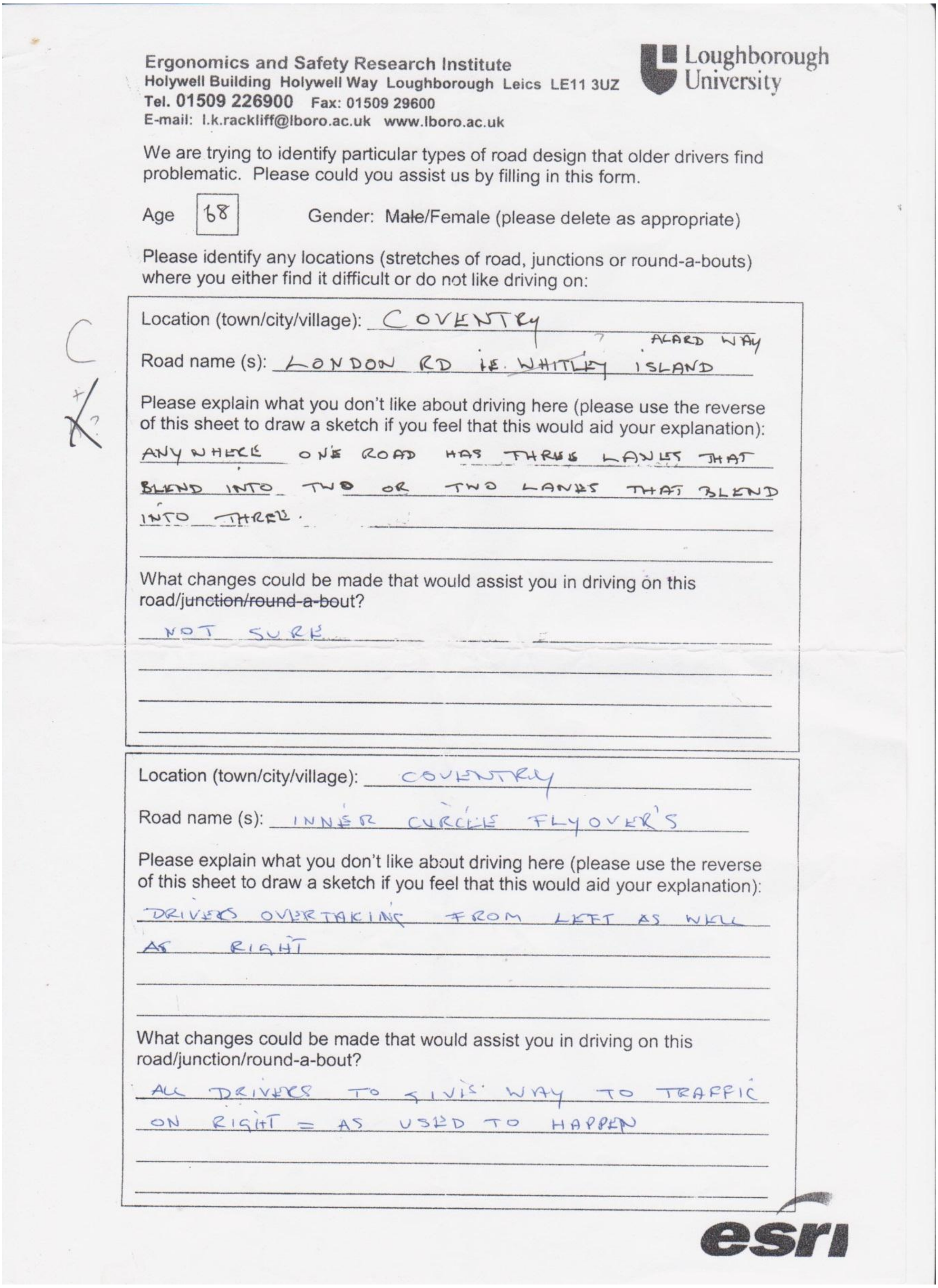
Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

Everytime you go through a set of lights you are in the wrong lane

[Where major road works were] (?)

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

esri



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Loughborough University

We are trying to identify particular types of road design that older drivers find problematic. Please could you assist us by filling in this form.

Age 68 Gender: ~~Male~~/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

C

Location (town/city/village): COVENTRY

Road name (s): LONDON RD I.E. WHITLEY ISLAND ? ALARD WAY

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

ANYWHERE ONE ROAD HAS THREE LANES THAT BLEND INTO TWO OR TWO LANES THAT BLEND INTO THREE.

What changes could be made that would assist you in driving on this road/~~junction/round-a-bo~~ut?

NOT SURE

Location (town/city/village): COVENTRY

Road name (s): INNER CIRCLE FLYOVER'S

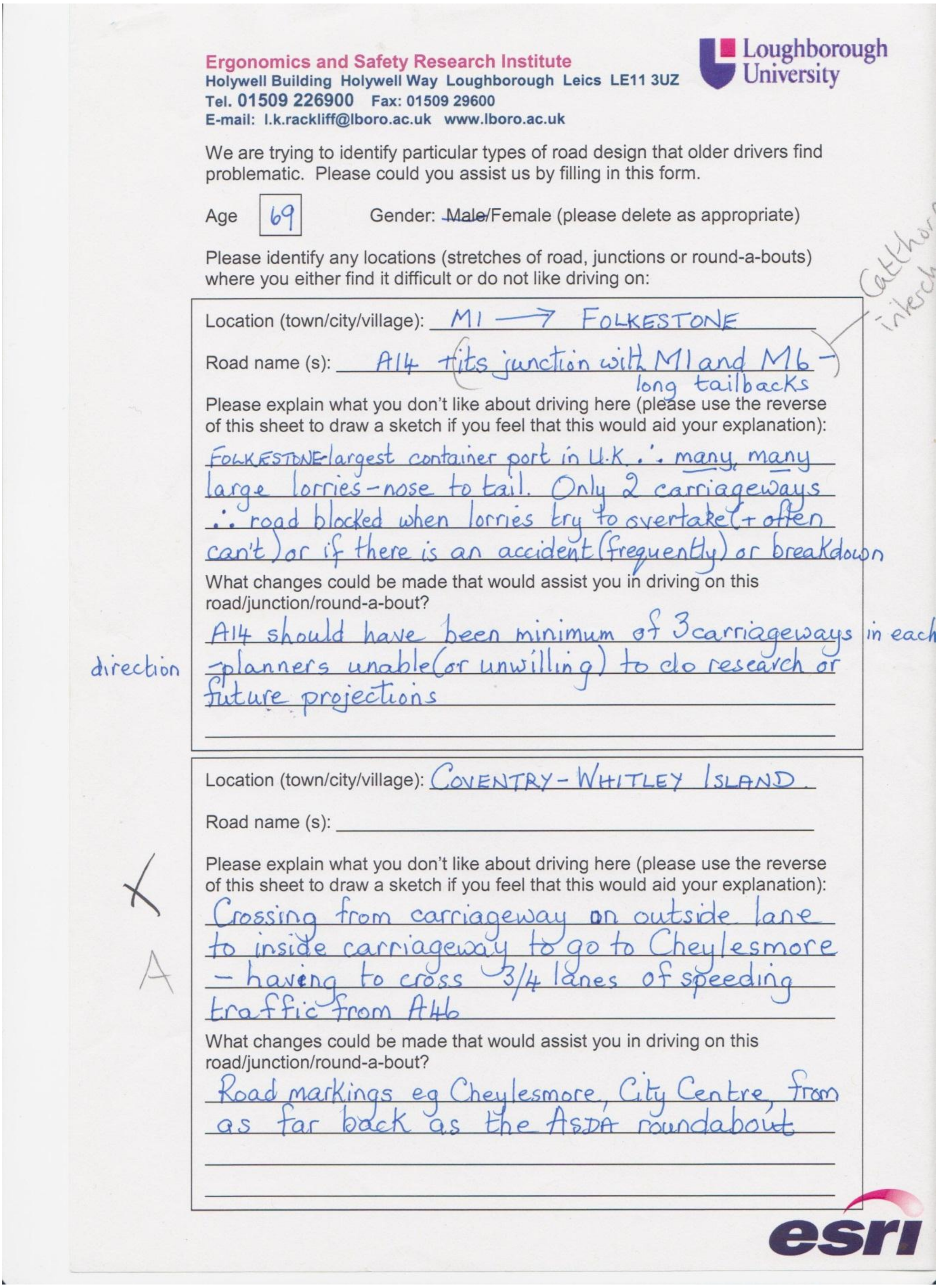
Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

DRIVERS OVERTAKING FROM LEFT AS WELL AS RIGHT

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

ALL DRIVERS TO GIVE WAY TO TRAFFIC ON RIGHT = AS USED TO HAPPEN

esri



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Age 69 Gender: ~~Male~~/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Catthor
intersch

Location (town/city/village): M1 → FOLKESTONE

Road name (s): A14 + its junction with M1 and M6 – long tailbacks

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

FOLKESTONE-largest container port in U.K. ∴ many, many large lorries-nose to tail. Only 2 carriageways ∴ road blocked when lorries try to overtake (+ often can't) or if there is an accident (frequently) or breakdown

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

A14 should have been minimum of 3 carriageways in each direction -planners unable (or unwilling) to do research or future projections

Location (town/city/village): COVENTRY - WHITLEY ISLAND.

Road name (s):

X
A

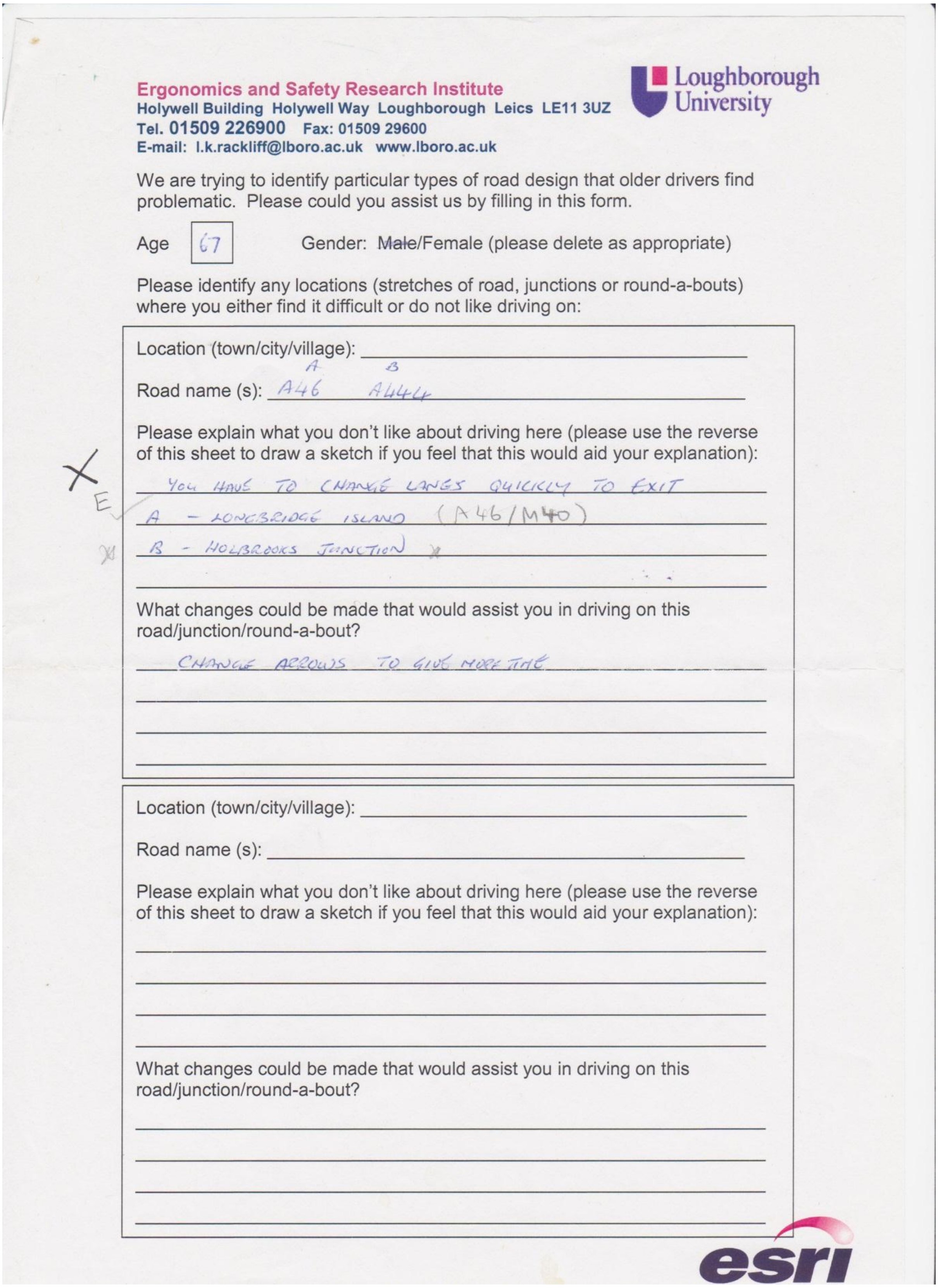
Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

Crossing from carriageway on outside lane to inside carriageway to go to Cheylesmore – having to cross 3/4 lanes of speeding traffic from A46

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Road markings eg Cheylesmore, City Centre, from as far back as the ASDA roundabout

esri



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Age 67 Gender: ~~Male~~/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village):

Road name (s): A A46 B A444

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

X E

YOU HAVE TO CHANGE LANES QUICKLY TO EXIT

A – LONGBRIDGE ISLAND (A46/M40)

B – HOLBROOKS JUNCTION

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

CHANGE ARROWS TO GIVE MORE TIME

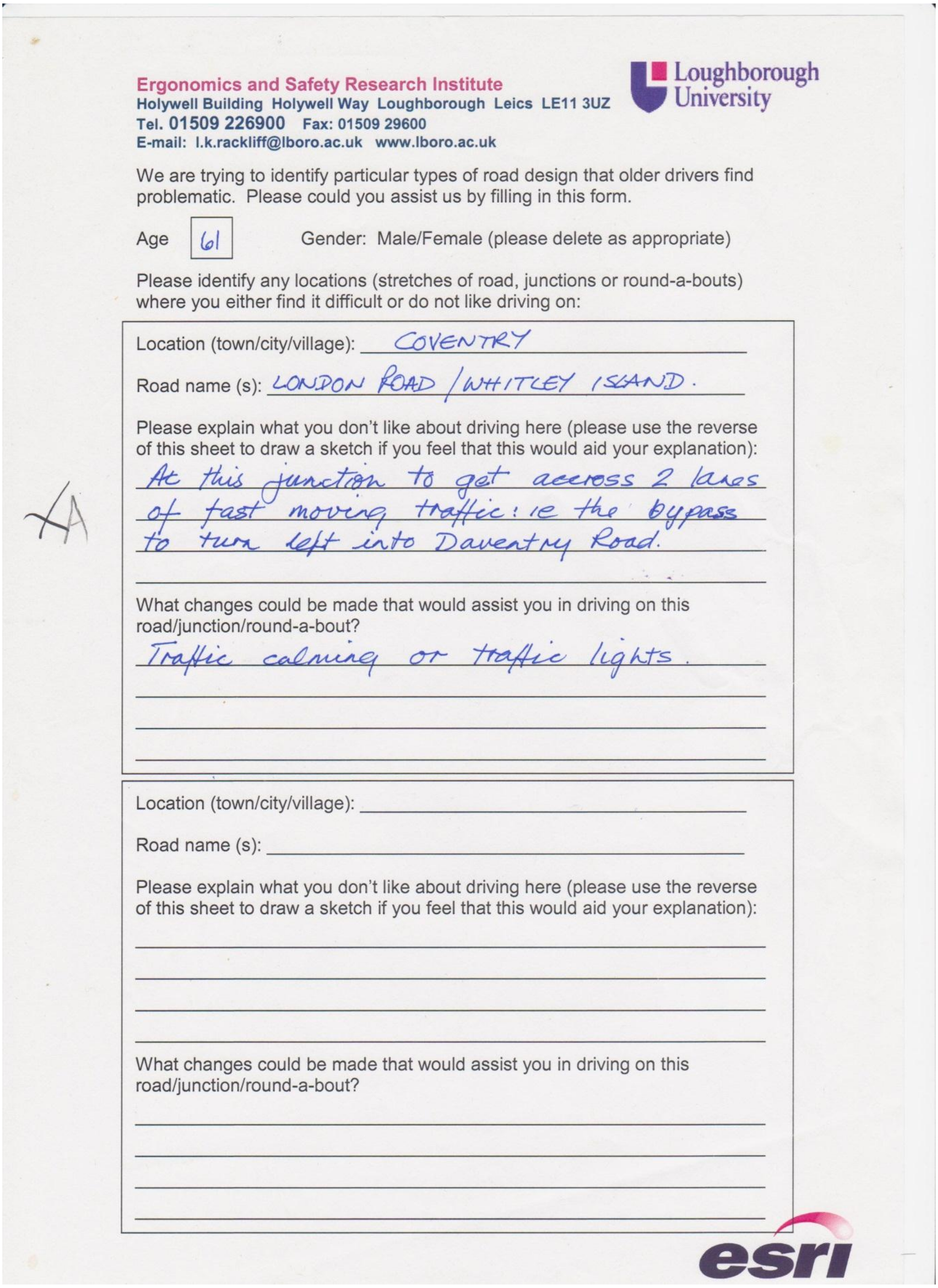
Location (town/city/village):

Road name (s):

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

esri



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We are trying to identify particular types of road design that older drivers find problematic. Please could you assist us by filling in this form.

