Society of Chief Officers of Transportation in Scotland / Improvement Service

November 2019

The Value of the Local Roads Network - report

Contents

1.0 Executive Summary

The Society of Chief Officers of Transportation in Scotland (SCOTS) has commissioned a review which aimed to address the question of the value of the local road network to the social and to the economic wellbeing of Scotland and its communities.

A consultancy team has undertaken a combination of primary and desktop research to address this question and this report is the result of that work.

Infrastructure is widely recognised to be a key driver of success for nations and roads are a fundamental component of any nation's infrastructure. Scotland is no exception to this. Roads are ubiquitous - they permeate every aspect of our lives.

While there is always going to be a basic core function for the roads system, namely to get people or things from A to B, the enabling capacity of the local roads system is heavily influenced by its geographical context. In some places (e.g. city centres), this basic core function will share road-space with other functions. Expectations of the local roads network differ between cities, small towns, remote rural areas and so on.

In order to tackle the question of the value of the local roads network, this project considered local roads as a system which itself part of a connected group of systems. The term "local roads network" is not always helpful. At the national level, there is one roads network, consisting of interconnected roads sub-systems with a wide range of densities and levels of use. At a regional level, it is then possible to identify the roads networks which function as coherent sub-systems of the Scottish network.

The absolute separation between "local" and "trunk" roads is primarily administrative and not necessarily reflected in the way roads are used across the country.

What makes the Scottish roads network a genuine network is the local roads, not the trunk roads. It follows, therefore, that sustaining investment in local roads is fundamental to preserving an effective network for Scotland.

While access or connectivity (getting goods and services from Place A to Place B) still dominates much of the discussion on local roads, perspectives on what a local roads network is for seem to be intimately and, perhaps increasingly in recent years, tied up with a developing attention to "place" as a concept for communities and supporting policy.

Trying to quantify the "value" of local roads in an absolute sense serves no useful purpose. The local roads network is invaluable, because the country could not operate without it. It is irreplaceable. Therefore, we need to look for a relative measure of value.

Scotland's National Performance Framework is a unique, nationwide articulation of policy aspirations for the country as a whole. It follows that an approach to measuring value for local roads should align with this framework and as part of this work we have developed a tool to do this.

The literature review identified nine principal relevant studies, together with roads use data and forward projections for Scottish transport networks. Together, this body of work presents a complex picture, identifying a number of trends which may have transformative effects on the roads network, such as low emission vehicles and automated vehicles, changing age profiles and attitudes to car ownership, without definitively stating that the current direction of travel in terms of usage and the obligations that flow from this is likely to change significantly in the medium term. At the same time,

there are a number of useful studies that point to the need for a greater focus on transport inequalities and the absence of policy that is explicitly aimed at dealing with these.

Through the consultation exercise, a broad consensus was seen about the criticality of local roads infrastructure and the need to frame this in broader socio-economic terms, recognising the systemic nature of the network, as well as a willingness to enter into a debate about the strategic drivers for the network, both now and in the future.

Drawing on research and consultation, a framework was developed for an evaluation model that incorporates both functional and broader socio-economic components to serve as a policy and decision tool for the network across the country. The key principles for this model were that it should:

- Reflect the core function and purpose of roads as physical connectors for people, businesses and communities
- Be sensitive to variances in geography and place
- Treat the road as a network (or system) and a network within and connected to other networks
- Align with strategic policy objectives and drivers
- Be responsive to need at a community level
- Reflect expected future trends and changes in need

The **Local Roads Evaluation Model** ("LREM") incorporates three "levels" of analysis:

- Level 1 - **Utility Ratio** - which draws on readily available, directly attributable roads data to compare user willingness to pay ("User Spend") with the cost of the network ("Network Cost");
- Level 2 - **Social Value** - also evidence-based but drawing on wider non-roads specific datasets; and
- Level 3 - **Future Value** - which is essentially predictive and responsive to policy and future trends.

These levels are illustrated in the simplified diagram below.

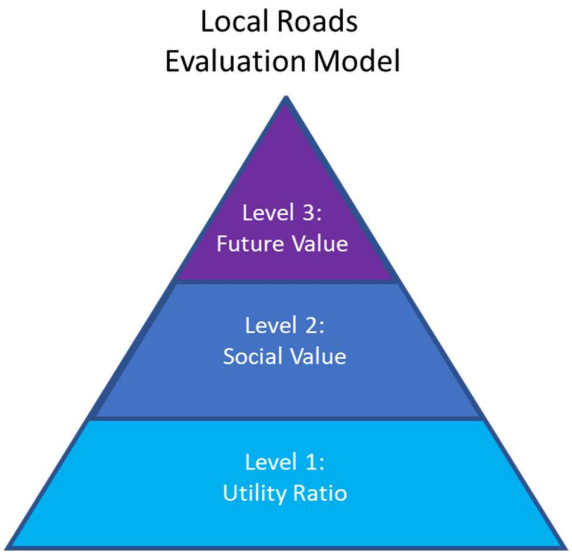

Fig. 1 – Local Roads Evaluation Model

"User Spend" is intended to be a measure of value for the local roads network, using what users of the network collectively spend in order to be able to make use of it. We derived a "Utility Ratio" from this User Spend by dividing it by the accumulated cost or expenditure required to sustain the network ("Network Cost"), including, but not limited to local authority expenditure. This ratio shows that what users are prepared to spend to use the local network is significantly greater than what is spent on making it available. In this sense, the network is arguably beneficial in net terms.

User Spend does not include a potentially important element, which is the value of the utility networks underneath the road surface. However, the research team does not at this stage have access to consistently quantifiable data that would allow assessment of impacts or costs for these underground networks. This may form part of subsequent research work.

Based on the data available for this report, we calculated an aggregated User Spend of **£6.4bn** for Scotland's local roads network and a "Utility Ratio" for Scotland of **3.46 to 1**. This can be taken as a form of input : output multiplier or a proxy measure of value for the local roads network. These figures provide a Scotland-wide ratio but it can be adapted regionally and locally, using the relevant data.

However, as with all cost : benefit ratios, it is important to put this ratio in context and treat this as a relative rather than an absolute measure of value; nor should it be used in isolation. What we are interested in is how this can be used as a component of a broader set of tools for measuring change.

The Utility Ratio could be applied for a number of purposes, for instance to evaluate:

- local authorities against the national ratio
- change over time (e.g. spend from one financial year to the next) at local authority level
- proposed investment (or disinvestment) in specific areas within local authorities
- the implications of spending decisions across local authority boundaries (e.g. through City Region plans).

The Utility Ratio can be thought of as a "Business as Usual" measure, based on historic data.

The purpose of the second (Level 2) level is to use broader socio-economic datasets to highlight key dependencies at regional, local and sub-local levels with a view to adjusting the baseline Utility Ratio to arrive at a more broadly defined broader measure of value, albeit one which is distinct from the more generic "business as usual" economic Utility Value.

The Level 2 analysis would still be data-led but use broader datasets that require a degree of interpretation as to their applicability. This might include information around economic activity, social need, consumption of other public or charitable services, use of community assets, and environmental quality.

Level 3 would incorporate "forward-looking" elements derived from policy and community consultation. The NPF alignment tool developed for this report could form part of the Level 3 toolkit. It is likely to be a primarily qualitative assessment. Reflecting the multiple functionality of the roads network, high-scoring networks or projects at Level 3 would be likely to demonstrate alignment with a significant number of National Performance Outcomes.

This report concludes that local roads are strategically significant for the social, economic and environmental wellbeing, not only of local communities, but Scotland as a whole, and that this needs to be reflected in policy and planning for the sector. There is, therefore, a strong case for adopting a new approach to valuing the roads network.

A new evaluation model has the potential to help policy-makers and practitioners to embed the wider social, economic and environmental impacts of local roads in their decision-making and therefore make more informed investment (or disinvestment) decisions going forward.

Potential next steps

This research report offers a "concept model" based largely on secondary research, with a small amount of primary data collected through the consultation work.

The next steps would involve a more extensive applied research phase, testing this conceptual approach "on the ground" in a broadly representative number of areas with a view to a wider rollout. This would seek to explore applicability across the typology of geographies set out earlier, the importance of interdependencies between and within the trunk and local roads systems, and the particular impact of cities on the wider regions in which they are located.

The key objectives of this testing stage would be to:

- Test and refine the theoretical model using user feedback to ensure that it works for roads and wider transport planning and management across all of Scotland's 32 local authority areas
- Establish potential for a standardised approach with accompanying guidance to ensure consistency and comparability
- Demonstrate how the model works to embed local roads in wider strategic considerations of prosperity and wellbeing.

2.0 Project Scope

The Society of Chief Officers of Transportation in Scotland (SCOTS), funded by Scottish Roads Research Board and supported by the Improvement Service, aims to fill a current gap in the understanding of the value of the local road network to the social and economic wellbeing of Scotland and its communities.

A consultancy team drawn from three organisations: Community Models, Caledonian Economics and the Social Value Portal was appointed by SCOTS to undertake a combination of primary and desktop research and to use this analysis to address this gap and propose a way of answering the question of the value of the local roads network in a way that is relevant to policy and practice within the roads sector in Scotland.

Preamble

For this work to have practical use, the consultancy team was clear from the outset that a 'baseline' was needed, as the question of the value of local roads was meaningful only by reference to a wide range of external factors. Our reasoning for this approach is discussed later in the report. We therefore made the assumption that we would be able to identify, from our research and our engagement with stakeholders, that there is a broad consensus of what 'good' looks like for local roads, and within that broad heading for local roads maintenance and conditions conducive to effective road haulage and freight.