Age 61 Gender: Male/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

4A

Location (town/city/village): COVENTRY

Road name (s): LONDON ROAD / WHITLEY ISLAND.

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

At this junction to get accross 2 lanes of fast moving traffic: ie the bypass to turn left into Daventry Road.

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Traffic calming or traffic lights.

Location (town/city/village):

Road name (s):

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

esri

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Age 63

Gender: ~~Male~~/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): FROM RYTON. A45 → COVENTRY

Road name (s): To LONDON RD to get to Humber RD.

F (c)

~~A/E~~

X

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

I ALWAYS GET IN CORRECT LANE BUT I AM UNEASY - To take the 3rd EXIT IT WOULD BE GOOD IF THE LANE WAS MARKED Willenhall ON THE ACTUAL ROAD. (Still called SUICIDE ISLAND)

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Location (town/city/village): COVENTRY

Road name (s): BINLEY RD. - Traffic Lights Church LANE

G

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

ROAD MARKINGS WERE ALTERED FOR A SHORT TIME TO SAY INSIDE LANE LEFT TO Church LANE. IT'S BEEN ALTERED BACK TO ORIGINAL LEFT OR STRAIGHT AHEAD - DRIVERS STILL GET MIFFED + TRY TO BEAT YOU TO THE BOLLARDS AT "The Biggin"

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

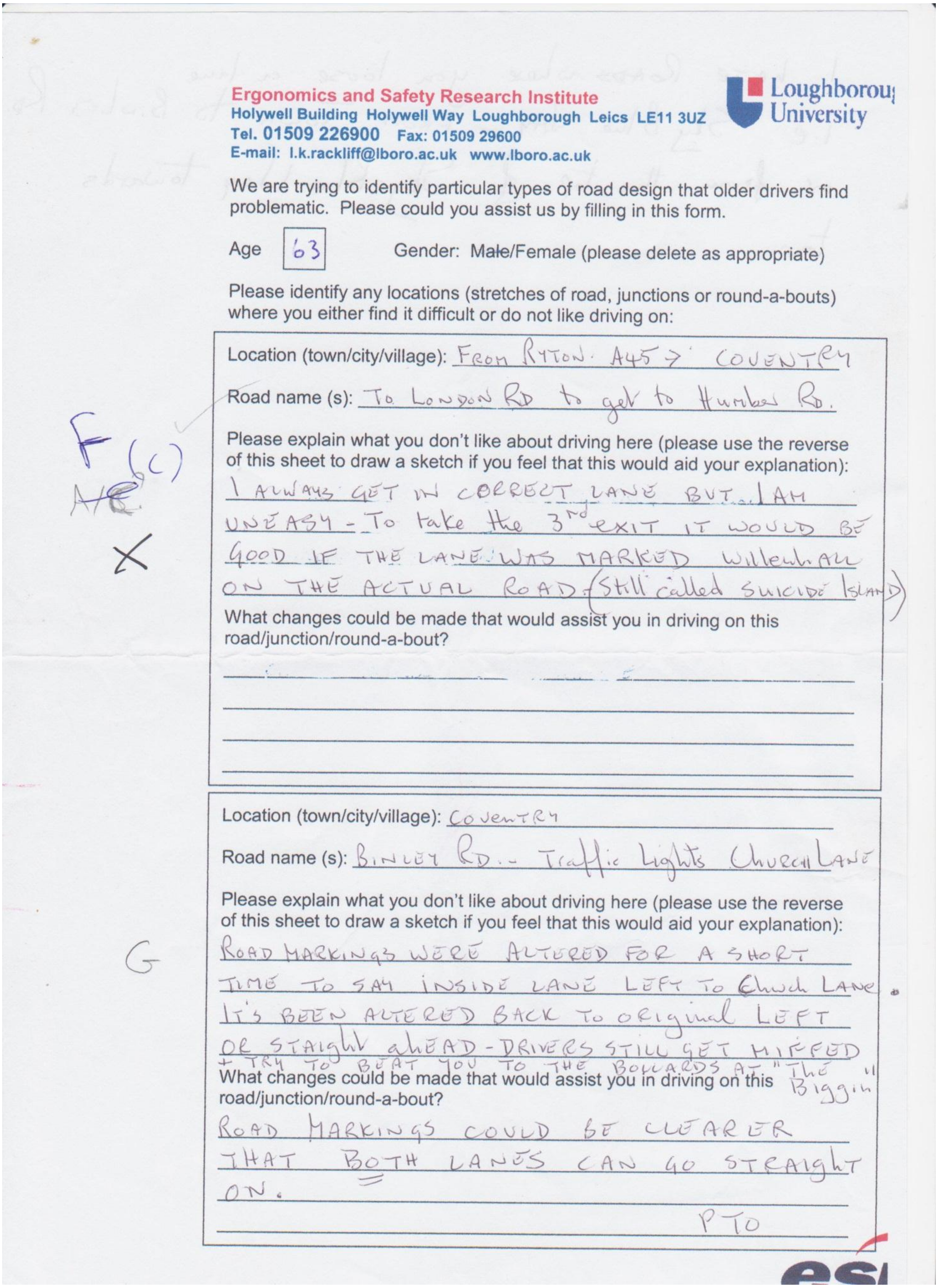
ROAD MARKINGS COULD BE CLEARER THAT BOTH LANES CAN GO STRAIGHT ON.

PTO

I HATE ROADS where you loose a lane i.e Sky Blue WAY FROM Town to B.inl

or from the top of Sky Blue WAY toward

town.



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Age 63

Gender: ~~Male~~/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): From Rytton. A45 → Coventry

Road name (s): To London Rd to get to Humber Rd.

F (c)

~~A/E~~

X

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

I always get in correct lane but I am uneasy - To take the 3rd exit it would be good if the lane was marked Willenhall on the actual road. (Still called Suicide Island)

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Location (town/city/village): Coventry

Road name (s): Binley Rd.. - Traffic Lights Church Lane

G

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

Road markings were altered for a short time to say inside lane left to Church Lane. It's been altered back to original left or straight ahead - drivers still get miffed + try to beat you to the bollards at "The Biggin"

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Road markings could be clearer that both lanes can go straight on.

PTO

is possible to see a distant signal and mistake it for the one you should be following.

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Loughborough University

We are trying to identify particular types of road design that older drivers find problematic. Please could you assist us by filling in this form.

Age 63 Gender: ~~Male/~~Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

F

Location (~~town~~/city/~~village~~): COVENTRY

Road name (s): LONDON RD. / A45 JUNCTION (TOLL BAR END)

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

1) HEADING WEST/NORTH - LANES VERY DIFFICULT TO FOLLOW ESP. HEADING TO CITY CENTRE.
2) SPEED/VOLUME OF TRAFFIC MAKE IT DIFFICULT TO EXIT B4110 ON TO A45 OR A46.

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

1) CLEARER LANE MARKINGS
2) LIGHTS TO EXIT B4110
3) TRAFFIC CALMING ?

Location (~~town/city/village~~): COVENTRY A444 - RICOH ARENA APPROACH.

Road name (s):

7

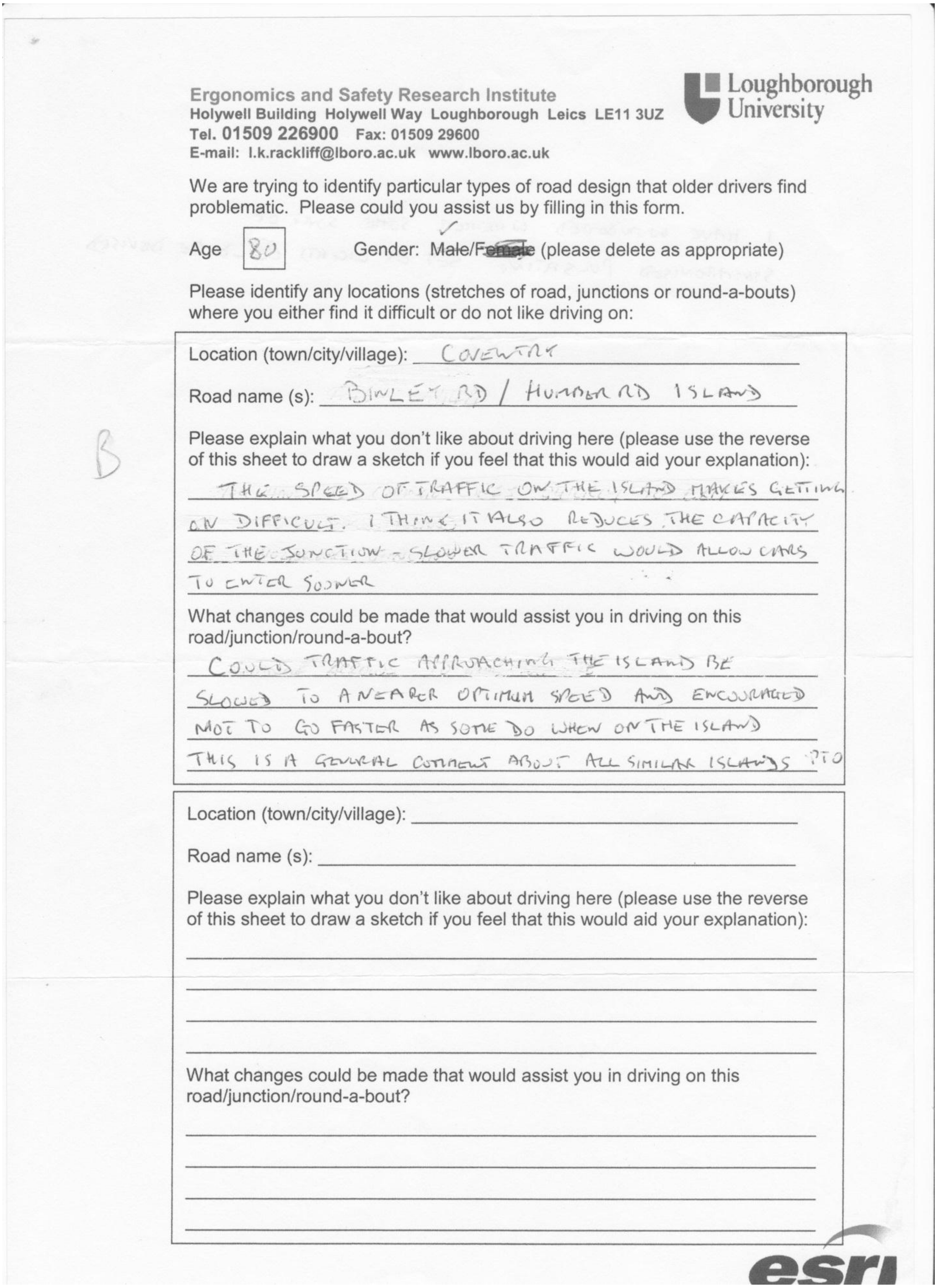
Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

1) VOLUME OF TRAFFIC 2) SPEED OF TRAFFIC
3) NUMBER OF LANES.
People unfamiliar with the road switch lanes, clearer dedication of lanes could ease confusion.

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Because of the number of lanes, with inadequate early warning of changes in direction markings people switch too quickly. Traffic light sighting is poor because it

esri



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Age 80 Gender: ✓ Male/~~Female~~ (please delete as appropriate)

B

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): COVENTRY

Road name (s): BINLEY RD / HUMBER RD ISLAND

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

THE SPEED OF TRAFFIC ON THE ISLAND MAKES GETTING ON DIFFICULT. I THINK IT ALSO REDUCES THE CAPACITY OF THE JUNCTION - SLOWER TRAFFIC WOULD ALLOW CARS TO ENTER SOONER

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

COULD TRAFFIC APPROACHING THE ISLAND BE SLOWED TO A NEARER OPTIMUM SPEED AND ENCOURAGED NOT TO GO FASTER AS SOME DO WHEN ON THE ISLAND THIS IS A GENERAL COMMENT ABOUT ALL SIMILAR ISLANDS PTO

Location (town/city/village): ______

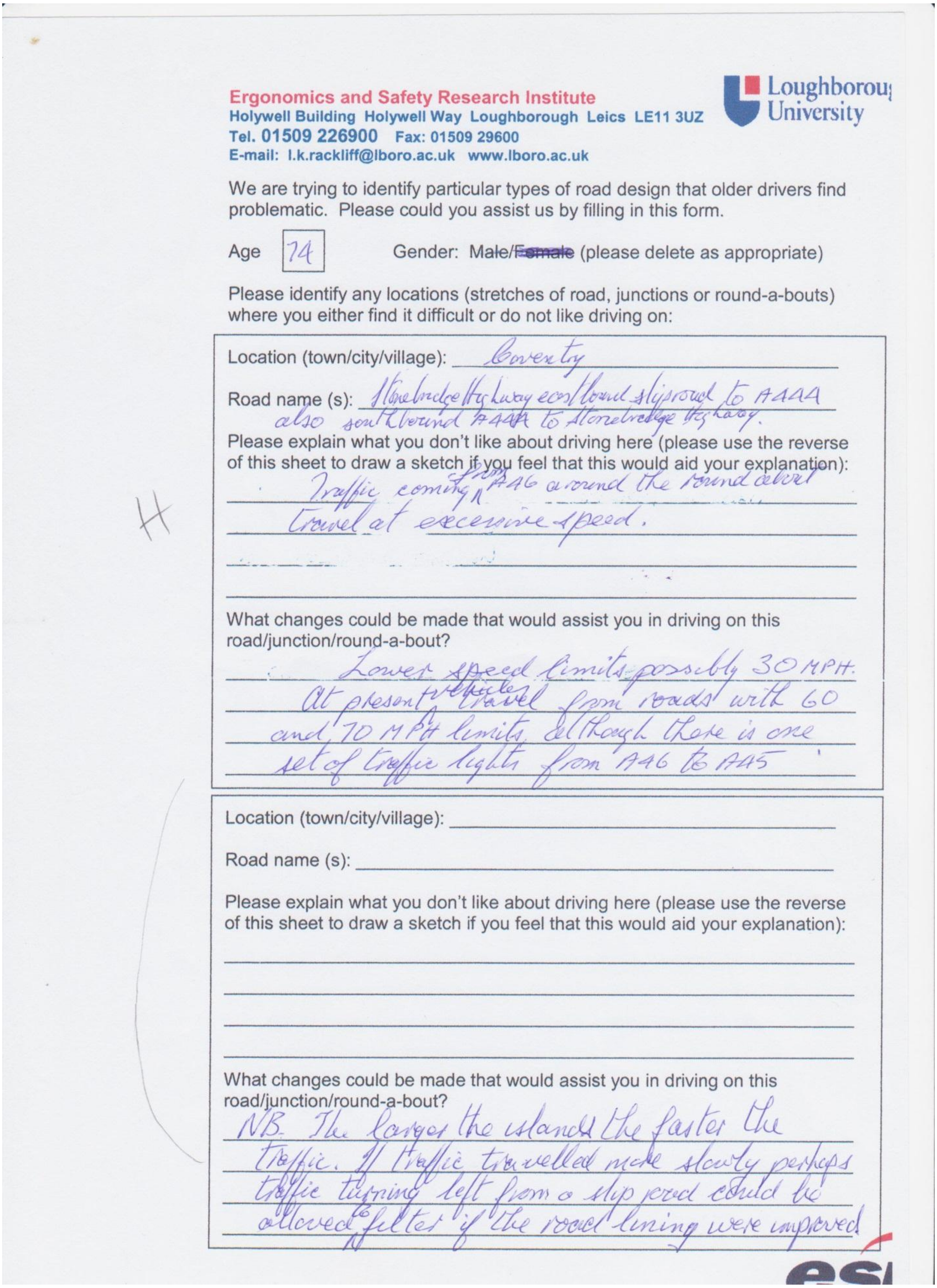
Road name (s): ______

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

______

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

______



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Age 74 Gender: Male/~~Female~~ (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

H

Location (town/city/village): Coventry

Road name (s): Stonebridge Highway eastbound sliproad to A444 also southbound A444 to Stonebridge Highway.

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

Traffic coming from A46 around the round about travel at excessive speed.

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Lower speed limits possibly 30 MPH. At present vehicles travel from roads with 60 and 70 MPH limits, although there is one set of traffic lights from A46 to A45

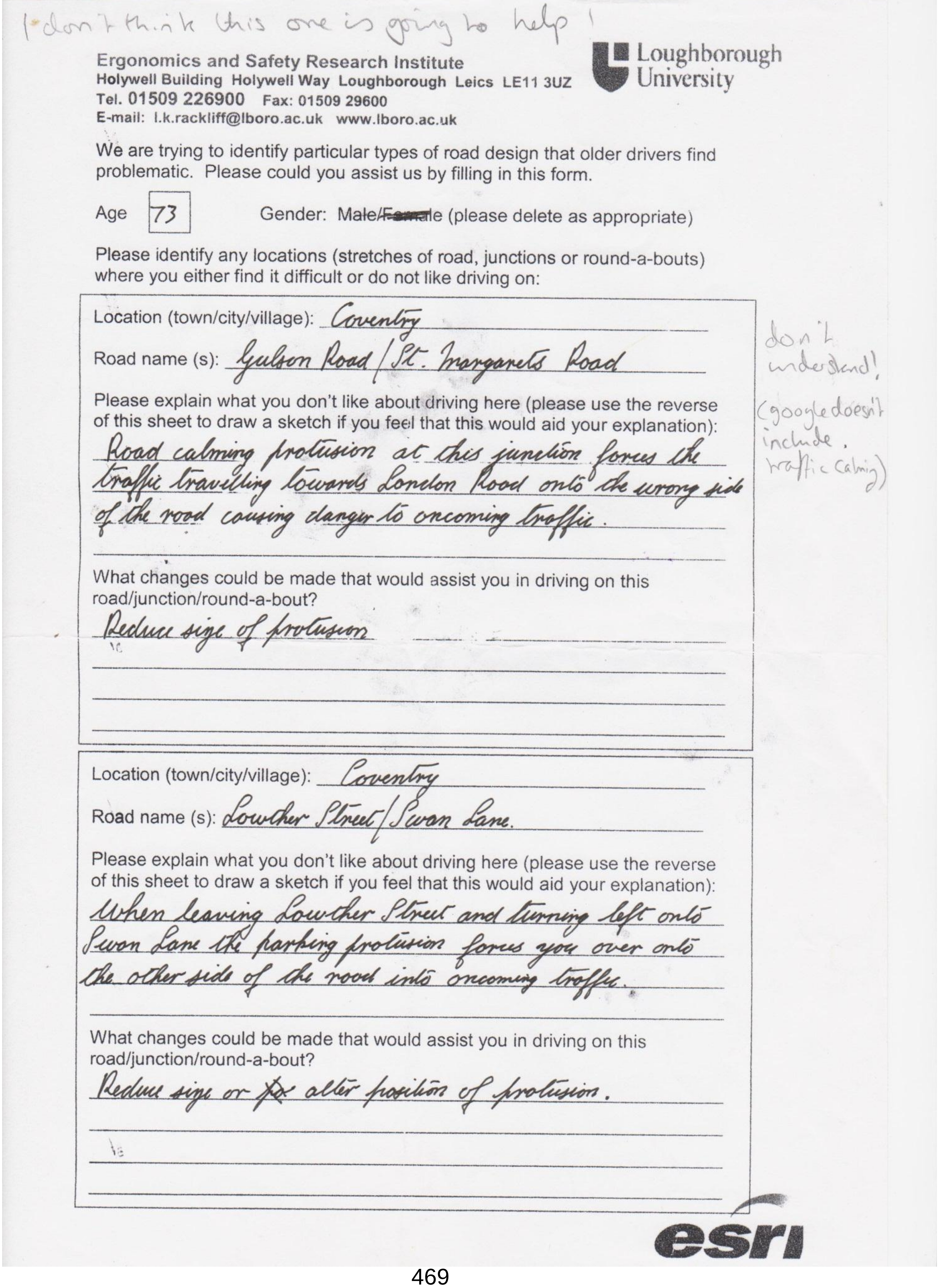
Location (town/city/village):

Road name (s):

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

NB. The larger the islands the faster the traffic. If traffic travelled more slowly perhaps traffic turning left from a slip road could be allowed to filter if the road lining were improved



I don't think this one is going to help!

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Age 73 Gender: Male/~~Female~~ (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): Coventry

Road name (s): Gulson Road / St. Margarets Road

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

Road calming protusion at this junction forces the traffic travelling towards London Road onto the wrong side of the road causing danger to oncoming traffic.

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Reduce size of protusion

don't understand! (google doesn't include traffic calming)

Location (town/city/village): Coventry

Road name (s): Lowther Street / Swan Lane.

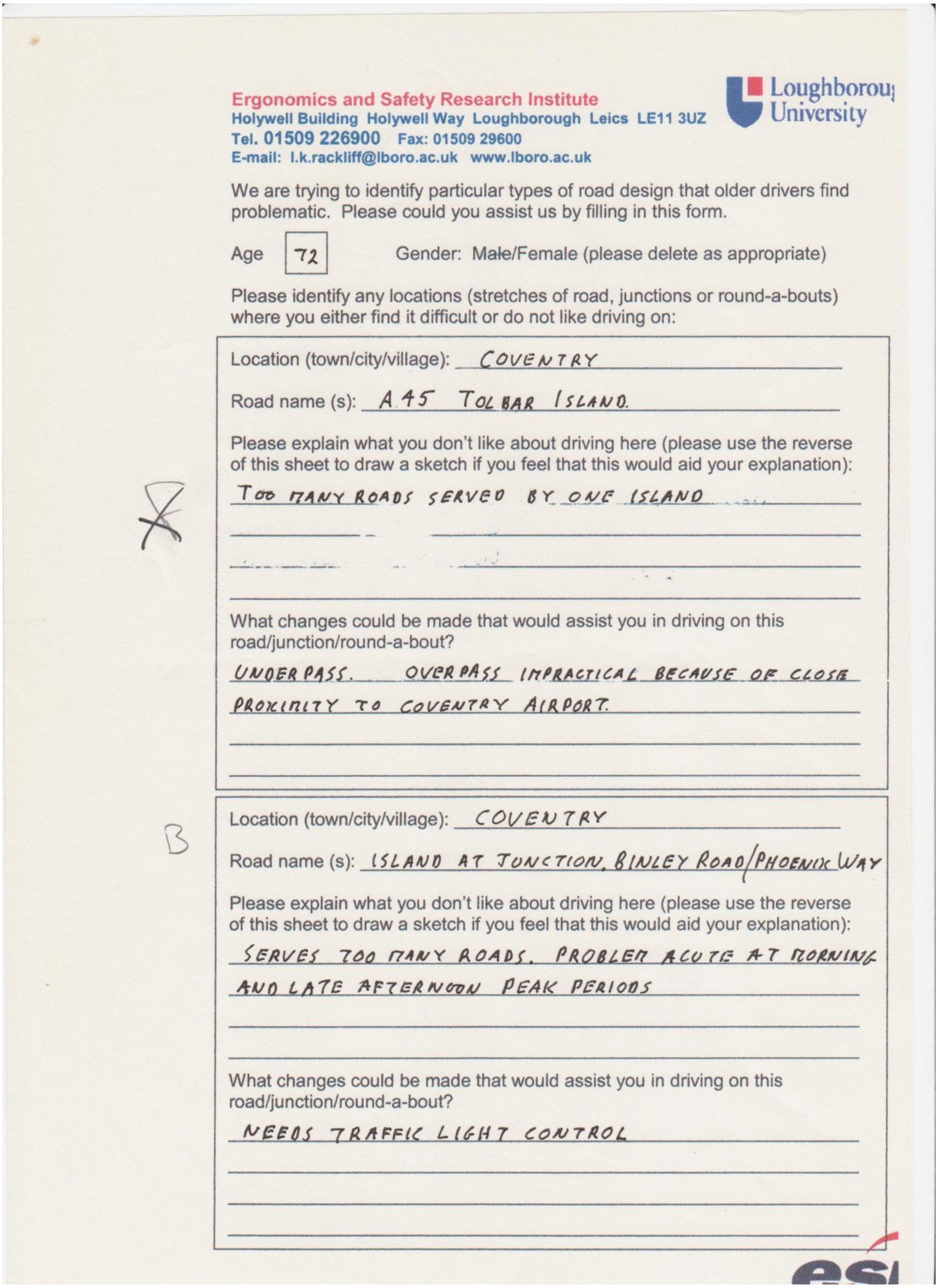
Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

When leaving Lowther Street and turning left onto Swan Lane the parking protusion forces you over onto the other side of the road into oncoming traffic.

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Reduce size or ~~pl~~ alter position of protusion.

esri



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We are trying to identify particular types of road design that older drivers find problematic. Please could you assist us by filling in this form.

Age: 72

Gender: ~~Male~~/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

A

Location (town/city/village): COVENTRY

Road name (s): A.45 TOLBAR ISLAND.

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

TOO MANY ROADS SERVED BY ONE ISLAND

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

UNDERPASS. OVERPASS IMPRACTICAL BECAUSE OF CLOSE PROXIMITY TO COVENTRY AIRPORT.

B

Location (town/city/village): COVENTRY

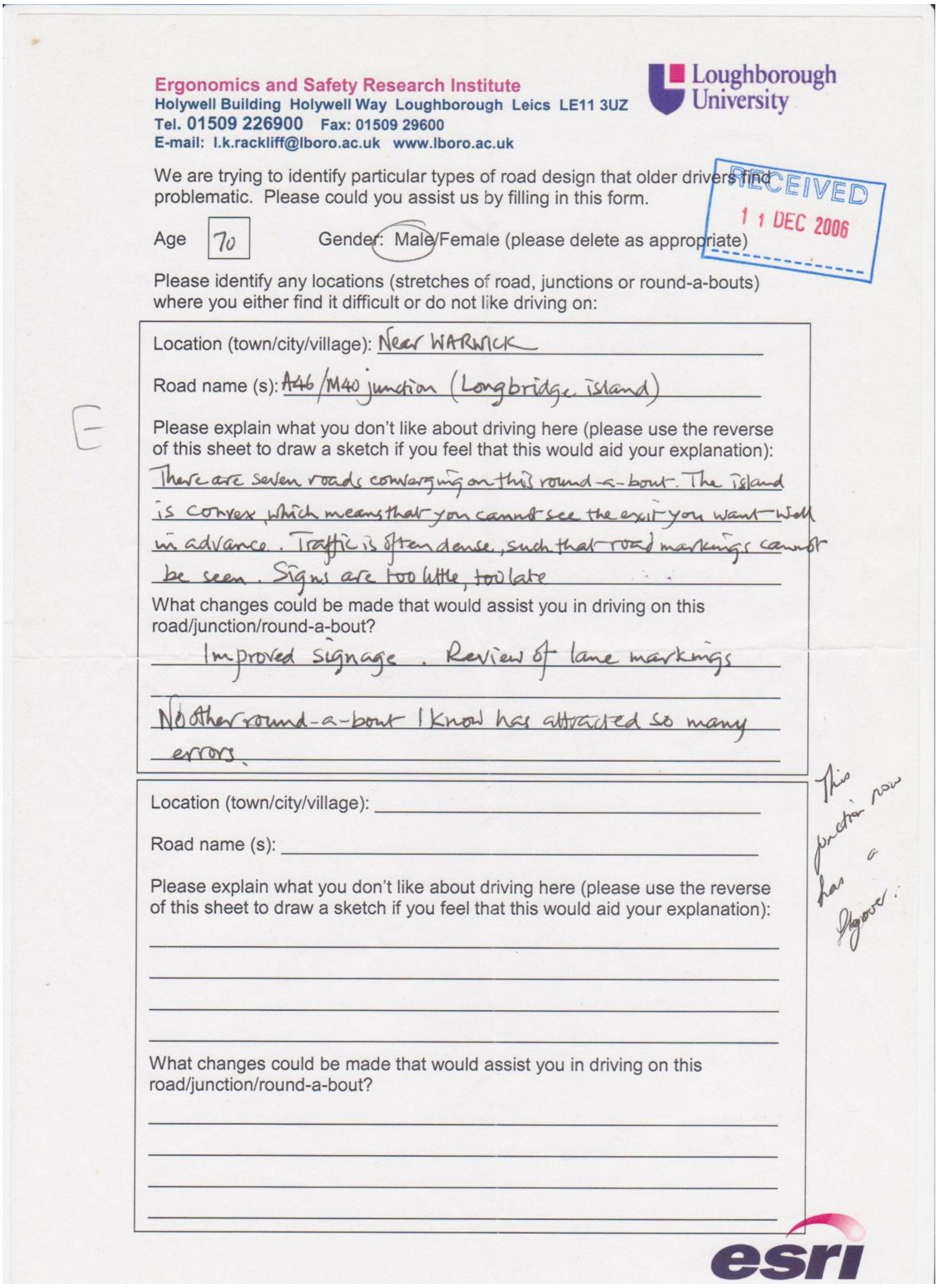
Road name (s): ISLAND AT JUNCTION, BINLEY ROAD/PHOENIX WAY

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

SERVES TOO MANY ROADS. PROBLEM ACUTE AT MORNING AND LATE AFTERNOON PEAK PERIODS

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

NEEDS TRAFFIC LIGHT CONTROL

**Ergonomics and Safety Research Institute**
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11 DEC 2006

We are trying to identify particular types of road design that older drivers find problematic. Please could you assist us by filling in this form.

Age 70 Gender: [✓ Male]/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

E

Location (town/city/village): Near WARWICK

Road name (s): A46/M40 junction (Longbridge island)

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

There are seven roads converging on this round-a-bout. The island is convex, which means that you cannot see the exit you want well in advance. Traffic is often dense, such that road markings cannot be seen. Signs are too little, too late

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Improved signage. Review of lane markings

No other round-a-bout I know has attracted so many errors.

This junction now has a flyover.

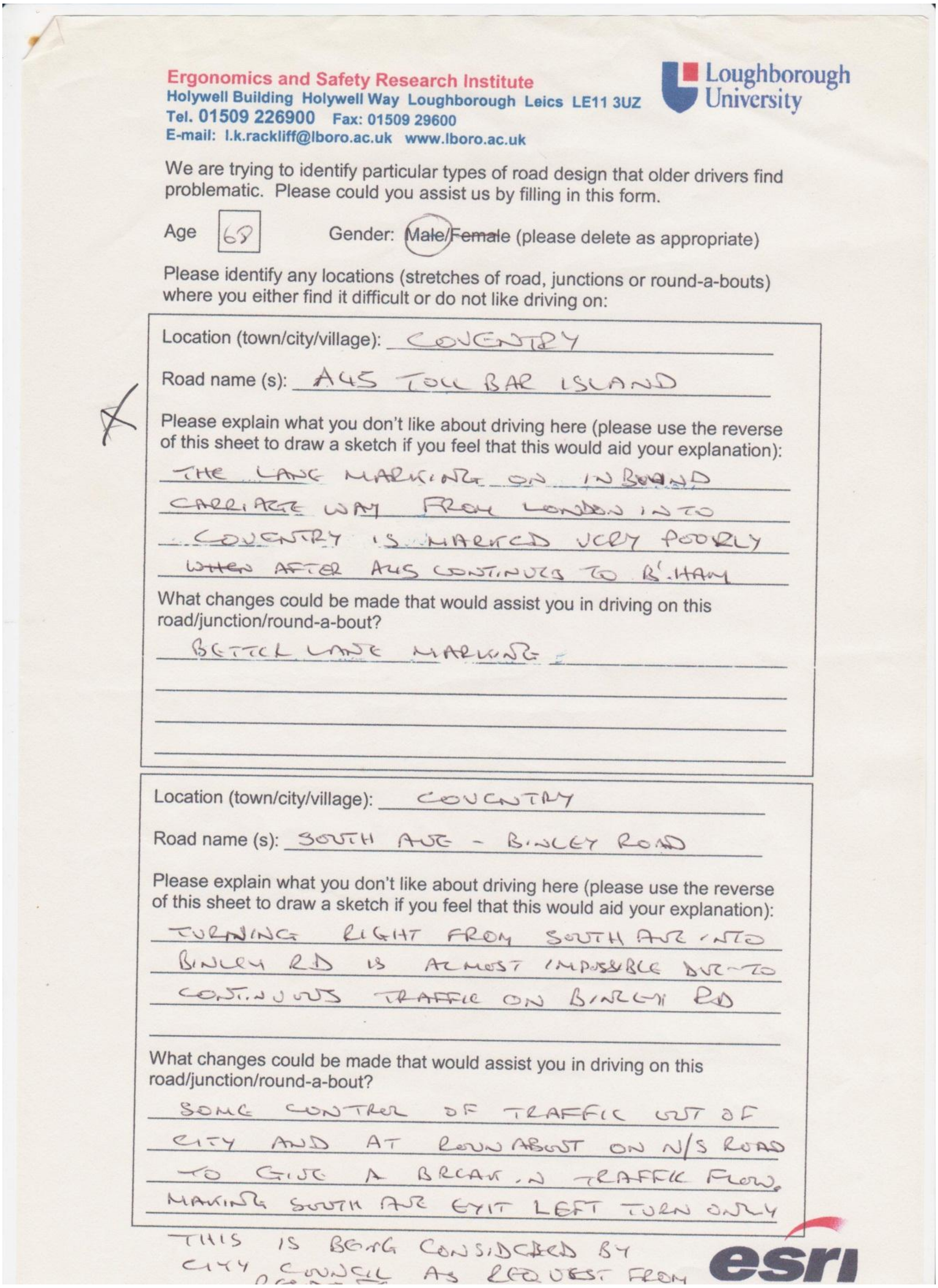
Location (town/city/village):

Road name (s):

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

esri



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We are trying to identify particular types of road design that older drivers find problematic. Please could you assist us by filling in this form.