We also assumed that there would be an accepted current baseline position around the current condition of local roads, current maintenance arrangements and identified investment requirements.

From this starting point, our intention was to focus on options, priorities, and potential economic and social impact.

This information would then (we thought) lead us to identifying the drivers, the rationale and the 'mandate' for continued investment in local roads (= the 'why'), the options available to policy makers/investors (the 'what') and the means of maximising economic and social value from the network (the 'how'). From here we would be able to consider the socio-economic impact of varying levels and types of investment (and disinvestment).

In practice, we did identify a broad qualitative consensus on the important determinants of "value" in a local roads network; while a range of different and not always mutually consistent elements emerged, these largely repeated themselves, which meant that the hypothetical definition we had constructed remained valid (see Chapter 5 below). We were also able to identify a cost-based approach which provides the foundation of our proposals in Chapter 6 of the report.

There was much less clarity on how future investment should be directed – and this in fact led us to our proposals and conclusions in Chapters 6 and 7 of the report. What was particularly revealing was how a new contextual and analytical perspective on the purpose and function of local roads opened up the potential for revalidating the role of local roads in communities and society at large – in particular making the case for decision-making about local roads to be strategic rather than tactical, which could in turn lead to a radical rethink of how we prioritise investment in all transportation and communication networks to deliver a sustainable future for Scotland.

Our approach

We undertook the following activities in order to complete the scope of work:

1. Framing the question. Articulation of the 'purpose' of local roads and how this varies between different settings (e.g. urban, suburban, accessible and remote rural, island, etc.) and how this

is likely to evolve in the context of macro-economic and societal trends, Government economic development strategies and consequential policy instruments.

2. **Data gathering and analysis**. Examination of the characteristics of the local road network, based on publicly available data.
3. **Literature review** – Assessment of existing methodologies for measuring the socio-economic impact of roads and other relevant research into the current and future drivers of local road use.
4. **Consultation**. A wide-ranging consultation to provide a cross-section of stakeholder views and primary evidence to support our data analysis.
5. **Evaluation Model.** Drawing on the research and consultation process, we then developed the foundations for a model which starts from a baseline value for the local roads network and builds an evidence-led approach on this foundation, drawing on wider socio-economic datasets and aligning with national policy objectives.

Report Structure

This report summarises our findings from the work. The core of the report sub-divides into four broad thematic segments, followed by conclusions and recommendations:

- Developing a theory of value for the local roads network (Chapter 3)
- Research and literature review (Chapter 4)
- Consultation results (Chapter 5)
- Draft Evaluation Model (Chapter 6)

3.0 Building a Theory of Value

3.1 Where do we start?

Infrastructure is widely recognised to be a key driver of success for nations[1] and roads are a fundamental component[2] of any nation's infrastructure.

Scotland is no exception. Roads are ubiquitous - they permeate every aspect of our lives. A meaningful discussion about the value of local roads has, therefore, to start from a broad conceptual platform, but at the same time recognise the immediacy of the connection between local roads and the communities and people they serve, which means the question of just how local roads are used will vary from place to place.

This meant that there were two routes for the research that we wanted to avoid:

- Firstly, making the study too narrowly confined to the technical and operational characteristics of roads (rather than considering roads as enablers in a wider socio-economic context)
- Secondly, over-generalising in terms of user, purpose and location, and failing to differentiate sufficiently between the effects of these factors.

Our research approach was designed to address these risks and we think was important in order to place the local roads network in its proper context. Infrastructure (and the local roads network is no exception) should be seen as an enabler and we need to be able to test whether and how well it performs that role; in other words, how well it fulfils its enabling capacity. For this, effective contextualisation is key.

In the remainder of this chapter, we set out the conceptual framework for valuing local roads that has emerged alongside our research and consultation with key stakeholders.

3.2 Geography

While it will be argued that there is always going to be a basic core function for the roads system, namely to get people or things from A to B, the enabling capacity of the local roads system is heavily influenced by its geographical context. The level of redundancy and the range of user types – motorised and otherwise - will vary. In some places (e.g. city centres), this basic core function will be sharing road-space with other ancillary functions where movement is less linear or even ceases altogether as streets become places for people to meet, extensions of indoor retail space, the setting for cultural and other collective activities. Expectations of the local roads network therefore differ from cities, to small towns, to remote rural areas.

This study therefore needed to reflect a diversity of geographical types in its evidence gathering and conclusions.

[1] See, for example, the OECD Global Competitiveness Report, 2018
[2] Ibid – the report weights transport and utility infrastructure 50:50 and roads form 25% of the transport element

The need for geographical "granularity" in the analysis needed to be balanced against keeping the research within a manageable scope, so we opted for a slightly modified version of the Scottish Government 6-fold Urban Rural Classification[3], as follows:

	Urban Rural Classification
1 Large Urban Areas	Settlements of 125,000 or more people.
2 Other Urban Areas	Settlements of 10,000 to 124,999 people.
3 Accessible Small Towns	Settlements of 3,000 to 9,999 people and within 30 minutes' drive of a settlement of 10,000 or more.
4 Remote Small Towns	Settlements of 3,000 to 9,999 people and with a drive time of over 30 minutes to a settlement of 10,000 or more.
5 Accessible Rural	Areas with a population of less than 3,000 people, and within a 30-minute drive time of a settlement of 10,000 or more.
6 Remote Rural	Areas with a population of less than 3,000 people, and with a drive time of over 30 minutes to a settlement of 10,000 or more.
7 Islands	Our additional classification. Not included separately in SG classification

Table 1: Scottish Government Urban-Rural classification model

How this classification is used in the conceptual framework is explained in more detail below. It shaped the way in which we sought a cross-section of views through the consultation process. It is also worth noting in passing that four of the classifications are defined by their drivetime to a larger settlement, which will almost certainly be determined predominantly or entirely by the local (as opposed to the trunk) roads network.

3.3 Systems thinking

In order to tackle the question of the value of the local roads network, we need to think of local roads as a system which itself is part of a group of systems. Systems make everything work – in the man-made as well as the natural world. This may sound obvious, but we can lose sight of this essential truth because people like to analyse things in their component parts. This mental approach of reducing a complex problem to its component parts (which we can call "reductionism") is an acquired analytical process embedded in us from our earliest years of education.

Reductionism works very well in many situations. The ability to dismantle a complex whole into its simple constituent parts gives us a great deal of insight and understanding. However, in dynamic systems, the component parts interact in a way that is not evident from examining them separately. Put simply, in a system, the whole is greater than the sum of the parts. The result is that systems behave in unpredictable ways or fail to deliver outcomes that analysis of the component parts suggest should have happened.

"Systems thinking" is not a new thing – it has been a defined concept in various academic fields since about the 1950s. Its key insight is that the essential features of a complex system lie not simply in the components that make up the system, but in the way they connect with one another. These connections create "feedback loops" where

[3] See https://www2.gov.scot/Topics/Statistics/About/Methodology/UrbanRuralClassification

events caused by the system feed back into the system and influence how the system works.

Systems have the capacity to surprise because of the way the elements interact. This is particularly true of systems involving people.

The element of surprise in the system its "non-linearity". In other words, the relationship between cause and effect is non-proportional. You might think that for every extra tonne of fertiliser you put on the soil the yield will go up by a proportional amount, but it won't – at some point the yield will go down because you have overloaded the system.

Changes in the system that arise from what is happening in the system itself are called feedback loops. Feedback loops can be *reinforcing* (they amplify or increase change) or *balancing* (they provide a counterweight to change). In ***Doughnut Economics***, Kate Raworth gives the simple example of chickens as illustrated in Fig. 2 below[4]. The reinforcing loop is more chickens laying more eggs, resulting in more chickens. The balancing loop is more chickens attempting to cross the road and being run over – resulting in fewer chickens. When both feedback loops are in play, even with a simple system such as this, predicting outcomes is difficult – the flock might continue to grow, collapse or even oscillate continuously around a stable size.

What we are seeing is the interplay of two systems – the chicken-producing system and the road transport system. Similarly, roads systems interact (often by hosting) with other forms of infrastructure such as communications networks, energy networks and other transport systems, as well as wider economic and social systems.

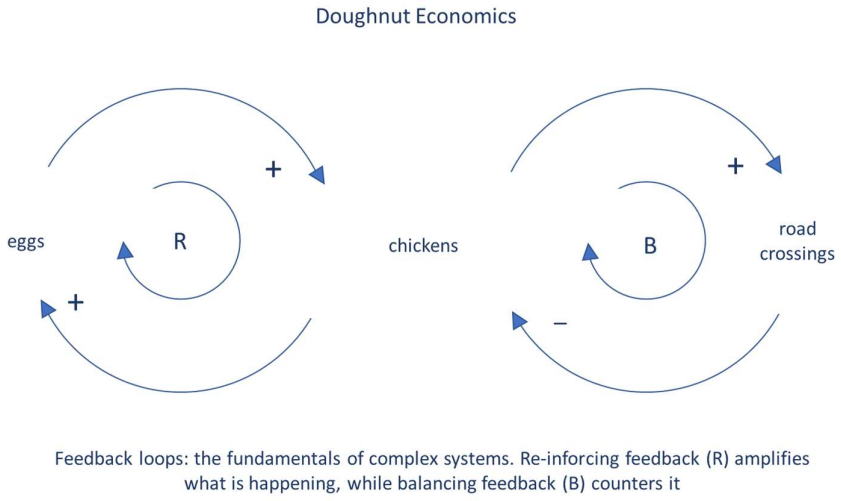

Fig. 2 – Why chickens cross roads: feedback loops in complex systems[5]

[4] Doughnut Economics (Ch 4, p120), Kate Raworth (Chelsea Green Publishing, 2017)
[5] Ibid

What makes systems thinking so hard to follow through in practice is that it runs counter to some deeply embedded ways of policy thinking and the expectations that result in policy implementation.