Age: 68 Gender: [✓ Male]/~~Female~~ (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): COVENTRY

Road name (s): A45 TOLL BAR ISLAND

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

THE LANE MARKING ON INBOUND
CARRIAGE WAY FROM LONDON INTO
COVENTRY IS MARKED VERY POORLY
WHEN AFTER A45 CONTINUES TO B'HAM

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

BETTER LANE MARKING

Location (town/city/village): COVENTRY

Road name (s): SOUTH AVE - BINLEY ROAD

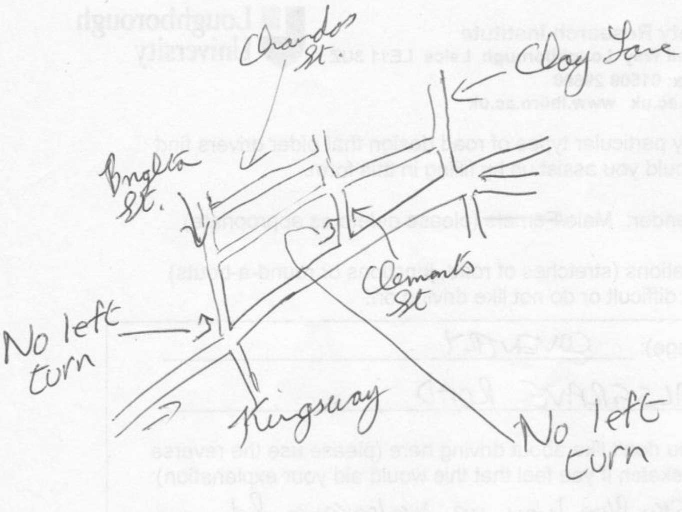
Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

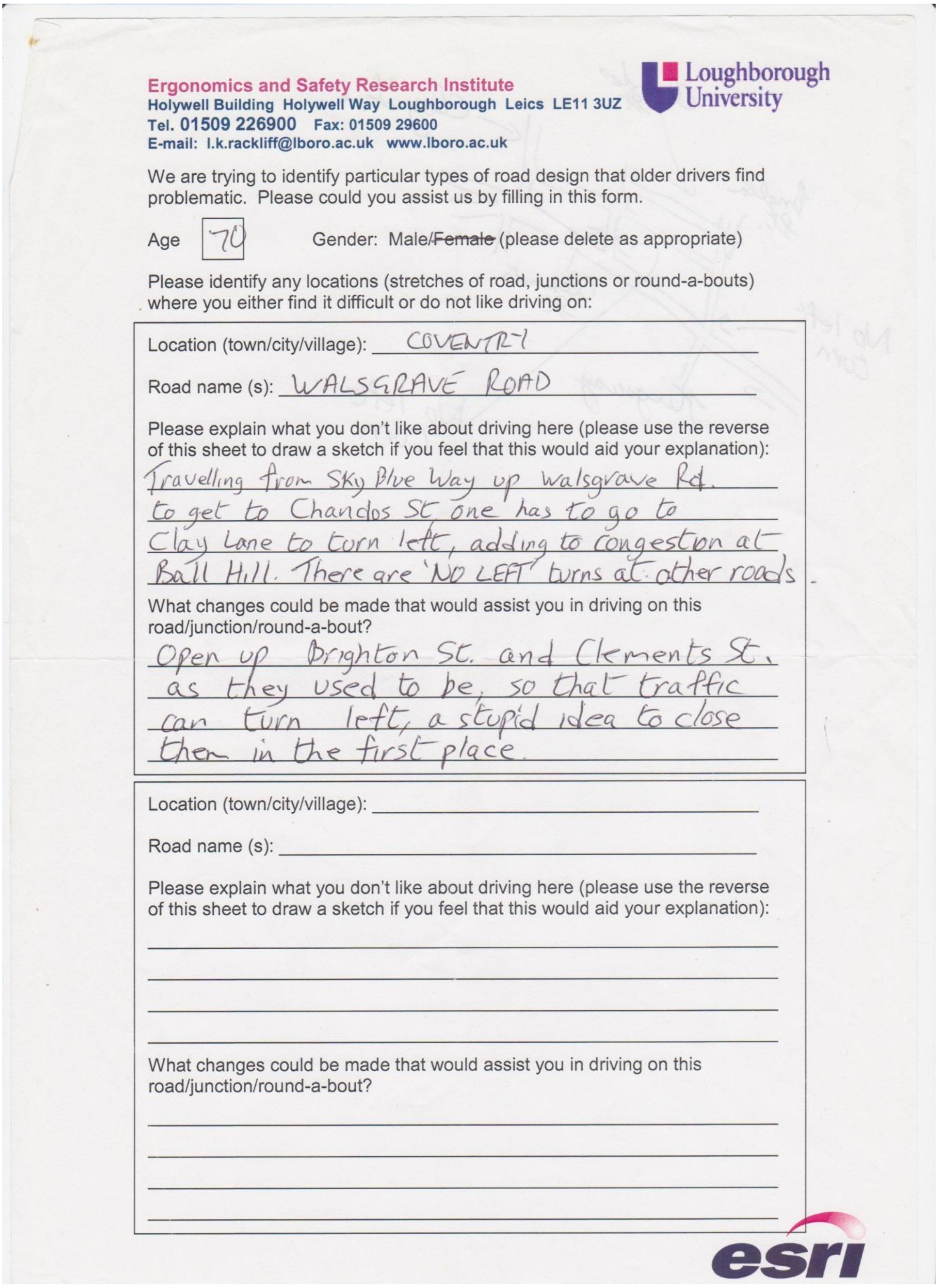
TURNING RIGHT FROM SOUTH AVE INTO
BINLEY RD IS ALMOST IMPOSSIBLE DUE TO
CONTINUOUS TRAFFIC ON BINLEY RD

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

SOME CONTROL OF TRAFFIC OUT OF
CITY AND AT ROUNDABOUT ON N/S ROAD
TO GIVE A BREAK IN TRAFFIC FLOW.
MAKING SOUTH AVE EXIT LEFT TURN ONLY

THIS IS BEING CONSIDERED BY
CITY COUNCIL AS REQUEST FROM


Chandos St
Clay Lane
Brighton St.
Clements St
No left turn
Kingsway
No left turn



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Age 70 Gender: Male/~~Female~~ (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): COVENTRY

Road name (s): WALSGRAVE ROAD

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

Travelling from Sky Blue Way up Walsgrave Rd. to get to Chandos St one has to go to Clay Lane to turn left, adding to congestion at Ball Hill. There are 'NO LEFT' turns at other roads

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Open up Brighton St. and Clements St. as they used to be, so that traffic can turn left, a stupid idea to close them in the first place.

Location (town/city/village):

Road name (s):

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

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Loughborou
University

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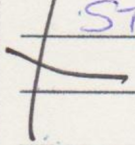
Age ☐ Gender: ~~Male~~/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/~~city/village~~): NUNEATON

Road name (s): TOMKINSON RD → COCK & BEAR BRIDG

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):



STEEP – BLIND JUNCTION.

[redacted]

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

TRAFFIC LIGHTS.

Location (town/city/village): ______

Road name (s): ______

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

______

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

______

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Age 65 Gender: ~~Male~~/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): NUNEATON

Road name (s):

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Location (town/city/village):

Road name (s): GREENMOOR ROAD NUNEATON

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

See overleaf

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Staggered Traffic Lights.

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Loughborou
University

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Age 68 Gender: ~~Male~~/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): NUNEATON

Road name (s): BULKINGTON LANE / GYPSY LANE JUNCTION.

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

JUNCTION IS ON A BEND AND DUE TO THE ANGLE OF THE JUNCTION IT IS NOT POSSIBLE TO CROSS THE ON COMING TRAFFIC LANE QUICKLY. THE LANE IS ~~[illegible]~~ CAN BE BUSY. COMPLICATED BY CHILDREN CROSSING.

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

ALTERNATIVE ACCESS ROAD TO GYPSY LANE EITHER VIA BUS ACCESS OR USING THE ACCESS ROAD FROM BULKINGTON.

Location (town/city/village): ____________________

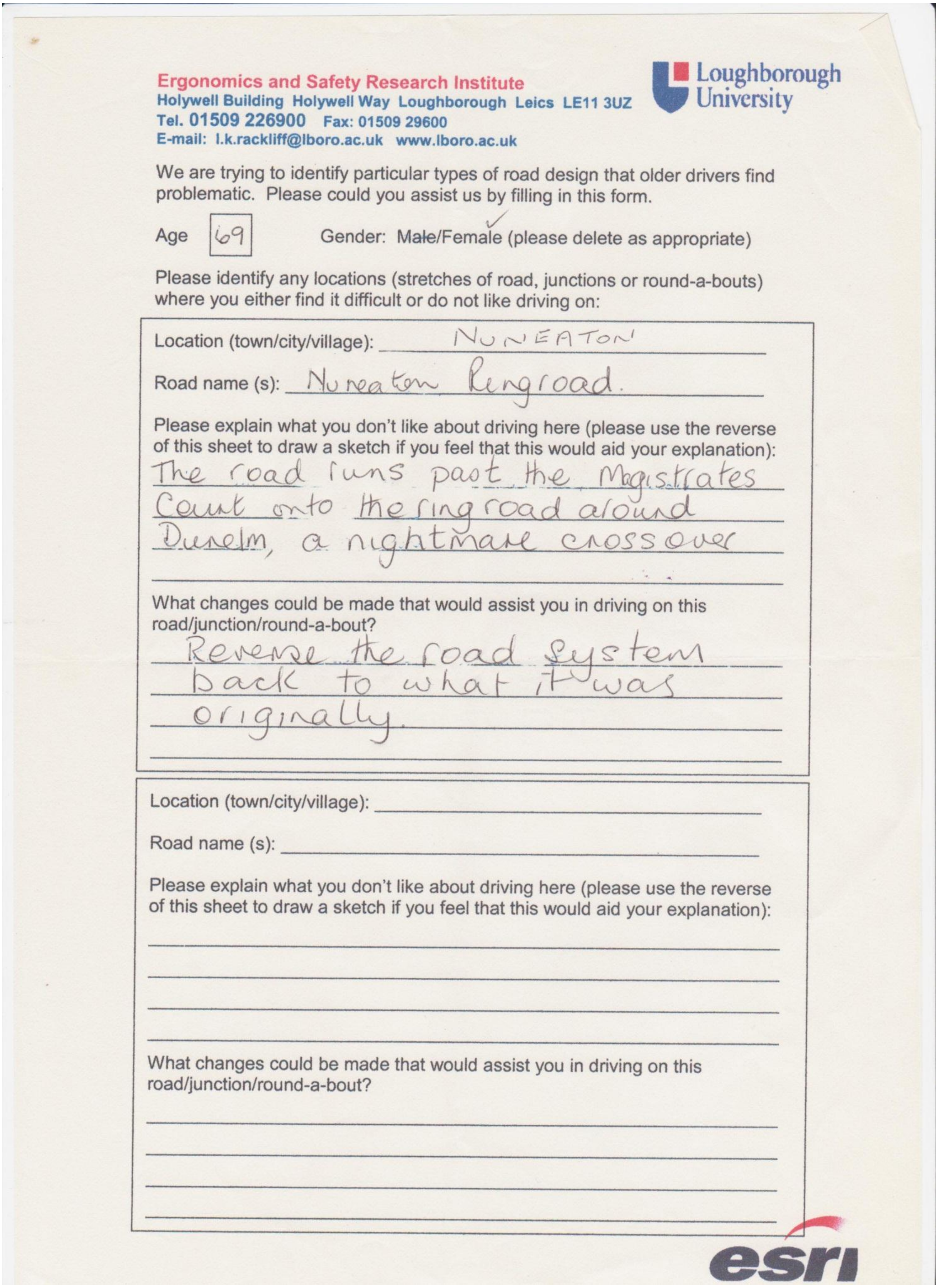
Road name (s): ____________________

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

____

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

____



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Age 69 Gender: ~~Male~~/Female ✓ (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): NUNEATON

Road name (s): Nuneaton Ringroad.

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

The road runs past the Magistrates Court onto the ring road around Dunelm, a nightmare crossover

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Reverse the road system back to what it was originally.

Location (town/city/village):

Road name (s):

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

esri

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Age 57

Gender: ~~Male~~/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

D

Location (town/city/village): Coventry

Road name (s): A46 - A428 junction - TGI FRIDAY Roundabout Southbound.

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

3 lanes on ⊙, one for turning right, one for left/straight on, centre for straight-on. Left hand lane traffic rarely keep to their lane, cutting across middle lane - causing problems for other 2 lanes.

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

There are markings on the road, but possibly clearer sign-posts about the 3 lanes might help.

R.

Location (town/city/village): Coventry

Road name (s): A444 - Ricoh roundabout - northbound.

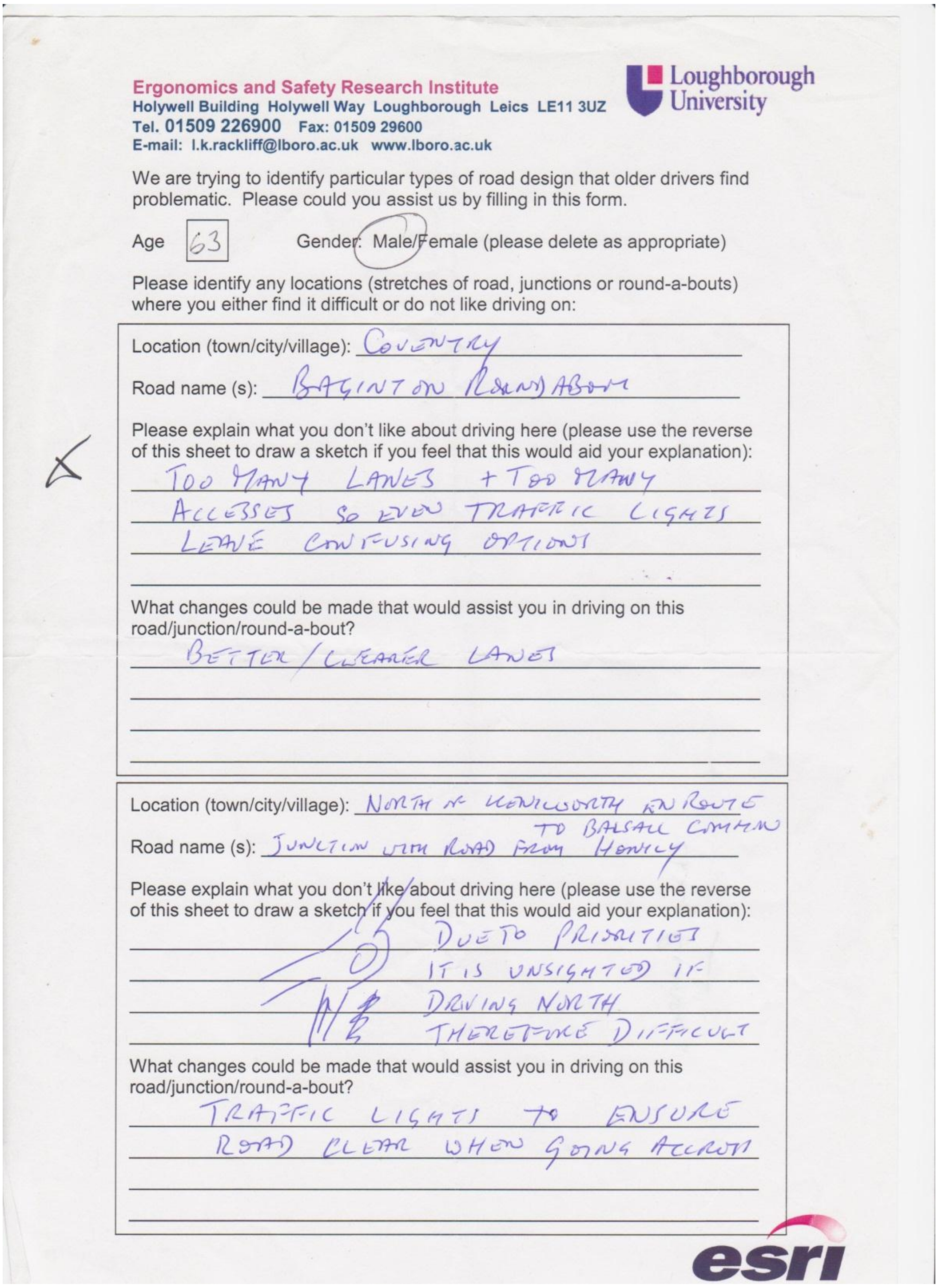
Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

Very few vehicles follow the lane markings - the left hand lane does make a very wide arc. Many vehicles end up in the right hand lane without realising it, and with traffic speeding past on the inside can't easily get back. There are also effectively 4 lanes reducing to 2 quite rapidly.

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

I'm not quite sure how you can improve lane discipline, which is the real problem at these roundabouts - but possibly make the lane markings reflect the line that drivers actually take.

esri



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Age 63 Gender: [✓ Male]/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

Location (town/city/village): COVENTRY

Road name (s): BAGINTON ROUNDABOUT

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

TOO MANY LANES + TOO MANY ACCESSES SO EVEN TRAFFIC LIGHTS LEAVE CONFUSING OPTIONS

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

BETTER / CLEARER LANES

Location (town/city/village): NORTH OF KENILWORTH EN ROUTE TO BALSALL COMMON

Road name (s): JUNCTION WITH ROAD FROM HONILEY

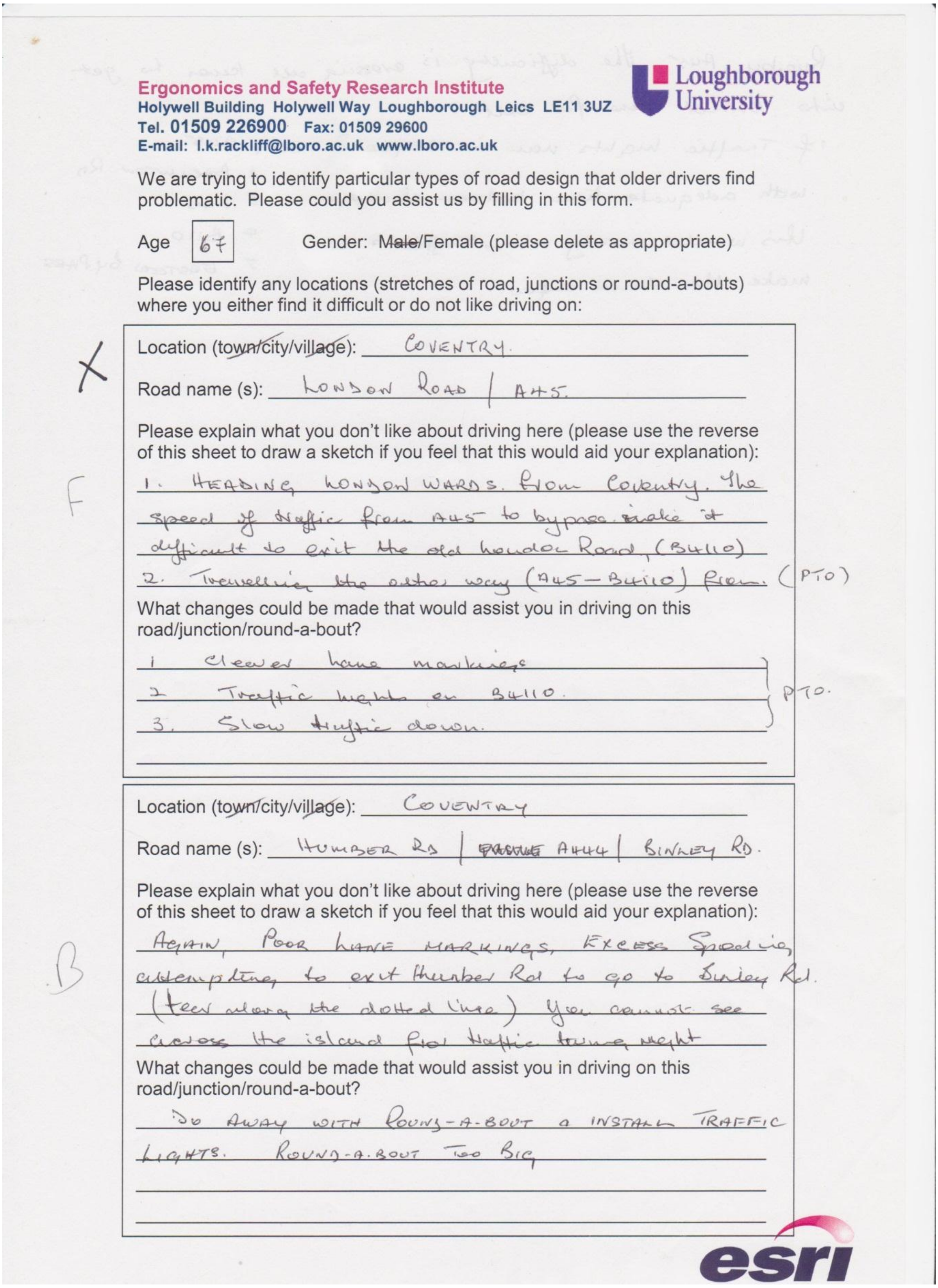
Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

DUE TO PRIORITIES IT IS UNSIGHTED IF DRIVING NORTH THEREFORE DIFFICULT

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

TRAFFIC LIGHTS TO ENSURE ROAD CLEAR WHEN GOING ACCROSS

esri



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Age 67 Gender: ~~Male~~/Female (please delete as appropriate)

Please identify any locations (stretches of road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

X

Location (~~town~~/city/~~village~~): COVENTRY.

Road name (s): LONDON ROAD / A45.

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

F

1. HEADING LONDON WARDS. from Coventry. The speed of traffic from A45 to bypass. make it difficult to exit the old London Road, (B4110)
2. Travelling the other way (A45 – B4110) from. (PTO)

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

1 Clearer lane markings
2 Traffic lights on B4110.
3. Slow traffic down.
PTO.

Location (~~town~~/city/~~village~~): COVENTRY

Road name (s): HUMBER RD / A444 / BINLEY RD.

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

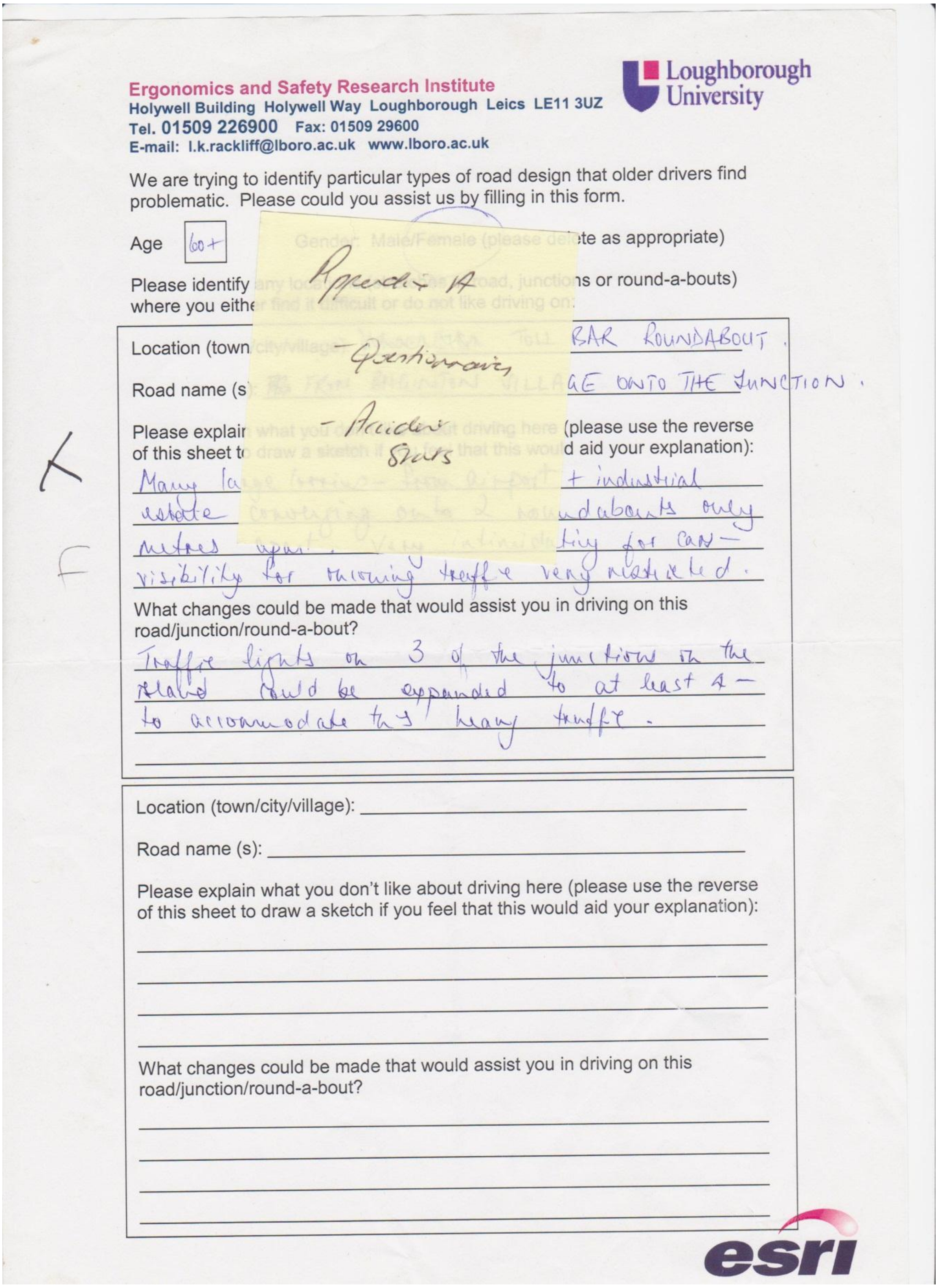
B

AGAIN, POOR LANE MARKINGS, EXCESS Speeding, attempting to exit Humber Rd to go to Binley Rd. (tear along the dotted line) You cannot see across the island for traffic turning right

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

DO AWAY WITH ROUND-A-BOUT & INSTALL TRAFFIC LIGHTS. ROUND-A-BOUT TOO BIG

esri



Appendix A
- Questionnaires
- Accident Stats

Ergonomics and Safety Research Institute
Holywell Building Holywell Way Loughborough Leics LE11 3UZ
Tel. 01509 226900 Fax: 01509 29600
E-mail: l.k.rackliff@lboro.ac.uk www.lboro.ac.uk

Loughborough University

We are trying to identify particular types of road design that older drivers find problematic. Please could you assist us by filling in this form.

Age 60+ Gender: Male/Female (please delete as appropriate)

Please identify any locations (i.e. the road, junctions or round-a-bouts) where you either find it difficult or do not like driving on:

K

F

Location (town/city/village): [illegible] TOLL BAR ROUNDABOUT.

Road name (s): FROM BAGINTON VILLAGE ONTO THE JUNCTION.

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

Many large lorries - from airport + industrial estate converging onto 2 roundabouts only metres apart. Very intimidating for cars - visibility for oncoming traffic very restricted.

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

Traffic lights on 3 of the junctions on the island could be expanded to at least 4 - to accommodate this heavy traffic.

Location (town/city/village): ______

Road name (s): ______

Please explain what you don't like about driving here (please use the reverse of this sheet to draw a sketch if you feel that this would aid your explanation):

______

What changes could be made that would assist you in driving on this road/junction/round-a-bout?

______

esri

Appendix B – Travel Diaries

Origins and destinations

1	Permanent residence (own home)
2	Other residence (including holiday/weekend home)
3	Own place of work
4	Own school or place of study
5	Business trip related location
6	Place to pick up person or goods
7	Day care, children's school
8	Supermarket, shopping centre or other retail location
9	Location related to personal business (bank, office, doctor, etc.)
10	Restaurant, cafe or similar
11	Place of leisure activities
12	Hotel or similar
13	Other location, describe

Travel modes

1	Walking, running, wheelchair, rollerblades etc.
2	Bicycle
3	*Passenger* in a car or van
4	*Driver* in a car or van
5	Local bus (including courtesy bus), school transport
6	Long distance coach
7	Metro
8	Tram
9	Train
10	Taxi
11	Aeroplane, helicopter
12	Motorcycle
13	Moped, moped car
14	All-terrain vehicle
15	Water transport (boat, ship, ferry)
16	Truck/lorry
17	Tractor/self propelled, (road maintenance vehicles etc.)
18	Other form of transport, describe

Trip purposes

1	Commute to work, commute home (or to other residence)
2	Business trip (usually a work related trip paid for by one's employer, to/from)
3	Trip to/from school, place of study
4	Purchase of daily goods, shopping trip (to/from)
5	Personal business (to/from)
6	Lunch/eating/restaurant visit (to/from)
7	Transporting another person or goods (to/from)
8	Leisure activities (to/from)
9	Vacation travel (to/from)
10	Other trip, describe

Driver system functions

SI-T	Speed Info (TeleFOT)
SA-T	Speed Alert (TeleFOT)
NAV-T	Navigation (TeleFOT)
SI-O	Speed Info (Other)
SA-O	Speed Alert (Other)
NAV-O	Navigation (Other)

TeleFOT
Field Operational Tests of Aftermarket and Nomadic Devices in Vehicles

TeleFOT Travel Diary

Write down all trips made during the survey days in the diary.

INSTRUCTIONS
A trip is moving from one place to another for an end purpose. A trip can comprise one or more modes of transport. **Remember that most trips include a walking part.** A trip that includes only walking should also be logged. However, short walking distances (e.g. less than 5 minutes) at origin or destination should not be included. If you are uncertain whether you should report your travelling as one or two trips, report it as two.

For a return journey (eg going home, or returning to work after going out to the shops), the purpose of that return portion is counted as the reason for the outward leg of that journey. Some examples:

		Origin	Destination	Purpose
TRIP 1	From home to children's day care	1	7	7
TRIP 2	From children's day care to work	7	3	1
TRIP 3	Work to a meeting outside the office	3	5	2
TRIP 4	Back to work from the meeting	5	3	2
TRIP 5	From work to the shops	3	8	4
TRIP 6	Going home from the shops	8	1	1
TRIP 7	From home to a petrol station	1	8	8
TRIP 8	From petrol station to a swimming pool	8	11	8
TRIP 9	Home from the swimming pool	11	1	8

You may complete the diary using the codes shown on the back cover or use text.

THE SURVEY DAY starts at 4am and ends at 3:59am the following day. Your personal survey dates are stated in the covering letter. This means that you should log the trips you make during those days (separate diary table for each day).

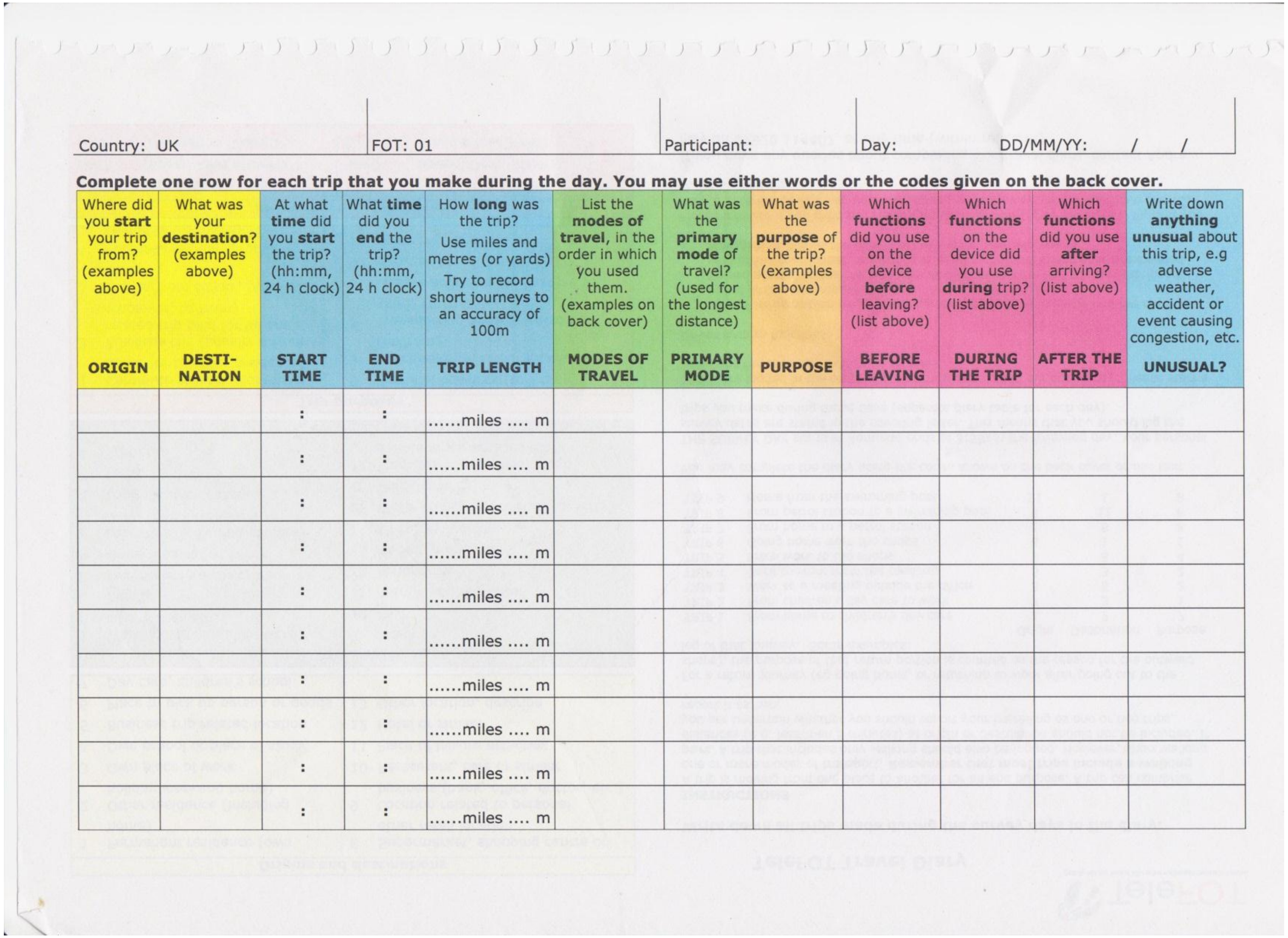
TRIPS are logged in the order in which they were made during the day. Please start a new page for each day in the survey week.

Driver system functions:

- **Speed information** displays the current speed of the vehicle and the current speed limit of the road/street used. No warning included.
- **Speed alert** displays the current speed of the vehicle and the current speed limit of the road/street. A warning is issued when the speed limit is exceeded.
- **Navigation** guides the user to a destination set beforehand.