There is an understandable desire to design policy instruments that will give rise to defined, predictable outcomes (the classic "silver bullet" approach) and, in the event of policy failure, to use evidence to deconstruct the "machine" and find out where the problem lies. If we accept that the whole is not the same as the sum of its parts, an element of irreducible uncertainty creeps into policy design that can be deeply uncomfortable. As a consequence, the question about how best to incorporate systems thinking into policy initiatives (for example, through place-based approaches) remains a difficult one to answer.

The local roads network in Scotland is part of a complex transport system, connected to other systems of communication, of transfer of people, data and things, and it is the way these all work together that defines the society in which we live. None of these elements can be examined without considering how they interact.

One of the key questions in the context of this report is *where does the local roads network start and stop?*

One set of boundaries is determined by responsibility for administering the network. As the national administrator, Transport Scotland has responsibility for the "strategic" or "trunk" network, while local authorities are tasked with the rest – or most of it, at least[6].

But if there is a functional concept of "local use" as opposed to "trunk" use, this does not necessarily follow the administrative division of responsibilities. There are areas of the country, for instance, without access to the Transport Scotland-administered trunk network, where local roads act as the principal arterial routes. There are trunk roads in other areas where the prevalence of short journeys suggests that they are for certain sections acting as local roads.

There are also roads in the same area which appear to have similar characteristics that are alternately designated "trunk" or "local". There are multiple-use roads (particularly in the centre of cities) which bleed into public spaces.

At a Scottish level of course, the term "local roads network" doesn't describe a single concept with a distinct identity. Scotland has one roads network – not two, one local and one "trunk" or national. This network consists of interconnected roads with a wide range of densities and levels of use. At a regional level, it is then possible to identify roads networks which function as coherent sub-systems of the Scottish network.

But the absolute separation between local roads and trunk roads is primarily administrative. To assume this separation is reflected in practice would be to overlook the way systems in general (and road systems in particular) function. In some of our discussions, the term "strategic" has been used interchangeably with "trunk" to describe the main arterial routes, but if by "strategic" we mean supportive of a clearly

[6] Some roads are private – either because they always have been or because at some point the road has been unadopted by the local authority

defined strategy (and therefore of "strategic" significance), that does not seem to be a robust distinction either.

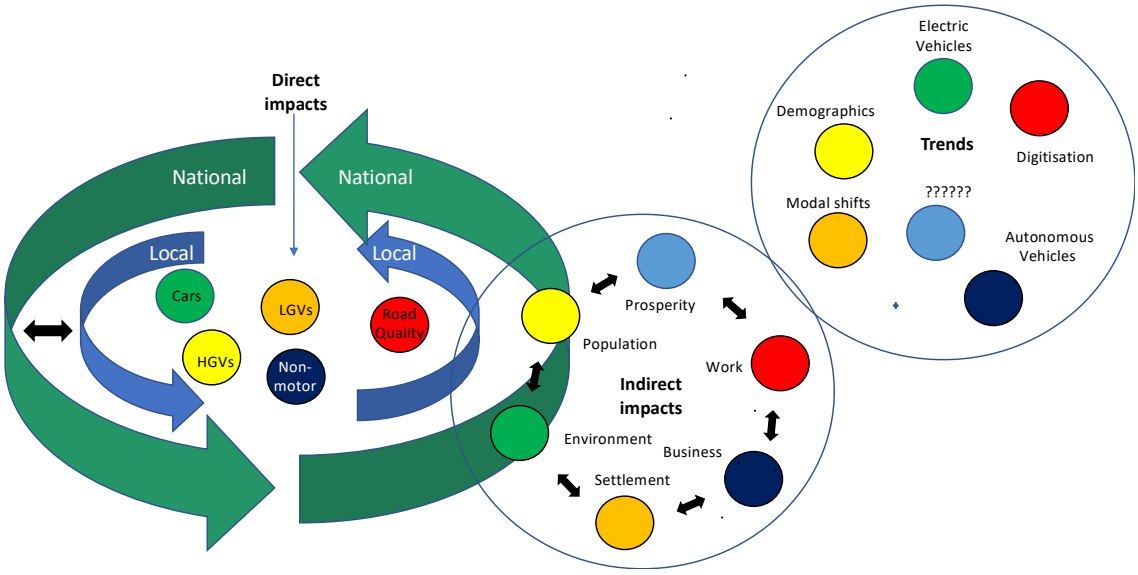

Fig. 3: Local roads system as part of a wider set of systems

3.4 Defining an "effective" roads network

We need to be clear about the role that local roads play across Scotland. Without underplaying the significance of the trunk roads network in macroeconomic terms, there are regions of Scotland where local roads function without trunk roads, while trunk networks in those parts of Scotland that have them also need the local roads network to feed them, draw off capacity and at times (when the trunk system malfunctions) bypass them altogether. The local network acts not just as a feeder, but also as a buffer, absorbing excess capacity and providing resilience.

One insight from our consultation process was that there are choices to be made between investing in the trunk network and the local network ***even when*** the primary objective is to strengthen the trunk network. What makes the Scottish roads network at a national level a true network is the local roads, not the trunk roads. It follows, therefore, that sustaining investment in local roads is fundamental to preserving an effective network for Scotland.

3.5 A sense of place

While access or connectivity (getting goods and services from Place A to Place B) still dominates much of the discussion on local roads, perspectives on what a local roads network is for seem to be intimately and, perhaps increasingly in recent years, tied up with a developing focus on "place" as a concept for communities and supporting policy. This of course has the potential to modify and multiply the purpose which roads serve. They may be streets as well as roads, public spaces for recreation or social interaction.

We only have to look at the Scottish Government's Place Standard (see Fig. 4 below) to see how extensively - both directly and indirectly - the local roads network is connected to our conception of place.

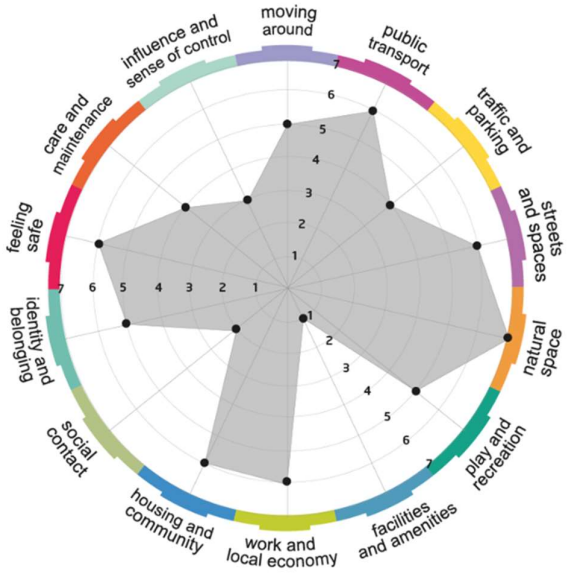

Fig. 4 – Scottish Government Place Standard[7]

It is not within the scope of this report to go into detail on placed-based approaches to development and service delivery, but it is clear in general terms that a focus on "place" as a development driver is inherently about making locations "stickier", more liveable and probably in some contexts (notably urban) denser, with shorter travel distances, all of which change the nature of the demands placed on the local roads network and raise questions about its capacity to reconcile increased demand for modes of active travel, notably walking and cycling, with motorised vehicle use.

3.6 Operating "within the doughnut"

The question of value can (in theory) be framed in absolute or relative terms. The absolute value of something is its replacement cost, if you use money as the conversion factor[8]. In this absolute sense, the local roads network is invaluable, because no country with any level of economic and social sophistication could operate without one. It is irreplaceable. The concept of a functioning nation would be inconceivable without a local roads network. Put another way, very few journeys, regardless of the main mode of transport, can be made without some use of the local roads network. There is no counterfactual, so trying to put an "absolute" value on local roads would be a meaningless exercise.

[7] See https://www.placestandard.scot/

[8] Or, as Adam Smith puts it in the Wealth of Nations: "The real price of everything, what everything really costs to the man who wants to acquire it, is the toil and trouble of acquiring it." Book 1, Ch V

So for our purpose, which is to find a measure of value that can inform strategic choices and decision-making, we need to ask the value question in relative terms. To do that, we need to ask what "good" looks like. In other words, what characteristics does a well-performing local roads network have? We can then ask what value is gained or lost by the network being above or below this benchmark. Seeing how the perspectives of different stakeholders vary on this question was therefore a key objective of our consultation process (see Chapter 5).

At the outset, we developed a working definition of what we thought an "effective" local roads network should be – to be tested by the consultation. We said it was one which:

"…enables people and businesses in the area to undertake their daily activities in a manner which does not hinder the ability of communities served by the network to prosper, or lead to undue environmental degradation."

It is important to stress the two key parameters in this benchmark. Firstly, that the network does not hinder the ability of people and communities to prosper, and secondly that it does not lead to undue environmental degradation. Essentially, we are recognising that there is an outer limit, which is the "ecological ceiling" and an inner limit, which is the prosperity and wellbeing of people and communities. This is the "doughnut" in Kate Raworth's Doughnut Economics, as illustrated in Fig. 5 below:

Fig. 5 Living within the Doughnut. Source: Kate Raworth, Doughnut Economics (2017)

As we discuss elsewhere in the report, the opportunities for people and communities to prosper vary by time, place and as a result of societal preconditions. Understanding these variances is key to assessing the "value" of the local roads network in any given area.

3.7 The National Performance Framework

Scotland's National Performance Framework ("NPF") is a unique, nationwide articulation of what "good" looks like for the country as a whole.