Please indicate if you used the system provided to you (SI-T, SA-T, NAV-T), or if you used a different device - eg your own speed or SatNav system, if you have one (SI-O, SA-O, NAV-O).

If you have any queries about completing this travel diary, contact Andrew May on 07920 114407, at any time (within reason!!)



Country: UK | FOT: 01 | Participant: | Day: | DD/MM/YY: / /

Complete one row for each trip that you make during the day. You may use either words or the codes given on the back cover.

Where did you **start** your trip from? (examples above) **ORIGIN**	What was your **destination?** (examples above) **DESTI-NATION**	At what **time** did you **start** the trip? (hh:mm, 24 h clock) **START TIME**	What **time** did you **end** the trip? (hh:mm, 24 h clock) **END TIME**	How **long** was the trip? Use miles and metres (or yards) Try to record short journeys to an accuracy of 100m **TRIP LENGTH**	List the **modes of travel,** in the order in which you used them. (examples on back cover) **MODES OF TRAVEL**	What was the **primary mode** of travel? (used for the longest distance) **PRIMARY MODE**	What was the **purpose** of the trip? (examples above) **PURPOSE**	Which **functions** did you use on the device **before** leaving? (list above) **BEFORE LEAVING**	Which **functions** on the device did you use **during** trip? (list above) **DURING THE TRIP**	Which **functions** did you use **after** arriving? (list above) **AFTER THE TRIP**	Write down **anything unusual** about this trip, e.g adverse weather, accident or event causing congestion, etc. **UNUSUAL?**
		:	:	......miles .... m							
		:	:	......miles .... m							
		:	:	......miles .... m							
		:	:	......miles .... m							
		:	:	......miles .... m							
		:	:	......miles .... m							
		:	:	......miles .... m							
		:	:	......miles .... m							
		:	:	......miles .... m							
		:	:	......miles .... m							

Please list any locations where you encountered difficulties, or any you thought noteworthy.

Table 2

Location description	Reason for inclusion
Trip to Cubbington	Car share to reduce impact on the environment
Trip to art exhibition	We nearly always go into the City Centre bus - cheaper + easier (no parking)
Trip to Sainsbury's on 6/5/2011	We try to do a weekly shop + we take a non-driving disabled person - reduces shopping trips
Trip to church	I enjoy the walk in the early morning but I get a lift home from someone who has to drive (walking difficulties)
Car Club Event	Gathering - long walk @ Draycote - scenic run to museum + pub at Husband's Bosworth
Various shopping trips	I try to use fairly local shops when possible

Instructions: Please complete a line of the table for each trip you make. Please include ALL trips (including walking), and if you make trips by public transport, include details of how you arrived at the public transport stop or station (for example, walking to bus stop, driving to train station). You can fill in the columns using words, or by referring to Table 3, you can use numbers to represent different options

Your Age:

Your Gender:

Table 1

Date	Where did you start your trip?	What was your destination?	At what time did you start the trip? (24 hour clock)	What time did you end the trip? (24 hour clock)	List the modes of travel you used, in the order you used them	If possible, briefly describe the route you took, mentioning any major roads.	What was the purpose of the trip?	Did you encounter any difficulties?
2/5/2011	Home	Cubbington	09·25	12·45	walk car	B4110/A444/B4113 + local roads	Craft class	No
5/5/2011	Home	Polling Station	09·30	09·50	walk	local roads	to vote	"
5/5/2011	Home	Central Library	18·15	19·00	walk bus walk	Route 13	art exhibition	"
6/5/2011	Home	J. Sainsbury Courthouse Green	17·20	19·00	car	local roads via son's house A444	shopping	"
8/5/2011	Home	Church	0720	09:30	walk car	local roads – walked up, got a lift home	to go to church	"
8/5/2011	"	Husband's Bosworth	11·50	21·00	car/walk/car	Fosse Way B4455	car club event	"
9/5/2011	"	Cubbington	09·25	12·45	walk car	see 1st entry	craft class	"
10/5/2011	"	local shops	15·00	15·30	walk	local roads	bank dry cleaners	"

Instructions: Please complete a line of the table for each trip you make. Please include ALL trips (including walking), and if you make trips by public transport, include details of how you arrived at the public transport stop or station (for example, walking to bus stop, driving to train station). You can fill in the columns using words, or by referring to Table 3, you can use numbers to represent different options

Your Age: 72

Your Gender: MALE

Table 1

Date	Where did you start your trip?	What was your destination?	At what time did you start the trip? (24 hour clock)	What time did you end the trip? (24 hour clock)	List the modes of travel you used, in the order you used them	If possible, briefly describe the route you took, mentioning any major roads.	What was the purpose of the trip?	Did you encounter any difficulties?
10.5.11	1	6	16.30	17.00	2	LOCAL ROADS AROUND COVENTRY	1	NO
10.5.11	1	4	09.10	10.15	2	AS ABOVE	1	NO
10.5.11	1	7	11.00	16.00	2	COVENTRY TO STRATFORD A46	2	NO
7.5.11	1	4	15.00	17.00	2	COVENTRY TO NETHER WHITACRE	2	NO
4.5.11	1	9 & 4	12.00	15.30	2	B4098 COVENTRY TO	1 & 2	NO
						LUTTERWORTH VIA BRINKLOW & PAILTON		
4.5.11	11	7	19.00	21.30	2	LOCAL ROAD AROUND COVENTRY	2	NO

Please list any locations where you encountered difficulties, or any you thought noteworthy.

Table 2

Location description	Reason for inclusion
STONEY STANTON/A444 ROUNDABOUT.	VERY LARGE. PHASING FREQUENTLY CAUSES CONGESTION: POSITIONING OF LIGHTS CAN BE CONFUSING. WHICH APPLIES
NEAR CHURCH IN CUBBINGTON.	LACK OF PARKING FACILITIES AT CHURCH CAUSE CONGESTION.
09/05 A444 FROM COTON ARCHES TO TOWN CENTRE INCLUDING AVENUE RD .	AT THE TIME, SEVERE CONGESTION FROM SCHOOLS LEAVING CAUSE TAIL BACKS. QUEUES HERE REGULAR AT PEAK TIMES.

Instructions: Please complete a line of the table for each trip you make. Please include ALL trips (including walking), and if you make trips by public transport, include details of how you arrived at the public transport stop or station (for example, walking to bus stop, driving to train station). You can fill in the columns using words, or by referring to Table 3, you can use numbers to represent different options

Your Age: 64

Your Gender: FEMALE

Table 1

Date	Where did you start your trip?	What was your destination?	At what time did you start the trip? (24 hour clock)	What time did you end the trip? (24 hour clock)	List the modes of travel you used, in the order you used them	If possible, briefly describe the route you took, mentioning any major roads.	What was the purpose of the trip?	Did you encounter any difficulties?
05/05	COVENTRY SOUTH AVE	NUNEATON	09.30	16.00	CAR	A444 OUT. BULKINGTON ANSTY: SHILTON - A4600 BACK.	TEACH AT CRAFT GROUP	STONEY STANTON RD. A444 JUNCTION.
06/05	COVENTRY 1	MARKET BOSWORTH	14.00	20.00	CAR	A444 : A5 LANES AROUND.	SHOPPING SIGHT SEEING	
07/05	COVENTRY	DAVENTRY	08.15	18.30	CAR	BINLEY RD. A45	EDUCATION (COURSE)	—
09/05	COVENTRY 1	CUBBINGTON	09.30	14.00	CAR	COVENTRY, STONELEIGH CUBBINGTON.	CRAFT GROUP (LEISURE)	AROUND CHURCH IN CUBBINGTON
09/05	COVENTRY 1	NUNEATON	14.30	18.00	CAR	A444	TAKE EXHIBITS FOR DISPLAY.	SECTION OF A444 FROM COTON ARCHES TO CENTR
19/04	1	SPAIN	06.15		TAXI TRAIN SKY RAIL			
10/05	1	LOCAL SHOP	15.00	15.45.	WALK		SHOPPING	

Please list any locations where you encountered difficulties, or any you thought noteworthy.

Table 2

Location description	Reason for inclusion
Bus Station	Shortage of short term parking.
Morrisons	Badly designed car park

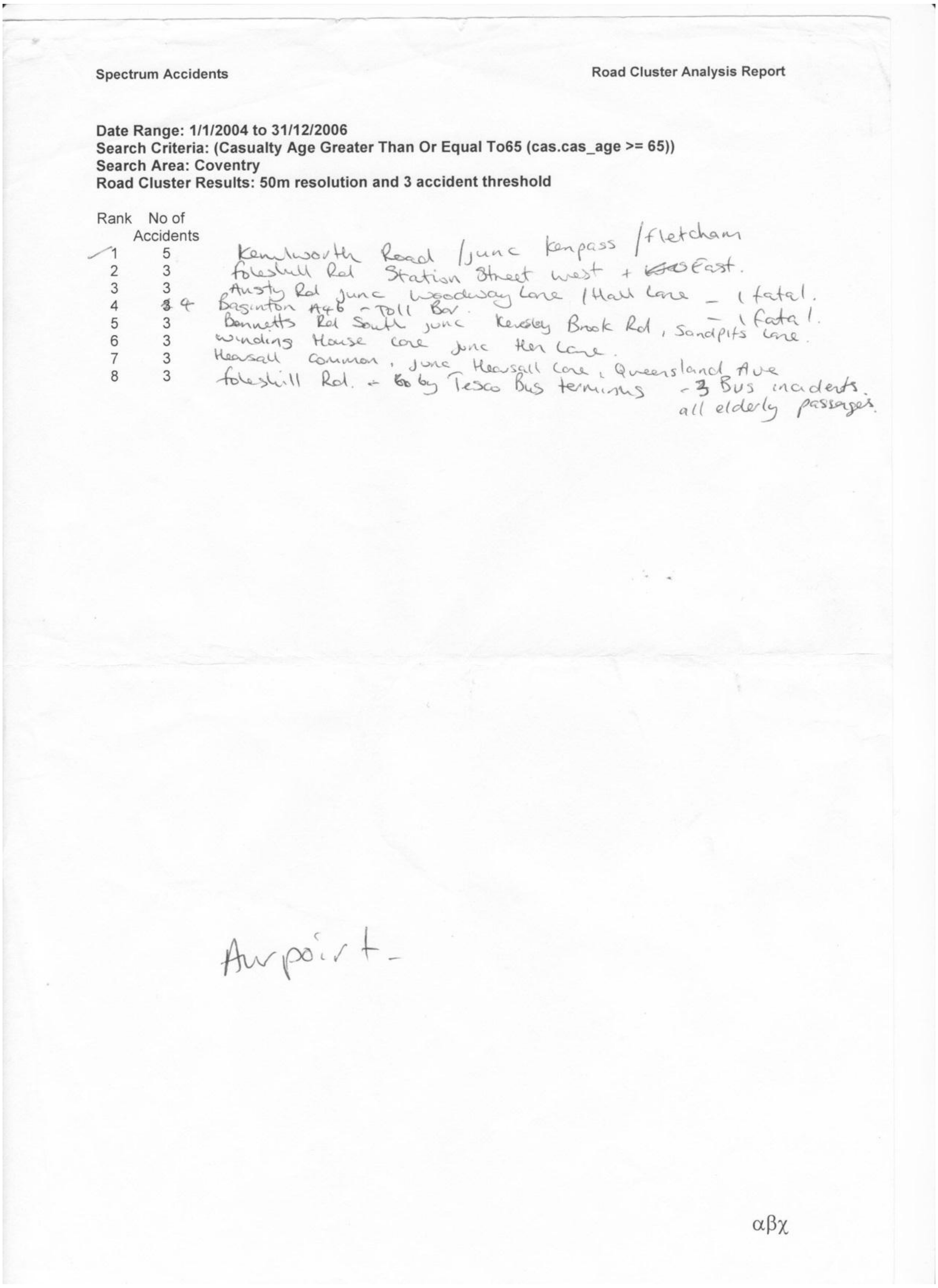
Instructions: Please complete a line of the table for each trip you make. Please include ALL trips (including walking), and if you make trips by public transport, include details of how you arrived at the public transport stop or station (for example, walking to bus stop, driving to train station). You can fill in the columns using words, or by referring to Table 3, you can use numbers to represent different options

Your Age: 85

Your Gender: Male.

Table 1

Date	Where did you start your trip?	What was your destination?	At what time did you start the trip? (24 hour clock)	What time did you end the trip? (24 hour clock)	List the modes of travel you used, in the order you used them	If possible, briefly describe the route you took, mentioning any major roads.	What was the purpose of the trip?	Did you encounter any difficulties?
8.5.11	Home	Bus Station Fairfax St	1640	1650	Car	Binley Rd Sky Blue Way	Collect visitor	No
"	Back	Home	1710	1725	Car	"	"	"
9.5.11	Home	Baths Fairfax St	1100	1130	Bus 86	Walked to Bulls Head	To excercise class	"
"	Back	Home	1300	1350	Bus 13	Walked to Herbert Museum.	"	"
10.5.11	Home	Morrisons Binley Wood	1015	1025	Car	Binley Road	Shopping	"
"		Home	1120	1130	Car	"	"	"



Spectrum Accidents **Road Cluster Analysis Report**

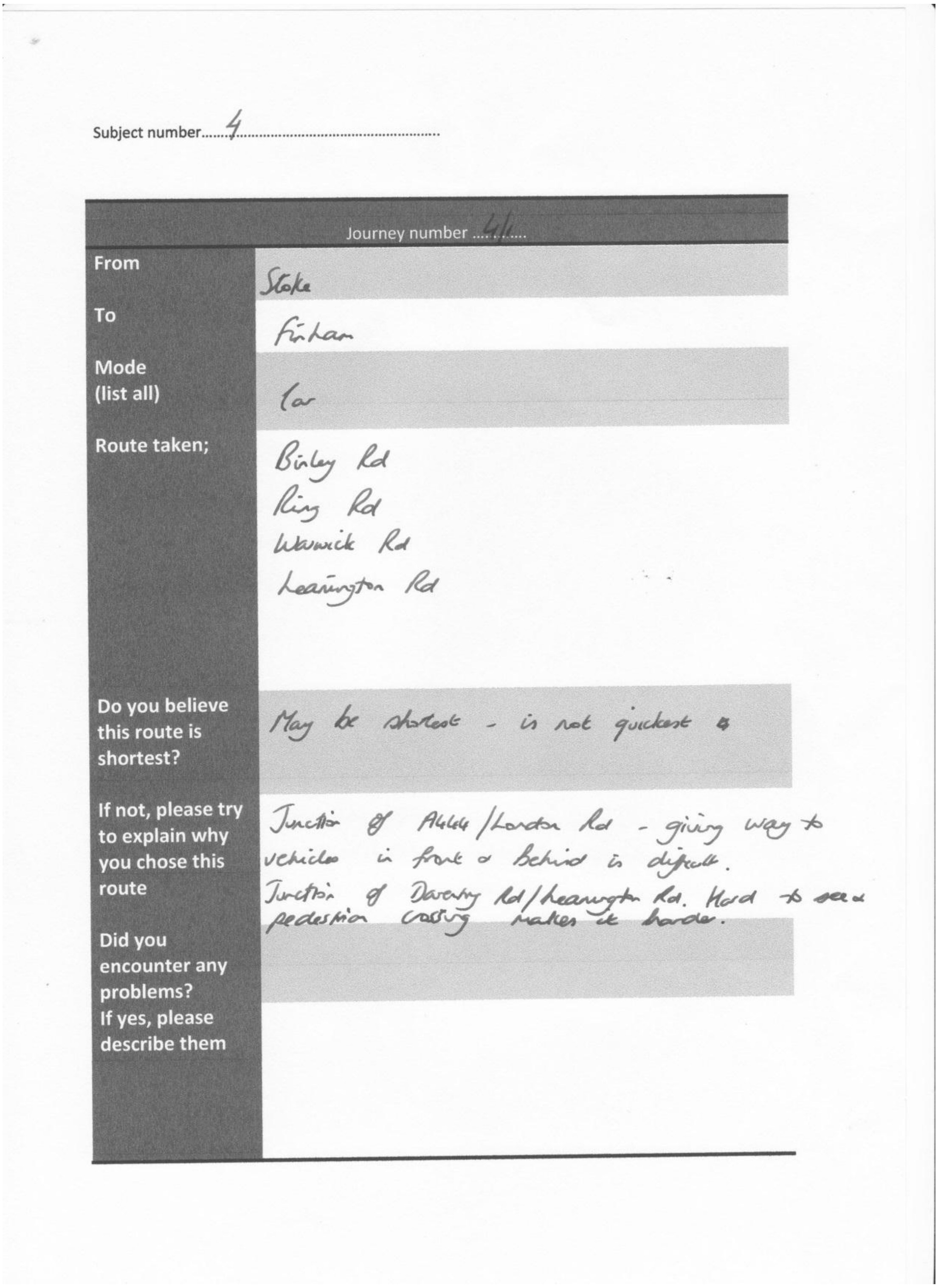
Date Range: 1/1/2004 to 31/12/2006
Search Criteria: (Casualty Age Greater Than Or Equal To65 (cas.cas_age >= 65))
Search Area: Coventry
Road Cluster Results: 50m resolution and 3 accident threshold

Rank	No of Accidents	
1	5	Kenilworth Road /junc Kenpass /Fletcham
2	3	Foleshill Rd Station Street west + East.
3	3	Austy Rd junc Woodway Lane /Hall Lane – 1 fatal.
4	~~3~~ 4	Baginton A46 – Toll Bar.
5	3	Bonnetts Rd South junc Keresley Brook Rd, Sandpits Lane – 1 fatal.
6	3	Winding House Lane junc Hen Lane.
7	3	Hearsall Common, junc Hearsall Lane, Queensland Ave
8	3	Foleshill Rd. – by Tesco Bus terminus – 3 Bus incidents. all elderly passages.