The framework aims to:

- create a more successful country
- give opportunities to all people living in Scotland
- increase the wellbeing of people living in Scotland
- create sustainable and inclusive growth

It aims to reduce inequalities and gives equal importance to economic, environmental and social progress[9]. It has developed a set of "national outcomes" with accompanying "national indicators" against which progress is measured.

Fig. 6 below shows the NPF.

Fig. 6 Scotland's NPF

All infrastructure must serve a purpose and it is only reasonable to expect the country's roads network to be assessed against its national performance framework. In essence, we can use the NPF to ask the question: *what is the local roads network for?*

[9] https://nationalperformance.gov.scot/what-it

This ties in with the overarching message of the National Transport Strategy, which provides the sectoral link between the transport sector and the NPF; the strategic "glue" between the framework and the local roads network, as illustrated in the diagram below.

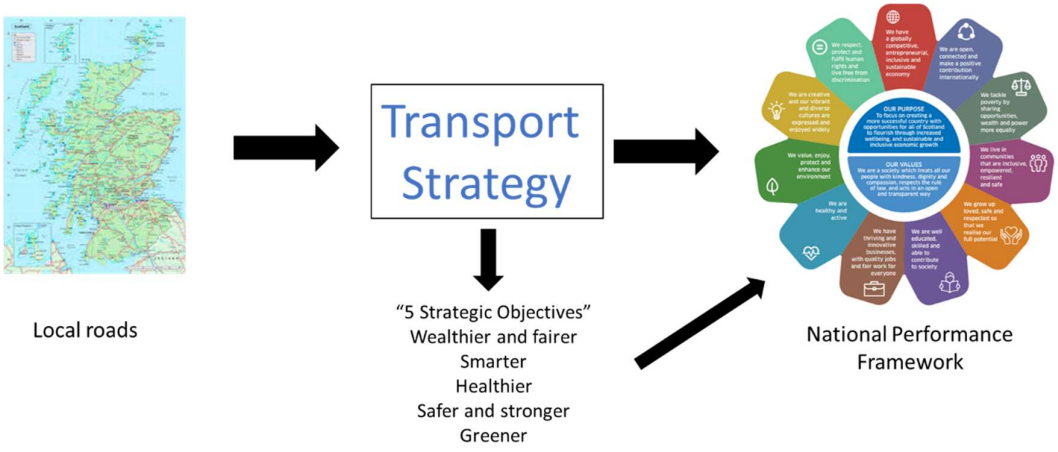

Fig. 7 Connecting the local roads network with the NPF

The NPF also forms a policy planning framework for a breadth of regional and local bodies, including local authorities as the managers of the local roads networks on the ground. These local priorities are captured in the Local Outcome Improvement Plans (LOIPs) agreed by partners in each local authority area.

As part of this project, we developed a high-level geographical "mapping" tool for the local roads network against the NPF. The purpose of the tool is to examine, against each of the Urban-Rural categories, the alignment of the local roads network with the NPF.

If this tool were to be tested with wider groups of stakeholders as part of a process of determining prioritisation and the type of future investment needed in roads, it could help to provide greater clarity over the strength of the conceptual connections that can be made against specific components of the NPF.

From here we could then start to identify areas where investment in the local roads network can start to make a difference to wider policy objectives.

We considered the strength (Strong, Moderate, Weak) of the perceived connection with each National Outcome across the urban-rural classification, initially on an unweighted basis, then by weighting the categories 3, 2, 1 respectively. Positive alignment attracted a positive score, while negative alignment attracted a negative score.

We tested this tool with a small group of participants – the idea being that it could form part of a broader assessment toolkit for assessing policy alignment. The results were an interesting illustration of how participants saw the exercise and the opportunity to consider the function of roads differently.

The sample size was not large enough to include this exercise as evidence in the main body of the report, but more detail on the preliminary mapping exercise is included at Appendix B.

Communities and most businesses (the Scottish economy comprises predominantly SMEs) are primarily dependent on the local roads network. Moreover – and this seems to us to be crucial for a government pursuing an inclusive growth strategy – the local roads network is the key to accessibility and mobility for groups that face social and / or geographical disadvantage, more so than the trunk roads or even the rail network, because of cost and distance.

3.8 Towards a "theory of value" for local roads

To develop a workable framework for assessing the value of local roads, we need a good dose of realism about the evidence base on which such a framework can be built, as well as a focus on clarity and transparency.

A widely recognised analytical tool for forecasting socio-economic impacts is the theory of change. We think the theory of change concept uses key methodological principles which we will do well to follow, but that it struggles to absorb the complexity of a set of nested systems like roads.

Essentially, a theory of change consists of "reverse engineering" the causality of a sequence of events, starting with the desired outcome and allowing people to follow a thread backwards to actions or inputs that they believe will deliver these desired outcomes.

A good theory of change has the ability to map non-linear relationships, thereby linking into systems thinking. However, the development of a theory of change for local roads would face a number of significant obstacles.

The outcomes desired by stakeholders are likely to be many, interconnected, complex, not always internally consistent or even well known. If we define the desired outcomes for local roads so that the causal relationships could be unequivocally plotted between the inputs (e.g. a programme of fixing potholes) and the outcomes, we would end up with a relatively narrow set of outcomes – for instance reduced damage for car-owners and better road safety statistics - which do not reflect the network's wider impacts.

On the other hand, as soon as we widen the scope of the desired outcomes (e.g. better access to employment opportunities), the strength of the causal link becomes much harder to determine – or even unknowable.

A theory of change has the potential to become a useful tool at a more granular level for specific interventions where the social outcomes can be clearly be defined (e.g. better air quality for a particular neighbourhood). The objective of this report is to help map a pathway to a broader practical framework which can ultimately lead to outcomes-based implementation, by mapping out how value can be defined through the process – in effect, a **"theory of value".** This is described further in Section 6.

4.0 Research and Literature review

4.1 Overview

As part of the brief, we undertook a desktop research and literature review to draw on available thinking around how to value roads or aspects of roads provision, as well as to fix some of the key policy drivers and analysis on present and expected future trends of roads use and operation. We examined data from a variety of sources, falling into three main categories:

- Mainstream approaches to valuing roads in the UK
- Demographic and other statistics that can provide trend insight into the wider economic and social use of the local roads network
- Additional transport and roads-related research that addresses broader socio-economic issues

The purpose of this section is to summarise the findings from the review that we think are particularly pertinent to the development of an approach to valuing local roads.

There are nine referenced studies in this section, together with roads use data and a set of forward projections for Scottish transport networks. Together, they present a complex picture, identifying a number of trends which may have transformative effects on the roads network, such as low emission and automated vehicles, changing age profiles and attitudes to car ownership, without suggesting that the current direction of travel in terms of usage and the obligations that flow from this are likely to change significantly in the medium term. At the same time, there are a number of useful studies that point to the need for a greater focus on transport inequalities and the apparent absence of policy that is explicitly aimed at dealing with these.

One important caveat for this section is that transport is a rapidly moving agenda, not least because of the wider drivers of decarbonisation, automation and digitisation, and a retrospective literature review is likely to some extent to lag behind current trends.

4.2 Roads Use

In 2017, the total road length in Scotland 56,364 km (35,030 miles) of which 7% was trunk roads and 93% non-trunk and minor roads.

7% of Scotland's roads by length are trunk roads, of which 1% is motorway. Local Authority major roads account for 13% of the network and less than 0.5% of the network is dual carriageway maintained by local authorities. 48% of Scotland's network is unclassified, while 49% is single carriageway.

One-third of roads in Scotland come under 3 local authorities – Highland (14%), Aberdeenshire (10%), Dumfries & Galloway (8%). There are 10.4km of road per 1000 people in Scotland, which compares to 6.2km in the rest of Great Britain[10].

[10] Source: Scottish Transport Statistics 2018

Comparing the length of road networks in local authority areas with the levels of use and populations shows that there are wide variances across Scotland. Extracts from the data are shown in the table below to illustrate the ranges.

Highest roads use density (mvkm / km)	2.07	City of Edinburgh
Lowest roads use density (mvkm / km)	0.15	Orkney Islands
Median roads use density (mvkm / km)	1.12	East Dunbartonshire
Highest trunk roads density (mvkm / km)	15.53	West Lothian
Highest local roads density (mvkm / km)	1.62	City of Edinburgh
Highest road use per person (km)	17,333	Perth & Kinross
Lowest road use per person (km)	5,375	East Dunbartonshire

Table 2 – Sample road densities across Scotland

If we consider "density of use" – in other words, the relationship between the extent of the network and the number of km travelled, we see, perhaps unsurprisingly, that City of Edinburgh has the most densely used network (2.07 million km travelled for every km of road), while Orkney's is least densely used. Edinburgh at the upper end is closely followed by Glasgow (1.95) and Renfrewshire (1.88), while Orkney at the lower is closely followed by Eilean Siar (0.19), Shetland (0.21) and Highland (0.37). The mid-point is East Dunbartonshire.

West Lothian has the most densely used trunk road network, followed by Glasgow (14.56) and Renfrewshire (14.02) and other Central Belt authorities (North Lanarkshire, City of Edinburgh, East Renfrewshire. City of Edinburgh also has the most densely used local roads network.

The figures per head of population bring other aspects to the fore. Perth & Kinross has the highest road use per head of population, followed by Dumfries & Galloway (15,034) and Stirling (14,106). This may be due to the prevalence of through traffic due to trunk roads and motorways in these areas and in some cases may be due to limitations in terms of other modes of transport.

The 2017 statistics show the total size of the Scottish Local Road Network is 52,683km. This represented an increase of 2% on the 51,623 km (2010, RCI condition reports) stated in the Parkman et al 2012 Scottish study (see below).

We also reviewed the type of vehicle using Scotland's roads from the available transport statistics over the past decade (2006 to 2016). There was 12.8% increase in the number of cars over the period, although they stayed broadly steady at around 84% of all traffic. The largest increase in percentage terms was in Light Goods Vehicles which grew by 28.1% over the decade. As a proportion of all traffic light goods vehicles grew from 8.6% in 2006 to 9.7% 2016. The number of [Heavy] Goods vehicles stayed static in volume and dropped as a proportion of all traffic from 1.5% to 1.3% a decade later. This is important given the relative maintenance impact of the largest vehicles on the roads network.

This suggests a trend to direct freight via smaller vehicles on the road and that volume of freight fell overall (as evidenced below). It also supports other evidence of an increase in business to home deliveries of goods. Light goods vehicles will also be able to access parts of the local roads network that larger goods vehicles will be unable to due to height and/or weight restrictions.

Low emission vehicles are still proportionately a small part of overall car traffic - 0.7% including hybrid electric. However, consideration of future growth rates that includes adequate provision of including low emission charging infrastructure is already being undertaken by transport planning professionals, driven by policy changes that are likely to accelerate the penetration of low carbon vehicles, in particular the Scottish Government's commitment to phase out new petrol and diesel cars and vans by 2032, ahead of the UK Government's 2040 target.

Since the 2012 Scottish study, webTAG guidance has been updated to introduce an assumption for the kw/h for an electric car. It has also dropped the description of an 'average' car as electric consumption will be measured in a different unit (kw/h) to petrol and diesel (pence cost per km).

Detailed tables are included in Appendix C.

4.3 Scotland's Freight

270m tonnes of freight were transported on Scottish roads in 2016. By weight, 75.3% was carried by road, 24.6% by boat and less than 0.1% by air. Freight fell by approximately 65m tonnes (20%) between 1998 to 2012 which is broadly consistent with changes in make-up of the Scottish economy:

- In 1998 – the production sector accounted for 23% and the services sector 68%
- In 2012 – the production sector accounted for 16.7% and the services sector 75.6%[11]

4.4 Purpose of journeys

In assessing the wider economic impact and social value of the local roads network, understanding the purpose of journeys is an important consideration.

4.4.1 General Data

Table 3 below provides a breakdown of these journeys, based on a sampling approach[12].

[11] Source: https://www.transport.gov.scot/publication/transporting-scotland-s-trade/4-transporting-scotland-s-freight/
[12] Sources: https://www.transport.gov.scot/publication/scottish-transport-statistics-no-37-2018-edition/sct01193326941-08/#tb58

https://www.transport.gov.scot/publication/scottish-transport-statistics-no-32-2013-edition/j285663-08

Purpose of Trip (All Roads)	2012 Sample Size 9,836	2017 Sample Size 29,390	2012 %	2017 %
Commuting	2,550	7,810	25.9%	26.6%
Shopping	1,929	6,640	19.6%	22.6%
Visit friends or relatives	1,138	3,390	11.6%	11.5%
Go home	1,518	2,410	15.4%	8.2%
Other personal business	409	1,420	4.2%	4.8%
Education	389	1,370	4.0%	4.7%
Sport/Entertainment	471	1,680	4.8%	5.7%
Business	242	960	2.5%	3.3%
Escort	153	790	1.6%	2.7%
Other	492	760	5.0%	2.6%
Visit hospital or other health	193	690	2.0%	2.3%
Eating / drinking	124	530	1.3%	1.8%
Just go for a walk	139	500	1.4%	1.7%
Holiday/day trip	89	440	0.9%	1.5%
Total	**9,836**	**29,390**	**100.0%**	**100.0%**

Table 3 – purpose of journeys (Source: Scottish Transport Statistics 2018)

Although there is a greater sample size in 2017 which should be considered, overall the picture is broadly stable. There is a relatively consistent result with the top category of commuting – just over a quarter of journeys are travelling to a regular place of work – this category has grown slightly from 25.9% in 2012 to 26.6% in which could challenge suggested patterns of increases of working at home.

4.4.2 Tourism and Leisure

Tourism and Leisure both appear to have seen a growth in traffic in the period between 2012 and 2017 based on the samples. There are sector-specific reports that support this overall view; two of these are summarised below.

Scotch Whisky[13]

A study compiled by the Scotch Whisky Association found that there were a record number of visitors to distilleries in 2018, 1.9m visits to scotch whisky centres – up 11.4% on previous year and almost double the 2012 figure. Of 122 malt distilleries, 66

[13] Sources: https://www.bbc.co.uk/news/uk-scotland-scotland-business-45024218
https://www.visitscotland.org/binaries/content/assets/dot-org/pdf/research-papers-2/whisky-tourism-2018-final.pdf

have visitor centres that are open to public, with eight more accepting visitors by appointment. Spending at centres increased £60.9m year on year – up 15.6%.

There are five key whisky_visitors' regions, Highland, Speyside, Lowland, Islay and Campbeltown and the whisky industry accounts for 80% of the value of food and drinks exports for Scotland and supports 7,400 jobs in rural areas.

North Coast 500

North Coast (NC) 500 is a high -profile tourist initiative based on the revival of the road touring concept – in this case the 516 miles of Scotland's north coast road. NC 500 aims to "capitalise on the natural and cultural assets in the North Highlands and generate economic opportunities for the area"[14].

A baseline study was undertaken under the aegis of HIE and the University of Glasgow, shortly after its inception. The purpose of the study[15] was to examine the economic impact of the initiative and (albeit based on data taken over a limited period) suggested a material increase in economic activity (surveys indicate a 10% - 20% increase in trade along the route). The study also described the impact on north Highland's transport and road infrastructure. Traffic volume data was taken at 9 points on the route. These counting machines are now permanent fixtures. Anecdotally, we understand that there has been a significant increase in traffic volumes and business revenues as the popularity of the route rises, although up to date figures were not available at the time of this report.

A Facebook survey on three pages associated with the NC 500 highlighted the following stakeholder concerns, including:

Short-term - increased traffic/travel time; deterioration of roads e.g. using verges rather than passing places; bad driver behaviour; limited car parking spaces; increased speeding.

Longer term: availability of finance for maintenance and upkeep of roads, especially with increased motorhomes on the road; and infrastructure – public toilets, increased waste[16]

The early success of NC500 has prompted others to develop similar touring concepts – including Heart 200, which runs for 200 miles around Perth, Stirling, the Trossachs and Highland Perthshire, and the North East 250, which covers the whisky distilleries of Speyside, the mountain passes of the Cairngorms National Park, Royal Deeside, Aberdeen and the Moray Firth Coast.

4.4.3 Education and Health

Although they form a smaller proportion of total journeys, from a social impact perspective it is worth noting from the Scottish Transport Statistics the figures relating to visiting friends and relatives (which show a consistent level at 11.5% of journeys) and increases for education (4.0% to 4.7%) and hospital & healthcare (2.0% to 2.3%). While in themselves these figures are not indicative of increased use of roads for these

[14] North Coast 500 Economic Baseline Study, HIE / University of Glasgow TERU, June 2017
[15] Ibid
[16] Source: http://www.hie.co.uk/common/handlers/download-document.ashx?id=a79fc94d-cfce-4eca-aa9b-21b31ee9c331

activities, they do suggest that road journeys for these key social elements are not being replaced by some other mode of transport or communication.

4.4.4 Social care – home visits

A review of Social Care figures between 1998 and 2017 provides an interesting insight into how the pattern of social care provided to clients in their homes has changed.

The total number of clients receiving home care has declined from 79,290 to 59,640 between 1998 and 2017. However, the average number of hours per client has increased from 5.1 hours per week to 11.7.

In that time period the range of Local Authority provision of services has reduced and private service provision where the Local Authority is the only client fell from 74,200 to 27,960, whereas private clients grew from 1,310 in 1998 to 23,110 in 2017.

The number of clients aged 65+ receiving 10+ hours increased from 7,150 to 16,910 over the same period. The Scottish population aged 65+ increased from 792k to 999k over this time, which means that the percentage of over 65s receiving home care has almost doubled from 0.9% to 1.69%.[17]

Although the total time per client is given, the data does not capture the frequency of visits to each client. Further data could be sought from both public and private providers in order to better understand the flows of carers providing homecare within a given Local Authority area.

4.5 Licence holder demographics

One anecdotally observed trend (e.g. through the consultation process) was the supposed decline in licence-holders amongst younger people. As part of the literature review, we also examined the age and gender demographic of potential road users to see whether there was any evidence to support this perception.

4.5.1 Changes in number of licence-holders by age between 2012 to 2017

The Scottish Household Survey[18] in fact showed that in overall terms the percentage of licence holders during this period increased slightly – by 2% between 2012 and 2017. There was a slight reduction in the 20-29 and 30-39 group which could support the contention that millennials are less likely to be motivated to drive; on the other hand, there was an increase in the 17-19 age group.

Given the small sample size and only a 3-year span of this category (compared to 10 years or more in the other groups) there is more volatility in figures for the 17 to 19s.

The only major changes were an 8% increase (59% to 67%) of people aged 70-79 and a 10% increase (37% to 47%) of people aged 80+.

If the sample size is representative of the wider population, there could be a number of reasons for these results, including:

[17] Source: Scottish Household Survey
[18] Source: https://www.transport.gov.scot/publication/scottish-transport-statistics-no-37-2018-edition/sct01193326941-04/#tb117

- A generally aging population, which means that existing licence-holders are tending to remain licence-holders for longer;
- The limitations of public transport and / or distance constraints outside the main metropolitan areas means that younger people still have little option but to learn to drive a car (compared with London, for example, where car ownership is an increasingly unattractive option compared with the alternatives).