Airport –

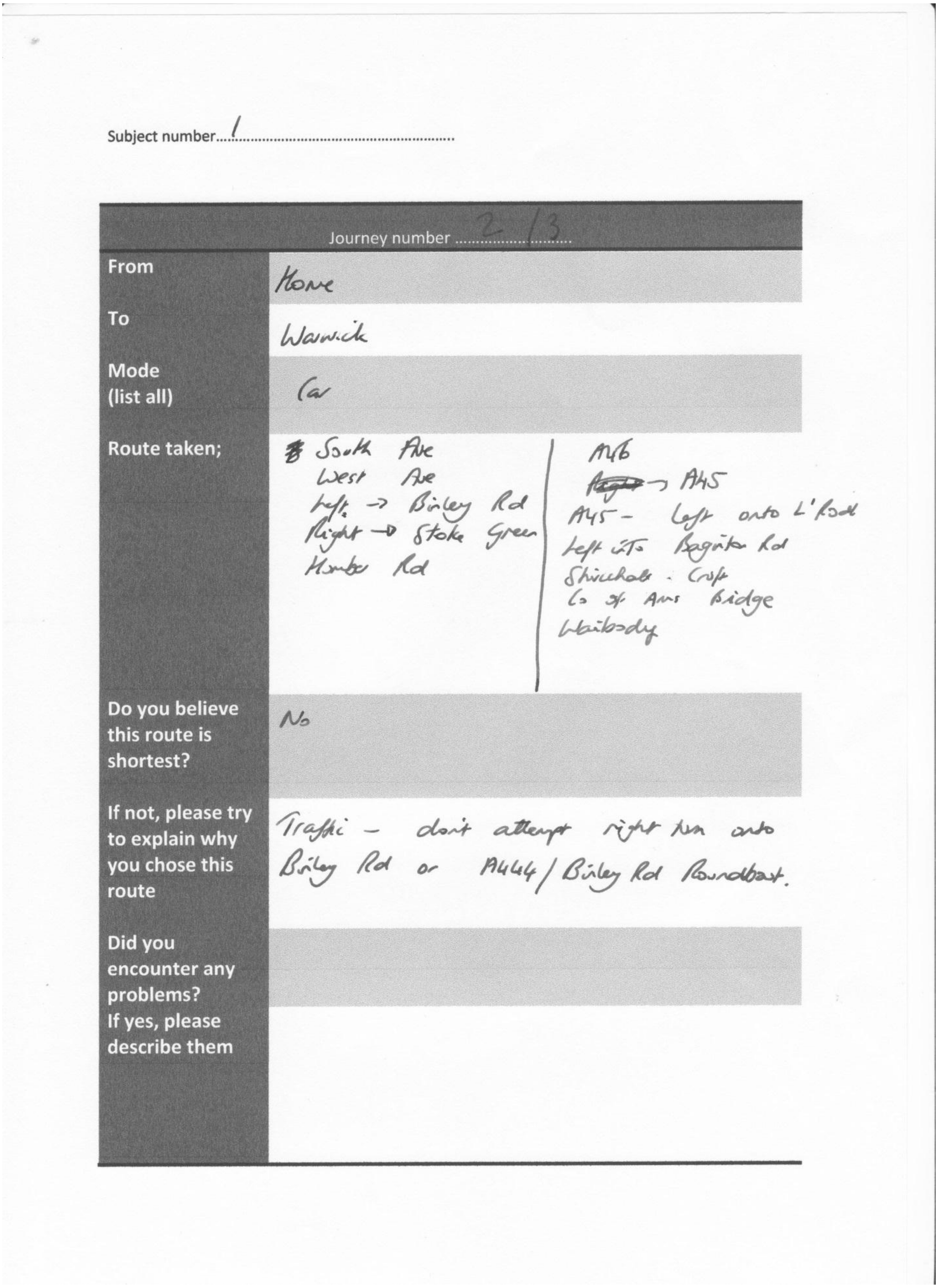
αβχ

Appendix c – Structured Interviews



Subject number......4...

Journey number ....4/......	
From	Stoke
To	Finham
Mode (list all)	Car
Route taken;	Binley Rd Ring Rd Warwick Rd Leamington Rd
Do you believe this route is shortest?	May be shortest - is not quickest
If not, please try to explain why you chose this route	Junction of Allard/London Rd - giving way to vehicles in front or behind is difficult. Junction of Daventry Rd/Leamington Rd. Hard to see a pedestrian crossing makes it harder.
Did you encounter any problems? If yes, please describe them	

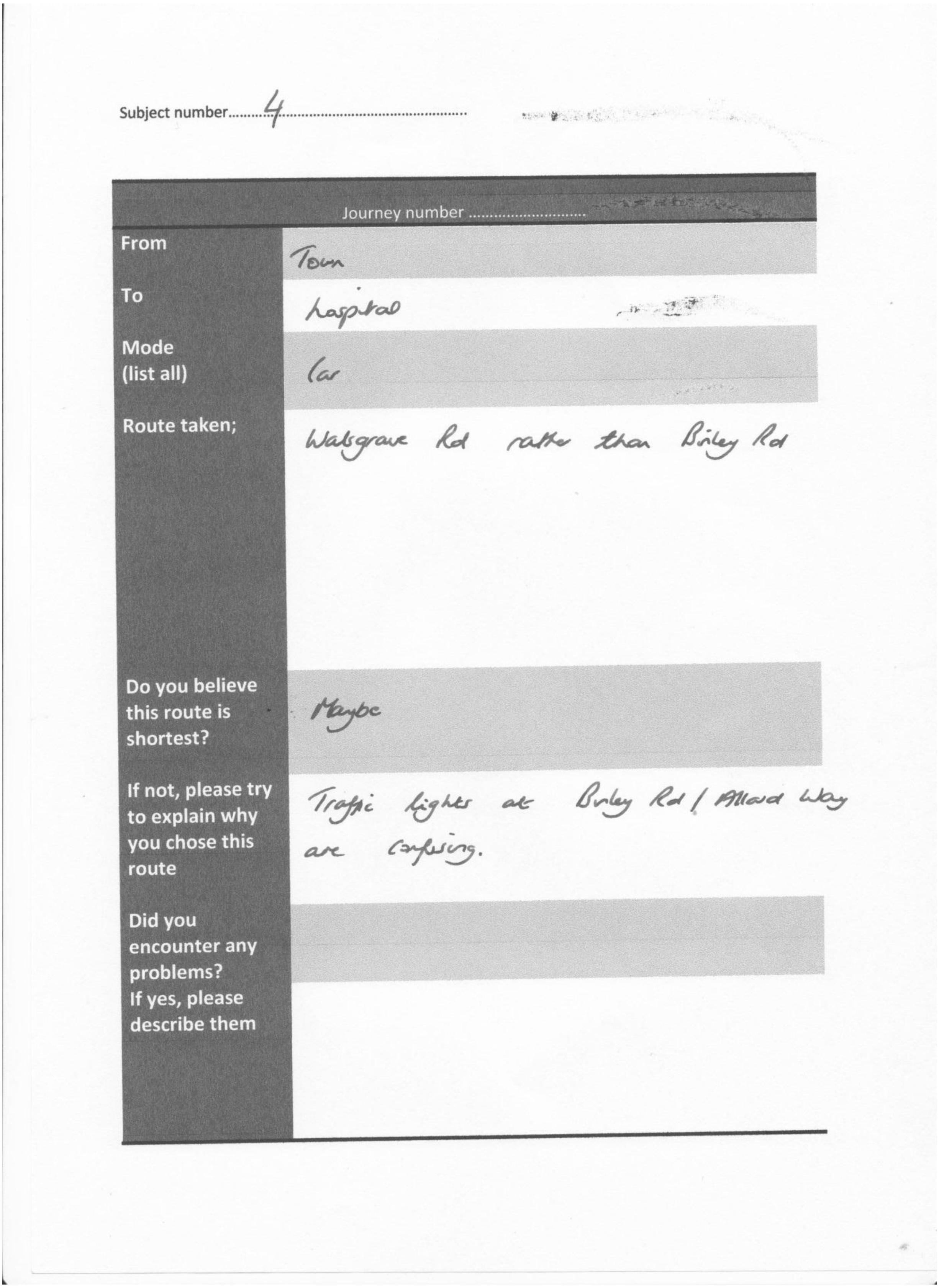


Subject number 1

Journey number 2 / 3	
From	Home
To	Warwick
Mode (list all)	Car
Route taken;	South Ave West Ave Left → Birley Rd Right → Stoke Green Humber Rd A46 → A45 A45 – Left onto L'Road Left into Baginton Rd Stivichall Croft Co of Arms Bridge Wainbody
Do you believe this route is shortest?	No
If not, please try to explain why you chose this route	Traffic – don't attempt right turn onto Birley Rd or A444 / Birley Rd Roundabout.
Did you encounter any problems? If yes, please describe them	

Subject number........1........

Journey number ...1...	
From	Home
To	Paper shop
Mode (list all)	Walk
Route taken;	
Do you believe this route is shortest?	No
If not, please try to explain why you chose this route	Had to go round cars on double yellow lines.
Did you encounter any problems? If yes, please describe them	



Subject number 4

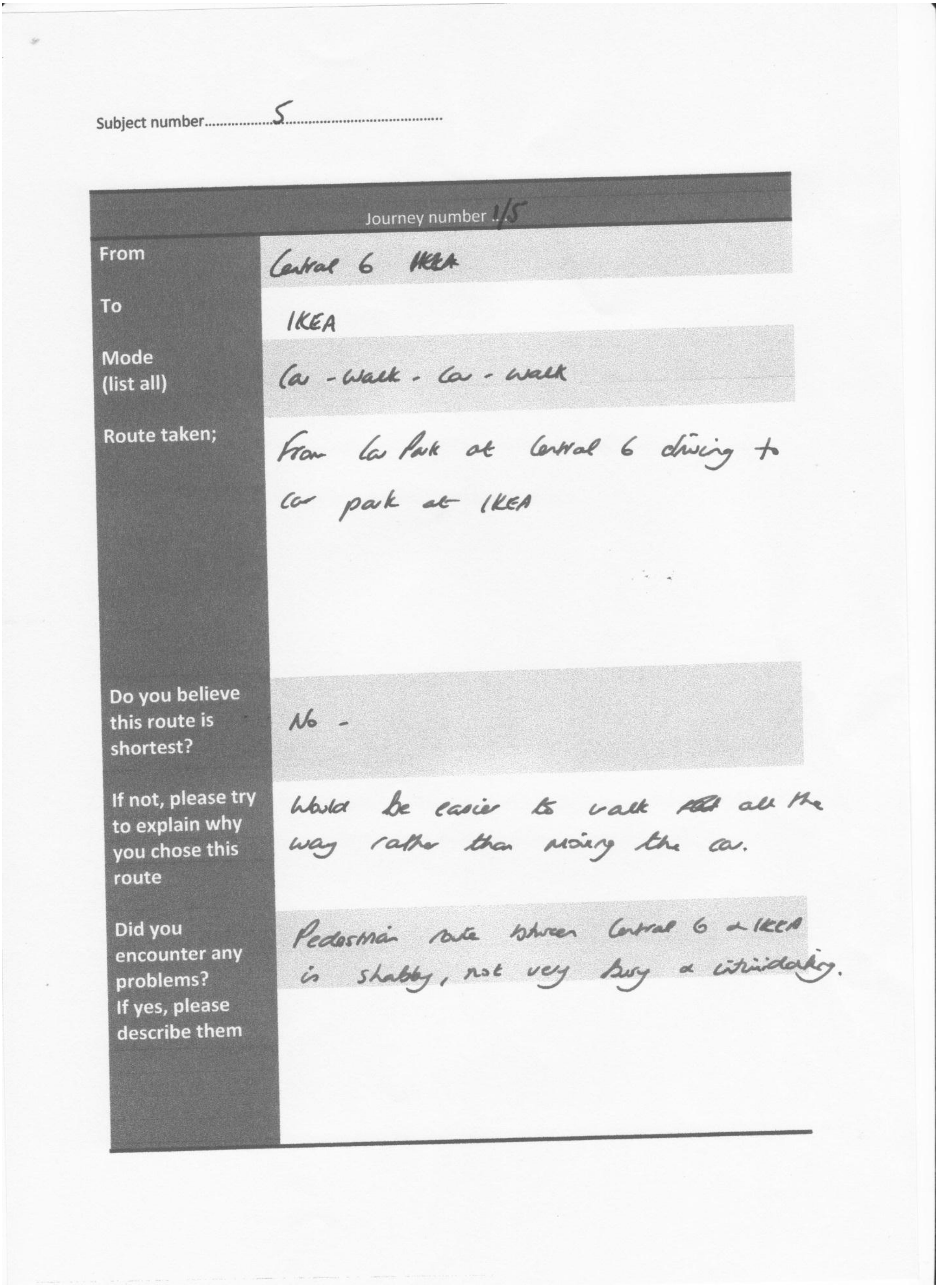
Journey number

From	Town
To	hospital
Mode (list all)	Car
Route taken;	Walsgrave Rd rather than Binley Rd
Do you believe this route is shortest?	Maybe
If not, please try to explain why you chose this route	Traffic lights at Binley Rd / Allard Way are confusing.
Did you encounter any problems? If yes, please describe them	

Subject number 3

Journey number 3/3

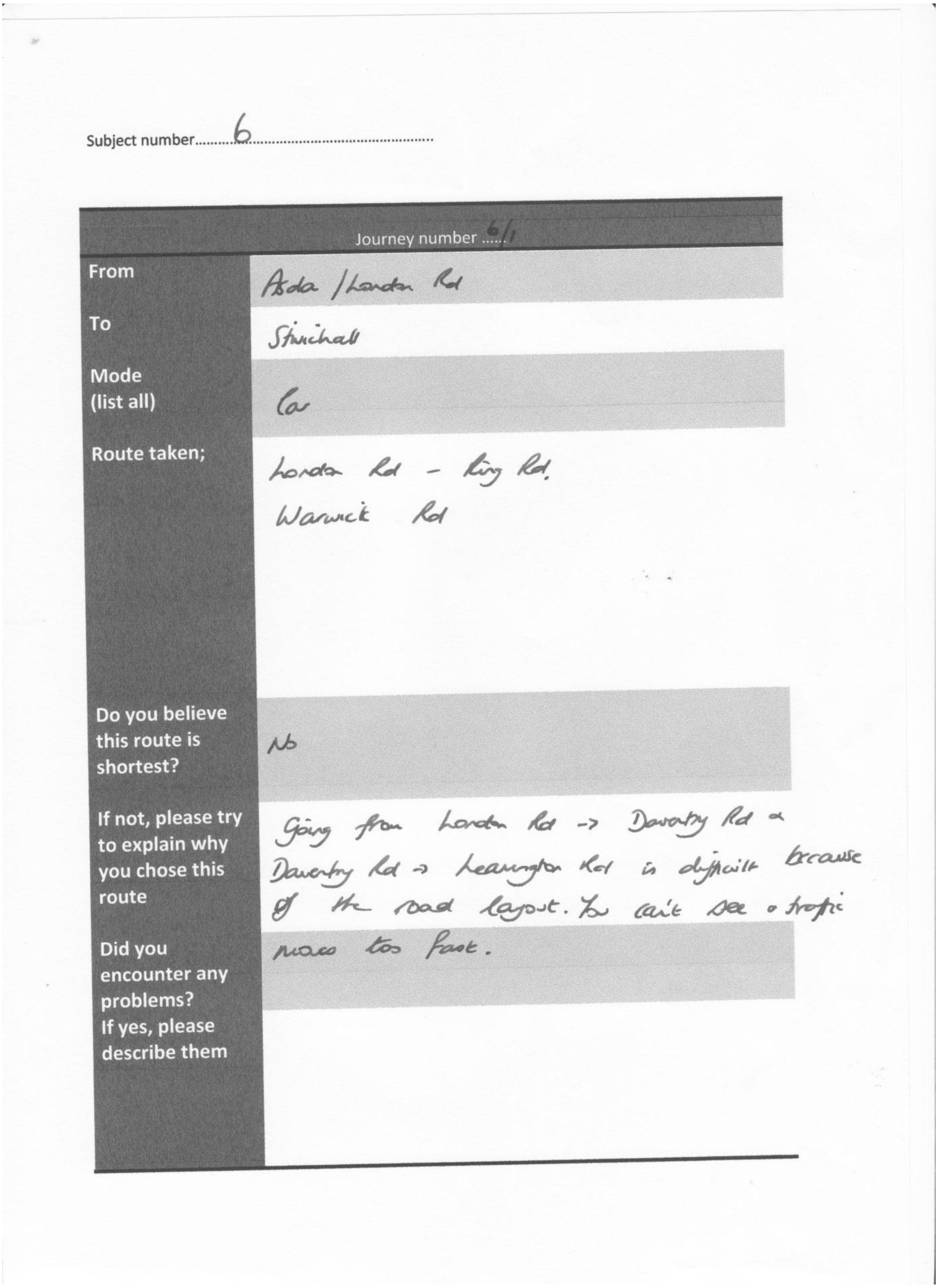
From	Home
To	Anywhere East - eg, hospital, Leicester
Mode (list all)	Car
Route taken;	
Do you believe this route is shortest?	
If not, please try to explain why you chose this route	
Did you encounter any problems?	Yes
If yes, please describe them	Road layout at Binley Rd / Allard Way junction is confusing & causes problems.