The greatest proportionate movement is seen amongst men aged 17-19 with a 7% increase (35% to 42%) now holding a licence, although there is significant volatility in the figures – 28% in 2015, 36% in 2016 and 42% in 2017 which may in part be attributable to a relatively small sample size.

The main movements in female licence holders are in above retirement age. Between 2012 and 2017 there has been a 13% increase (43% to 56%) in women aged 70-79 now holding a licence and a 12% increase in women aged 80+.

There has been a much smaller increase in the percentage of men in these age groups holding a licence so the overall increase in older people holding a driving licence appear to be almost entirely amongst women. Although the transport statistics do not offer explanation of the movement, some working hypotheses could be that these drivers would be more likely to be using the local than the trunk road network and that the increase is more likely to be through necessity than through choice.

4.5.2 Possible trends

There are a number of possible trends identifiable from the data but not one that is clearly dominant – and we need to be careful not to let perceived trends unduly influence the analysis and subsequent policy development. For instance, the prevailing narrative around millennials is probably largely not just an urban, but a big city narrative, which only applies to certain limited areas of the country. For much of Scotland, mobility remains heavily dependent on car ownership.

4.6 Forecasts

Transport Scotland models expected road and public transport use for Scotland. Combining their transport and economic land use modelling, the 2018 forecasts[19] offer the most likely scenario to 2037 as one which presents a picture of increased private car use, not only because of the projected increase in population but on a per capita basis as well, while bus use is projected to decline both within towns and cities and on inter-urban routes as well. Rail is projected to show a significant increase, but on roads, rising journey times and more congestion are predicted.

The modelling basically paints a picture of a Scotland that will travel more, either by private car or by train.

Leaving aside the question of whether the replacement of diesel and petrol cars will be rapid enough not only to offset but actually reduce emissions over the same time period, the projections raise issues of equality of opportunity for those without access to a private vehicle or affordable rail travel, worsening performance from the perspective of the private user and business and increased pressure on roads

[19] See: Transport Forecasts 2018 – results from Transport Scotland's land-use and transport models

maintenance budgets for local authorities – although disparities in provision are not explicitly dealt with in the Transport Scotland modelling.

Increased road use is projected to be spread across the country, as Table 4 below shows:

Regional Breakdown of travel miles

Sub-national Area	2014	2017	2027	2037	Change %
SESplan	4.33	4.62	5.35	5.98	38%
Aberdeen City & Shire	2.01	2.28	2.72	3.04	51%
TAYplan	2.46	2.68	3.12	3.40	38%
Glasgow & Clyde Valley	5.72	6.03	7.09	7.94	39%
Ayrshires	1.33	1.40	1.55	1.66	25%
Dumfries & Galloway	1.04	1.14	1.26	1.32	27%
Stirling, Clacks & Falkirk	1.28	1.34	1.54	1.72	34%
Highland, Argyll, Moray & Islands	2.20	2.52	2.81	3.00	36%
Scotland	**20**	**22**	**25**	**28**	**37%**

Table 4 – Regional road traffic forecasts from Transport Scotland forecasts 2018 (billion vehicle miles p.a.)

That said, while the projected increase in road travel miles is similar across the Edinburgh (SESplan), Glasgow and Dundee (TAYplan) areas, Aberdeen City & Shire shows the most significant increase. As the steepest annual increase occurs between 2014 and 2017, this suggests that the Aberdeen Western Peripheral route has not only reduced congestion but also resulted in a net increase in miles travelled.

The summaries in Tables 5 & 6 below show the projected increase in car use, congestion and journey times, as well as the continued decline in bus use.

Summary of road traffic forecasts

Year	Car trips (millions p.a.)	Goods vehicle trips (million p.a.)	Traffic (billion veh miles p.a.)	Journey Time (min/mile)	PM peak delay (secs/mile)
2014	1,830	388	20.4	1.49	29.3
2017	1,890	400	20.2	1.49	29.9
2022	1,990	434	23.8	1.51	33.8
2027	2,100	471	25.4	1.55	40.0
2032	2,190	514	26.9	1.61	47.8
2037	2,280	558	28.0	1.67	57.1
Increase %	**25%**	**44%**	**37%**	**12%**	**95%**

Table 5 – Forecast private vehicle use from Transport Scotland forecasts 2018 (billion vehicle miles p.a.)

Summary of public transport forecasts

Year	Urban Bus	Inter-Urban Bus	Rail
		Million passenger miles p.a.	
2014	236	1,320	2,400
2017	238	1,280	2,580
2022	233	1,280	2,840
2027	227	1,280	3,030
2032	223	1,250	3,220
2037	220	1,250	3,400
Incr / Decrease %	**-7%**	**-5%**	**42%**

Table 6 – Forecast public transport use from Transport Scotland forecasts 2018 (billion vehicle miles p.a.)

If we adjust for the projected increase in population, we see that private car usage (as well as rail usage) is projected to increase on a per capita basis, which does not seem consistent with, for example, a place-based trend to more active transport, shorter journeys and denser urban living. Car trips, for instance, show an increase of 16% per person.

Summary changes in modes of transport

	Population	Car trips pp	Urban Bus (miles pp)	Inter-urban Bus (miles pp)	Rail (miles pp)
2014	5.35	342	44	247	449
2037	5.76	396	38	217	590
Change		54	-6	-30	142
Change %	**8%**	**16%**	**-13%**	**-12%**	**32%**

Table 7 – Forecast changes in modal use from Transport Scotland forecasts 2018

These Transport Scotland projections indicate largely as a "business as usual" or "more of the same" base case, notwithstanding the potential for more disruptive social, behavioural or technological trends.

4.7 Existing relevant roads studies from the UK

Our review of relevant studies was undertaken with a specific focus on studies that could aid the evaluation of the wider economic and social value of the Scottish local roads network. What follows is a synopsis of the key reports.

Two main texts were included for this element of the literature review.

The first is a Scottish Study from 2012 that is the authoritative work on the technical calculation of economic value of the local roads network, based on budgetary spend, personal spend and preventative and consequential spend from better or poorer road conditions.

A high-level summary of the relevant aspects of this report follows.

Study 1	Economic, Environmental and Social Impacts of Changes in Maintenance Spend on Local Roads in Scotland
Authors (Sponsors)	Transport Research Laboratory C C Parkman, T Bradbury, D Peeling and C Booth 2012 (SCOTS, COSLA, SOLACE, Transport Scotland, The Office of the Scottish Roadworks Commissioner)
Study purpose	Assessed the economic, environmental and social impacts of cuts to the roads maintenance budgets for local roads in Scotland in a steady state scenario and with a reduction of 20% and 40% in current budgets for 10 years with an uplift thereafter.

Report Context

Prompted by the findings of the Audit Scotland Report – Maintaining Scotland's Roads (Audit Scotland, 2011), which highlighted that the overall maintenance backlog on Scotland's roads was £2.25 billion, the Parkman 2012 study examined the economic, environmental and social effects of reductions in the level of maintenance funding for local roads in Scotland between 2010 and 2030.

In addition to a quantitative assessment of the impacts of reductions in maintenance funding, a literature review and a workshop with a wide range of stakeholders were used to better understand the qualitative effects that could not be monetised.

Methodology

Comprehensive literature review over ten years. This found few reports that contained quantified evidence of the consequences of reduced road maintenance funding. There was a significant amount of qualitative evidence of the effect of low maintenance, although a large amount of this evidence did not fit directly with the current Scottish Transport Appraisal Guidance (STAG) criteria.

Quantitative Analysis

Scenario 1 (Base case): Constant annual level of spend (2010/11 funding level continues) for 20 years.

Scenario 2: Reduction in the annual spend by 20% for the first 10 years then progressive return to current (2010/11) levels then increase by 2.5% p.a. for the last 5 years.

Scenario 3: Reduction in the annual spend by 40% for the first 10 years. Return the maintenance budget to current 2010/11 levels using annual uniform increases, between 2020 and 2025. From 2026, increase annual funding by 2.5% p.a.

Specific Approach to wider economic value

The approach taken to assessing the economic value was predominantly based around vehicle operating costs, journey times and journey reliability. These areas were described in qualitative terms, although only Vehicle Operating Costs were quantified.

Vehicle operating costs

The quantification of Vehicle Operating costs identified Fuel Costs as the highest Vehicle Operating Cost (nearly half of VOC total), with labour for vehicle maintenance being the second largest component. Vehicle Operating Costs were 93% of Total Operating Costs.

The second highest quantified category was CO_2 emissions which made up less than 5% of the quantifiable total.

Journey times (not quantified)

Deterioration in road conditions was expected to cause increases in travel time as vehicles travel slower on roads in poorer condition. This effect could, however, be more than offset by less disruption to journeys due to reduced road works. Infrastructure failures are likely to increase journey times for all types of road users due to travel diversions. The possible effects on road-user journey times from potential breaks in network links can cause significant local issues and affect economic activity (e.g. freight diversions and loss of passing trade).

Journey reliability (not quantified)

It may be that, if the disruption is of short duration, the costs to road users of that disruption would be unlikely to outweigh savings from reduced direct maintenance costs or the changes in road-user costs that occur when maintenance budgets are reduced.

Planned Maintenance (not quantified)

Reductions in the maintenance budget are aimed primarily at planned maintenance activities. Studies have shown that the costs of recovering from deterioration in infrastructure quality are much higher than the costs of retaining existing quality levels.

Infrastructure failures are likely to decrease economic activity and reduce local trade. The possible effects on local trade from potential breaks in network links were not assessed in the Parkman 2012 study.

Specific Approach to Social Value

The approach to social value was predominantly captured in the STAG appraisal sections relating to accessibility and social inclusion. These identified the following impacts:

The STAG Accessibility and Social Inclusion Criterion involves a detailed appraisal against two sub-criteria:

Community Accessibility - includes consideration of public transport network coverage and access to local services.

Comparative Accessibility - concerns the distribution of accessibility impacts by people group (for example age, gender etc.) and by location.

Comparative accessibility: The study highlighted the potential impact of reduction on maintenance spend on older people. Older people are more likely to be adversely affected as defects on footways increase and street lighting and other amenities and activities are reduced due to a greater fear of crime and potential accidents. They will therefore experience a bigger effect than other road users for such impacts. People with disabilities could be disproportionately affected by cuts in maintenance that reduced accessibility to carriageways and footways, although the report reiterates Local Authorities obligations in under the Disability Discrimination Act.

Community Accessibility - Remote Communities: New investment may be focused on improving links with rural communities, which often do not show a quantifiable economic benefit. Lifeline roads, where there is usually only one route for access to a community, will be strongly affected if the condition of the route significantly deteriorates. Road maintenance management approaches inevitably focus funding where risks and traffic are most significant, therefore it is expected that remote communities will suffer a bigger disadvantage if maintenance funding is reduced and less-used routes are not prioritised.

An increased risk of structural failure could have a significant effect on community accessibility. For example, a bridge spanning a river with a community on both sides of the riverbank. However, due to safety concerns it is likely that such assets will be shielded the most from the effect of budget reductions. However, if facilities such as pedestrian underpasses or footpaths are poorly maintained and suffer reduced use due to fears of crime and accidents as noted elsewhere, a similar effect of severance will be realised in the long term.

Overall Conclusions and relevance

The report's literature review showed the user group most affected by a reduction in road maintenance would be pedestrians, especially those with mobility and visual impairments. Pedestrians would see the impact in terms of noise and vibration, global air quality, visual amenity, cultural and landscape, physical fitness, accidents, security, community and comparative accessibility.

In the quantitative analysis, the largest (non-works) effect on reductions in maintenance spend in the analysis came in Vehicle Operating Costs. These were also shown to be highly sensitive to the input assumptions and represented small percentage changes in the very large total vehicle operating costs. This sub-category is dominated by fuel costs. Of the £274.2m of costs around half of that total were calculated to be fuel costs.

The overall results of the analyses showed for every £1 (undiscounted) saved by reducing maintenance budgets, there would be an increase of more than £2 in non-works costs from the wider impacts of the reduced maintenance. The ratio was £1 to £1.67 for discounted costs with the 40 percent overall reduction in maintenance funding.

Perhaps the most interesting is the dominant position of fuel costs within the quantified Vehicle Operating Costs and of CO_2 emissions within the base case cost impacts.

The second study very much took its lead from the first, but in the context this time of England and Wales.

Study 2	The Economics of Roads Maintenance
Authors (Sponsors)	(RAC and ADEPT) Gould, Parkman and Buckland 2013
Study purpose	The RAC Foundation and ADEPT jointly commissioned research to help better understand the wider effects of local road maintenance spending changes in England and Wales. Specifically, the research was to review existing literature sources on the costs and benefits arising from a change in highway maintenance funding and investigate the need and potential for further research into the quantitative economic impact of road maintenance on English and Welsh local roads.

Premise

Inadequate investment in highway maintenance results in deteriorating road conditions, which can increase costs for users and society. For example, vehicles consume more fuel when travelling on poorly maintained roads, and diversions because of failed infrastructure or emergency repair works cause additional travel time costs. There may also be wider costs to society associated with poorer environmental management (e.g. flood damage), safety and security controls (e.g. inadequate lighting provision), and even accessibility if parts of the network have to be permanently closed or restricted for travel.

Such impacts affect businesses and economic activity. Delays to maintenance now can also lead to increased costs of maintenance later, when more significant interventions may be required.

Methodology

Literature Review - the aim of the literature review was not to repeat the review for Scotland, but to find any more recently published sources (in the 16 months since the review for Scotland) and, as far as possible, contextualise the information gained with information arising from the quantitative research.

A questionnaire was also developed, which was circulated in two stages to local authorities.

The questionnaire sought information to help understand what data may be available. This included:

- Network background
- Finance including capital budgets and maintenance spend

- Areas protected/ring-fenced from reductions in spend
- Change in staffing roles
- Network Performance
- Impact on Users
- Details of Planned and Preventative work over 5 years

Within each category, Authorities were asked to indicate whether they were able to provide data.

Key Differences noted to the Scottish Context

It was more of a challenge to complete a quantitative analysis for the English and Welsh local road networks compared to the Scottish study, for two reasons:

1. Scottish local authorities, through their Society of Chief Officers of Transportation in Scotland (SCOTS) collaboration, had developed a model that projected road conditions based on budget scenarios using a consistent approach for all local authorities in Scotland. Such a model was not available for the English and Welsh networks.
2. There was a greater proportion of C class and unclassified roads in England and Wales (for which there was less condition data available), which would mean the results of any scaling of results from the analyses on A and B class roads (for which information is more readily available) to provide the results for the whole network would be less reliable.

So whilst there was thought to be sufficient comparability to suggest that the headline from Scotland that a '£1 cut in road maintenance spending results in wider costs to society of around £1.50' would be equally applicable in England & Wales, it was not possible simply to scale up the data to get a different figure for England & Wales.

Overall Conclusions and Relevance

It was confirmed that no significant new impacts or approaches to the analysis had emerged since the completion of the Scotland study (Parkman et al., 2012a). However, the study indicated that the relative balance of impacts would be different in England and Wales, based on the differences in the networks (e.g. proportion of roads in urban areas and levels of traffic). It was also noted that the diversity across local authorities in England and Wales was possibly greater than in Scotland and this, in particular, would affect the formulation of any further in-depth study on the topic.

Older people were identified as more likely to be adversely affected by greater footway defects, or if assets such as pedestrian crossings or streetlights were not maintained to a working standard. Older people have a greater fear of crime and potential accidents, and they will experience a larger effect from deterioration of the road network than other groups in the population. Uneven footways are also likely to impact on pedestrians with disabilities, and those who are temporarily burdened (e.g. with luggage or a pushchair). Deterioration in the quality of assets can have a comparatively bigger effect on such groups.

To an extent, disabled groups are protected by relevant legislation such as the Equality Act 2010, but it was noted that not all authorities currently adhered to best-practice guidance.

From the returns and quality of data returned in the English study in some data areas, because of collaborative initiatives across councils in Scotland, it was thought likely that the divergence of information in England and Wales would be greater than in Scotland. This shows an early recognition of initiatives and approaches such as RAMPS which has continued its progress since 2012.

General trends in asset spends were thought to be difficult to ascertain as climate and weather events and political events can have large short-term impacts in the focus and nature of maintenance spend. The location and breadth of budgets within local authorities also vary widely, so overall spend may not be possible to collate for comparison.

Healthy lifestyles and physical fitness could be encouraged by providing well-connected, well-maintained, coherent and convivial routes and facilities. Strong connections were identified between road condition and policies on health and obesity: poor carriageway and footway condition would deter walking and cycling.

The study held it to be evident that maintenance of different asset types would produce different impacts on road users and parts of society. Local authorities would respond in different ways to budget reductions. The evidence from the sample of local authorities in this study suggests that budgets for safety-critical infrastructure (e.g. structures, lighting) are likely to be held constant and that other budget areas are reduced first in the event of an overall funding reduction. It would be more efficient therefore to concentrate any future analysis on the categories that are historically shown to have greater exposure to changes in overall budgets.

4.8 Wider social effects of transport disparities

A number of relatively recent studies have examined the latent societal impacts of the way economic and transport opportunities are distributed, notably:

Study 3	Transport poverty and its adverse social consequences
Authors (Sponsors)	(Institute of Civil Engineers) Lucas, Verlinghieri, Mattioli, Guzman, University of Leeds, January 2016
Study purpose	Transport poverty is an issue that has never fully captured the attention of the transport engineering profession either in developed or developing countries. Yet it is a problem that adversely affects the daily lives of millions of people across the globe. What precisely constitutes transport poverty is not adequately articulated within academic, policy or infrastructure design literature. This paper aims to demonstrate how the different ways that academic studies and policy programmes have defined and recorded the problem of transport poverty are directly related to the ways in which it has been subsequently addressed in practice. The paper argues that this issue is not currently being taken seriously enough by the transport profession and requires its urgent attention.

The poorest groups in any country tend to be less mobile and most often suffer from a lack of options in terms of both private and public transport services. They may be forced to rely on options such as walking and cycling, often over long distances and in unsafe conditions. They are therefore also more exposed to road-related casualties and deaths and to traffic-related pollutants (both in the living/working areas and in their mobility patterns), which also have negative consequences for their health and well-being.

In urban areas poor people are most often located in peripheral locations at the edges of cities with a low amenity value, where there are few local employment opportunities and an absence of local services and basic facilities. This combines conflates with a lack of access to transport options to produce a 'poverty trap', which limits their wider access to jobs, education and health facilities, social networks and so on.

A number of academic studies have suggested that the poorest sectors of society also do not equally benefit from new or improved transport infrastructures and services. This may either be because they do not have access to motorised transport or because they cannot afford transit services.

What precisely constitutes transport poverty has never been fully articulated within either academic or policy literature, unlike, for example, the concept of fuel poverty, which in many countries now has its own relatively well-established set of definitions and evaluation metrics. This may in part be attributable to the more nebulous nature of mobility as a 'merit good', as well as to a less obvious causal chain between a lack of transport and any knock-on negative social consequences.