Subject number 5

Journey number 1/5

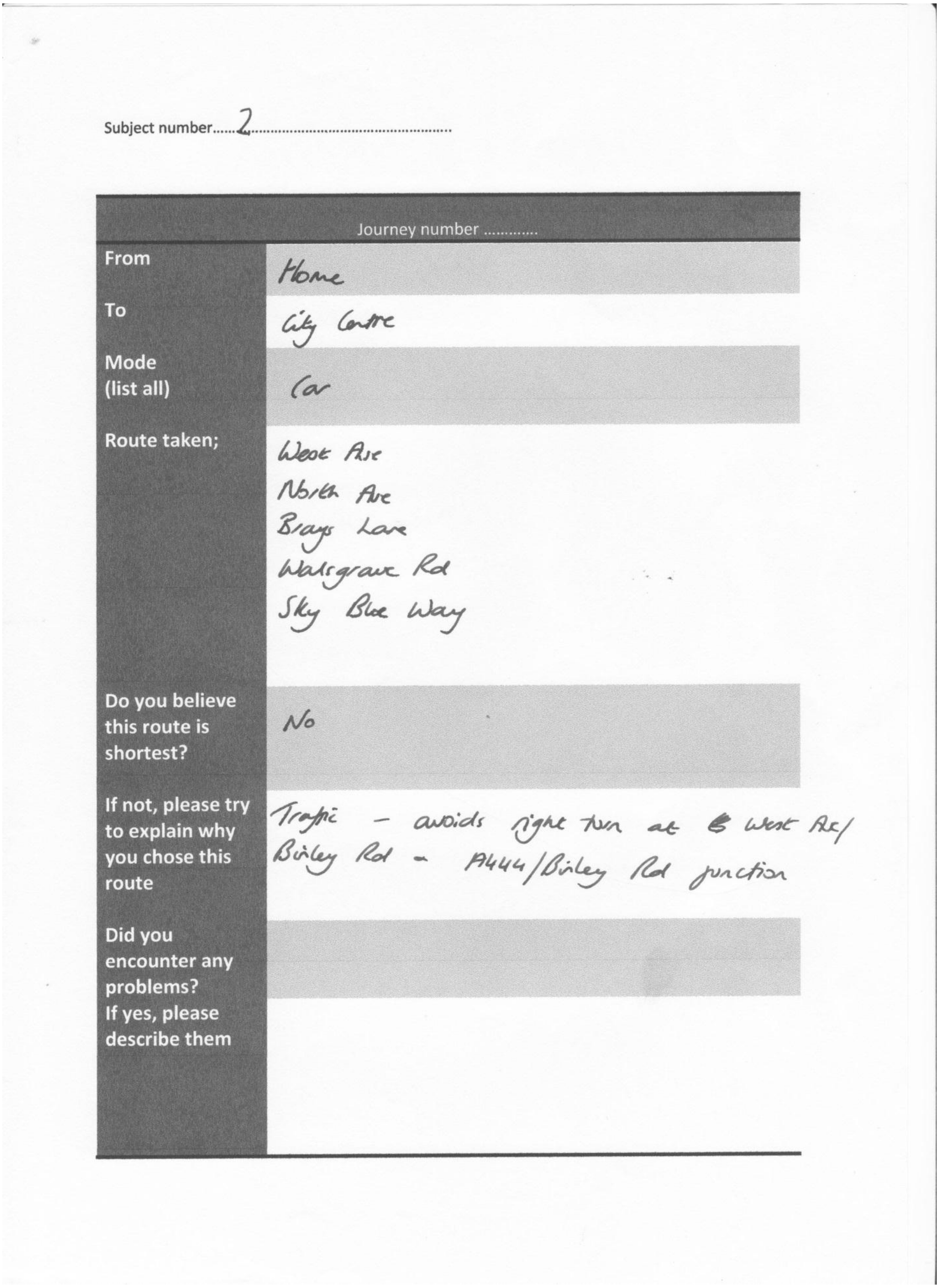
From	Central 6 ~~IKEA~~
To	IKEA
Mode (list all)	Car - Walk - Car - walk
Route taken;	From Car Park at Central 6 driving to car park at IKEA
Do you believe this route is shortest?	No -
If not, please try to explain why you chose this route	Would be easier to walk all the way rather than moving the car.
Did you encounter any problems? If yes, please describe them	Pedestrian route between Central 6 & IKEA is shabby, not very busy & intimidating.



Subject number 6

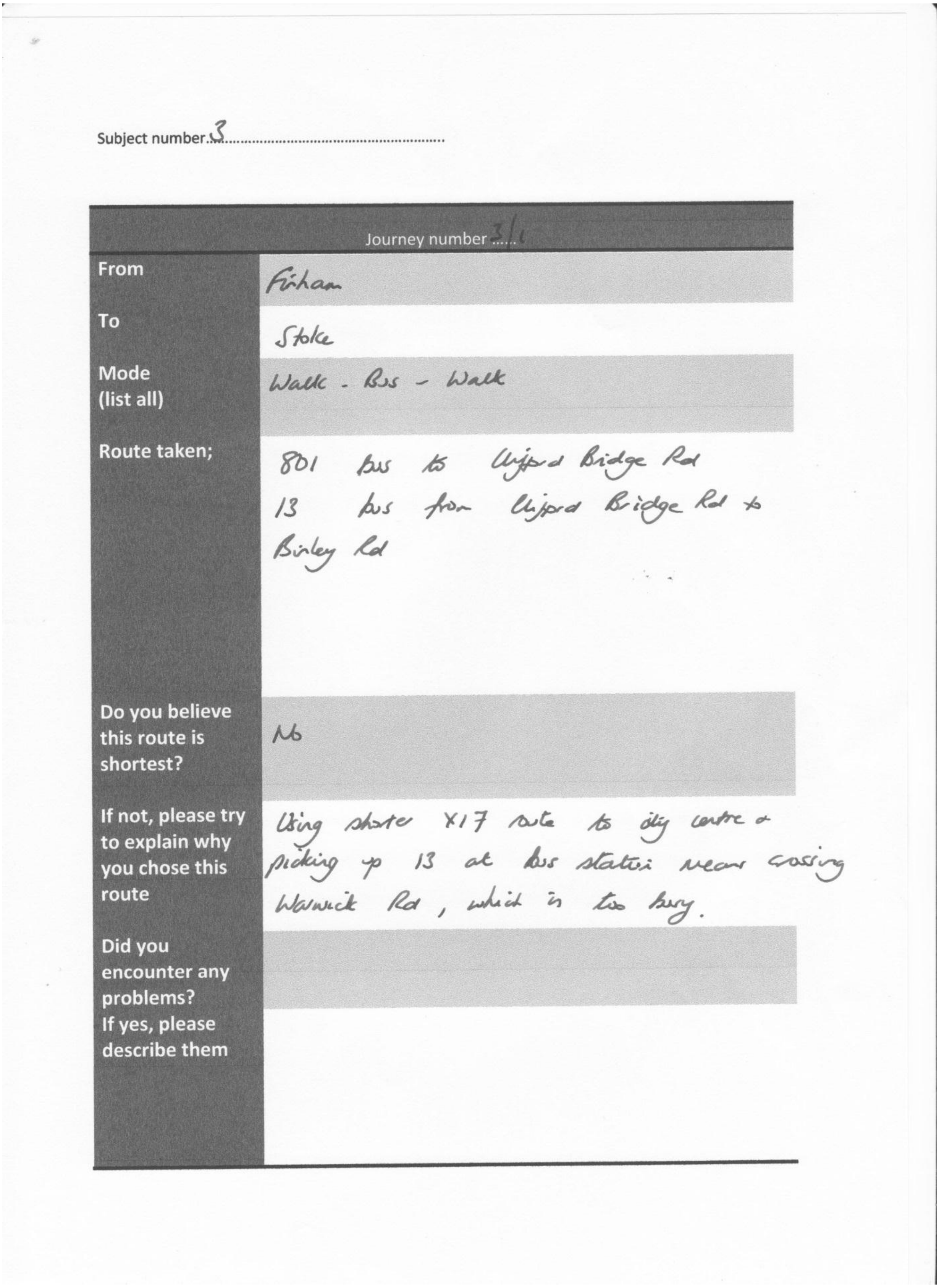
Journey number 6/1

From	Asda / London Rd
To	Stivichall
Mode (list all)	Car
Route taken;	London Rd – Ring Rd, Warwick Rd
Do you believe this route is shortest?	No
If not, please try to explain why you chose this route	Going from London Rd -> Daventry Rd & Daventry Rd -> Leamington Rd is difficult because of the road layout. You can't see & traffic moves too fast.
Did you encounter any problems? If yes, please describe them	



Subject number......2..

Journey number	
From	Home
To	City Centre
Mode (list all)	Car
Route taken;	West Ave North Ave Brays Lane Walsgrave Rd Sky Blue Way
Do you believe this route is shortest?	No
If not, please try to explain why you chose this route	Traffic – avoids right turn at West Ave/ Binley Rd – A444/Binley Rd junction
Did you encounter any problems? If yes, please describe them	



Subject number 3

Journey number 3/1	
From	Finham
To	Stoke
Mode (list all)	Walk - Bus - Walk
Route taken;	801 bus to Clifford Bridge Rd 13 bus from Clifford Bridge Rd to Binley Rd
Do you believe this route is shortest?	No
If not, please try to explain why you chose this route	Using shorter X17 route to city centre & picking up 13 at bus station near crossing Warwick Rd, which is too busy.
Did you encounter any problems? If yes, please describe them	

Subject number....3..

Journey number 3/2	
From	Kenilworth
To	Stoke
Mode (list all)	Car
Route taken;	Kenilworth Rd Warwick Rd Leamington Rd A45 London Rd
Do you believe this route is shortest?	No
If not, please try to explain why you chose this route	It is too difficult to turn right from Kenilworth Rd directly to A45. Taking short detour means turning right at traffic lights
Did you encounter any problems? If yes, please describe them	

Appendix D – Audit Forms

Factor	Possible Values
Length of section	• Free text
Section description	• Free text
Surrounding Land Use	• Residential • Commercial • Parks/gardens • Mixed • Derelict
Speed limit	• 20 • 30 • 40
Road type	• Local access • Distributer • Strategic • Multi-functional
Number of lanes	• Free text
Number of signs in section	• 1 • 2 • 3 • 4 • 5 • 6+
Number of items of information	• 1 • 2 • 3 • 4 • 5 • 6+
Visual obstructions present	• Yes • No
If yes, describe	• Free text
Alignment/Topography	• Flat • Small change in level • Significant change in level
Pedestrian Activity	
Traffic flow type	• Local traffic – cars • Local traffic – cars and buses • Mixed – cars, buses and goods vehicles
Are traffic movements clear and predictable?	• Yes • No
What factors affect traffic flow	• Bus lane • Bus stop • Cycle lane • Lanes merging • Other (describe)
Are there junctions within the section?	• Yes • No
What is the approximate distance between junctions	• Free text
Travel time at speed limit	• Free text
Complete junction table for each junction	

Factor	Possible Values
Number of junctions in section	• 1 • 2 • 3 • 4
Junction type	• Crossroads • T-junction • Roundabout • Other
Signalised	• Yes • No
Speed limit at junction	• 20 • 30 • 40
Number of signs within 500m of junction	• 1 • 2 • 3 • 4 • 4+
Total items of information on signs within 500m of junction	• 1 • 2 • 3 • 4 • 5 • 5+
Number of lane choices	• 1 • 2 • 3 • 3+
Perception reaction time for intersection sight distances	• Free text
Any issues with signage and visibility of junction?	• Free text
Any issues with observations at junction	• Free text
Are there any issues with visibility of signage itself?	• Free text
Are there any factors complicating traffic flow at junction?	• Free text

Factor	Possible Values
Surrounding Land Use	• Residential • Commercial • Parks/gardens • Mixed • Derelict
Road type	• Local access • Distributer • Strategic • Multi-functional
Pavement surfacing	• Tarmac, • block paving • slabs • mixed • other
Pavement Condition	• Largely flat • uneven • damaged
Evidence of deviation of pedestrian route from desire line	• Yes • No
Poorly signed/difficult to follow routes	• Yes • No
Discontinuous routes	• Yes • No
Presence of shared cycle/pedestrian infrastructure	• Yes • No
Presence of tactile surfaces	• Yes • No
If yes are they across all or part of footpath	• All • Part
Are there obstructions to the footpath	• Yes • No
If yes, what are they (tick all that apply)	• Street furniture • Business-related items (stock) • Parked vehicles • Cycles
Is there traffic intrusion	• Yes • No
What is the nature of any intrusion	• Noise • Speed • Vibration • Other
Alignment/Topography	• Flat • Small change in level • Significant change in level
Where significant changes of level, how is this catered for	• Steps • Slope
Is the local environment attractive	• Yes • No
What factors contribute to this	Free text field
Is area well light during the day	• Yes • No
Is area well lit at night	• Yes • No

Factor	Possible Values
Speed limit at junction	20 30 40
Length of section	Free text
Number of junctions in section	1 2 3 4
Number of safe crossing points	1 2 3 4
Approximate distance between safe crossing points	Free text
Number of Lanes	1 2 3 More
Junction type	Crossroads T-junction Roundabout Other
Signalised	Yes No
Divided/Undivided Roadway	Divided Undivided
For each crossing in section:	
At junction	Yes No
Divided/Undivided Roadway	
Number of Lanes	

Factor	Possible Values
Is there pedestrian access to public transport	• Yes • No
Which modes can be accessed from here	• Bus • Train • Taxi
Is access level	• Yes • No
If no, describe access	• Free text
Can return journeys be made with equal convenience	• Yes • No
If no, which of the following applies	• Access for return journey is elsewhere • Access for return journey involves crossing traffic • Access for return journey involves steps • Other

1. Link

Street/Road Name	
Suburb	
Road Functional Classification	
Road Length Examined	
Section Description	
Alignment/Topography	
Number of intersections	
Traffic Control Type	
Number of crossing points	
Surrounding Land Use	
Divided/Undivided Roadway	
Number of Lanes	
Speed limit	
Pedestrian Activity	

2. Intersections

Intersection Identifier	
Intersection type	
Details of signage	
Number of items of information on signs	
Are there any additional features (merging traffic etc)	
Number of lane choices at junction	
Perception reaction time for intersection sight	

distances	
Are there any issues with signage and visibility of junction?	
Are there any issues with visibility of signage itself?	
Are traffic movements clear and predictable?	

Are there sufficient safe gaps to allow older drivers to negotiate the intersection?	
Is the intersection free of obstructions from Fences Street furniture Parking facilities Signs Landscaping	
What is the perception-reaction time for intersection distances	
Is there a pedestrian refuge where protected turning lanes are provided	
Are there unrestricted sight lines at right turn intersections	
Other information	
How might junction design affect mobility	

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What is the perception-reaction time for intersection distances	
Is there a pedestrian refuge where protected turning lanes are provided	
Are there unrestricted sight lines at right turn intersections	
How might junction design affect mobility	

1. General information

Place Identifier	
Suburb	
Road Functional Classification	
Section length	
Section Description	
Alignment/Topography	
Road type	
Urban Clearway	
Surrounding Land Use	
Divided/Undivided Roadway	
Number of Lanes	
Speed limit	
Pedestrian Activity	

2. Traffic conditions

Number of intersections	
Intersection locations	
Intersection type 1 2	
Other crossing provision	
Approximate distance between safe crossing points	
Are there any issues with crossing design?	

Are there any additional features (merging traffic etc)	
Is there a cycle lane or other provision?	
Are cycle/pedestrian facilities shared?	
Is Place served by buses?	
Are there any issues which would affect pedestrian access to bus stops?	
Is there guard rail between carriageway and pavement?	
Describe location & extent of guard rails, & any implications for safety and mobility	

3. Pavement conditions

Are pavements wide or narrow	
Are pavements used exclusively for pedestrians?	
What other uses are pavements put to?	
Are pavements obstructed by anything, e.g roadside furniture, trees	
Is surface treatment uniform, or many different materials?	
Are surfaces smooth?	
Where not smooth, what factors contribute to this?	
Is there any seating.	
If yes, describe the level of provision	

Any other information	

4. Intersections

Intersection Identifier	
Intersection type	
Is there dedicated crossing provision?	
Is there pedestrian guard rail	
Are there any additional features (merging traffic etc)	
Number of lane choices at junction	
Perception reaction time for intersection sight distances	
Are there any issues with signage and visibility of junction	
Are there any issues with visibility of signage itself?	
Are traffic movements clear and predictable?	
Other information	