Transport poverty is difficult to define because it is an individual rather than a whole household issue (i.e. one member of a household may experience it while another member of the same household may not) and is particularly polarised around gender differences.

In addition, mobility is largely associated with the secondary benefit of providing accessibility to goods, services and activities, which themselves are highly context-specific, making it more difficult to construct a single definitive indicator of transport poverty.

Overall Conclusions and Relevance

The paper is useful because it tackles issues of deprivation and inclusivity in relation to transport and mobility by proposing a four-part definition of transport poverty. Transport poverty itself is explained as an overarching combination of the subset of:

- transport affordability – that is, inability to meet the cost of transport
- mobility poverty – that is, the lack of (usually motorised) transport
- accessibility poverty – that is, the difficulty of reaching certain key activities such as employment, education, healthcare, etc
- disproportionate exposure to the negative effects of the transport system, such as road traffic casualties and chronic diseases and deaths from traffic related pollution.

The paper also discusses possible measures for transport poverty.

Study 4	Transport poverty in Scotland
Authors (Sponsors)	(Sustrans), August 2016
Study purpose	The report presents the findings of new research undertaken to examine the concept of transport poverty in Scotland. Building on previous research, Sustrans uses data on household income, car availability and access to the public transport network to allocate risk ratings to each Scottish data zone. This highlights areas where motoring costs may place pressures on income, and where there may be risk to communities from exclusion when alternatives to accessing key services are not available.

Risk of transport poverty was considered to be greatest in areas with (relatively) low income, high car availability and low access to essential services by public transport. Of the 6,505 data zones 20% (1,321) were placed in the 'high' risk category, encompassing 466,000 households and a population of 1 million. Most high-risk data-zones were located in accessible rural areas (30% of all high-risk data zones) and accessible small towns (28%). Twenty per cent were located in remote rural/very remote rural areas, 13% in remote small towns/very remote small towns, and 9% in large/other urban areas.

The analysis produced the following distribution across Scotland:

Figure 1: Percentage of high risk data zones located in each council area

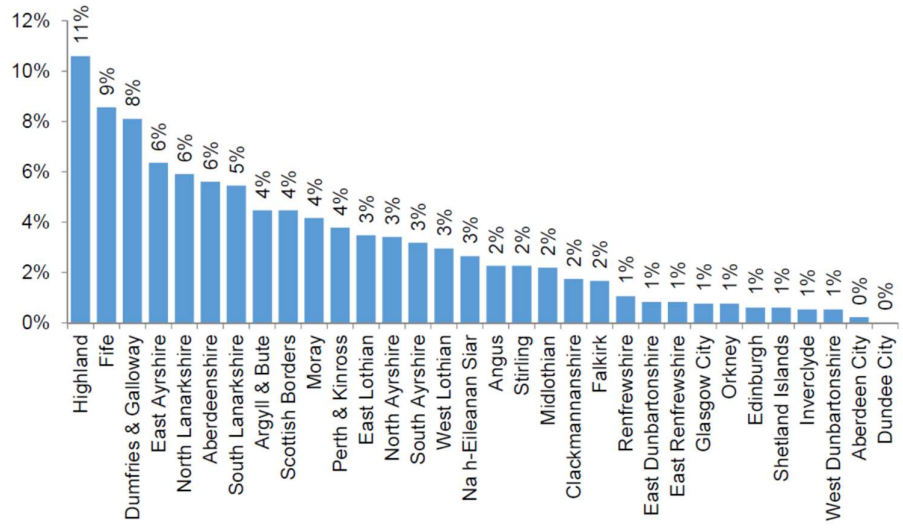

Fig. 7 – Sustrans data zones in Scotland at "high risk" of transport poverty

Overall Conclusions and Relevance

The paper is intended principally as an analytical aid, so does not draw any specific conclusions. However, it is useful in that it introduces the concept of areas that are

"at risk" through a combination of deprivation and availability of transport options and using SIMD data to pinpoint these risk areas. This is a key concept that we draw on in the development of our evaluation tool (see Section 6 below).

Study 5	Tackling transport-related barriers to employment in low-income neighbourhoods
Authors (Sponsors)	(Joseph Rowntree Foundation) Crisp, Ferrari, Gore, Green, McCarthy, Rae, Reeve and Stevens, August 2018
Study purpose	This report set out to examine the transport issues facing out-of-work residents in six low-income neighbourhoods across England and Scotland[20], and how these issues might be overcome. The authors interviewed 79 residents across these areas to find out the length of time and distances that residents were willing and able to travel to work and considered the extent to which local transport systems were available, reliable and affordable to potential places of work.

There is a perception that individuals from lower income barriers are reluctant to travel a distance for work, but the report found little evidence of "limited spatial horizons" amongst the interviewees – most were willing to commute for an hour or more but there were significant concerns around the feasibility of public transport in terms of availability, reliability and affordability. The location of suitably skilled jobs was often on the periphery of conurbations, involving more than one bus journey, which was not always seen as a feasible commute. This appears to have changed in recent years. Between 2010 and 2017, for example, low paid jobs in in the "core" city of Glasgow were found to have declined by 5.3%[21]. Low-waged work constrains the amount that can be spent on travel, so affordability also becomes a key issue.

An earlier study for the Joseph Rowntree Foundation (JRF) found that the poorest areas of towns and cities can be disconnected from their wider labour market areas and cut off from job opportunities (Rae et al, 2016). These patterns can be exacerbated by changes in housing markets and a failure to invest in new social housing in more central locations, which among other things have seen tenants increasingly consigned to peripheral areas in towns and cities.

The report articulates the need for greater focus on local transport systems as follows:

"Away from the focus on, and sometimes furore over, major new transport projects such as Crossrail, HS2 and Northern Powerhouse Rail, this report is a timely reminder that more attention needs to be paid to local transport systems that do not appear to serve low-income households well."[22]

Low-income groups tend, not surprisingly, to have less access to private transport and are, as a consequence, more reliant on public transport. A feature of low-income neighbourhoods is therefore a relatively low incidence of motor vehicle ownership. This has direct consequences in terms of accessibility of workplaces. For example, the

[20] Harpurhey (Manchester), Hattersley (Tameside), Seacroft (Leeds), Dewsbury Moor (Kirklees), Port Glasgow (Inverclyde) and Castlemilk (Glasgow).
[21] Tackling transport-related barriers to employment in low-income neighbourhoods, Joseph Rowntree Foundation, p19
[22] Ibid, p5

report showed that arriving for a typical 6am shift start at Manchester Airport could take up to 5 times as long by public transport as by car.

The report references the "transport poverty" definition set out in Study 3 (Lucas et al) above.

Overall Conclusions and Relevance

The report's key finding was that public transport is all too often seen as a constraint rather than an enabler, because of a lack of affordable and reliable transport that gets people to locations where there is suitable work.

Study 6	Are we nearly there yet? Exploring gender and active travel
Authors (Sponsors)	(Sustrans) Motherwell, February 2018
Study purpose	To examine how women's experience of transport and travel is different from men's and identify barriers that are specific to women.

The report argues that designing cities to be more inclusive has stalled. Despite some progress, women continue to be constrained by a number of barriers that affect how they travel, and the experience of those journeys. The evidence presented in the paper shows that women's experience of transport and travel is different from that of men. Although there are common barriers to active travel, many barriers are specific to women.

Systemic issues include:

- the gender pay gap
- under-representation of women in public and civic life
- risks to women in public places

The journey patterns of men and women are different:

Women and men's journey patterns are different

- Women make more multi-stop trips than men, in line with care and domestic responsibilities
- Men make more journeys at peak times, while women make more off-peak journeys
- Radial journeys for commuting purposes are more commonly conducted by men, while women are more likely to make multi-stop trips, often by different modes
- Women are increasingly balancing journeys for work and childcare
- Women make shorter trips than men
- Women make more journeys using public transport, with children and otherwise "encumbered"

The participation of women's in the work-force participation has increased by 17% in the last 46 years, with the majority of mothers (74%) now in employment. However, women face a "triple work burden" - the balancing of paid work alongside unpaid work within the household and unpaid work within the wider community. This can affect how women need to move around a city and the lack of adequate transport options to meet these needs increases the time spent travelling.
Public transport prioritises peak travel, which exacerbates the problem.

Personal safety is a major concern. In Glasgow, women stated that this was one of the biggest deterrents to cycling and walking after dark in the city, although these concerns were not confined to travelling at night.

Overall Conclusions and Relevance

The report argues that a step change is required to ensure cities become more inclusive and that the narrative must shift focus from expecting women to change their behaviour to embedding a gender analysis in policy, planning and practice that considers the evidence and experiences of women. This requires women not just to be considered as users, but to be involved in the governance and operation of transport systems.

4.9 Comparable geographies

While our primary focus for research was on Scotland and the rest of the UK, we looked for the key themes for some comparable geographies, particularly in relation to future use of the roads network. We identified Scandinavia as a whole and although we picked up some studies in Finland and Norway, the extensive research and most interesting insights from the perspective of this study were to be found in Sweden.

We also looked at New Zealand as having a comparable population and range of physical geographical types, albeit with arguably more extremes than Scotland and with a landmass more than 3 times the size of Scotland. New Zealand provided a broad range of reports but little that was additive to the research already undertaken in connection with other locations.

Below is a synopsis of what we found to be of interest. The names of the studies are provided in the associated footnotes.

Sweden

Social and Demographic

Study 7: Socio-economic costs of the transport sector[23]

Trafikanalys is mandated by the Swedish Government to provide annual analyses of the socio-economic costs of transport in relation to tax and levy charges. The analysis includes short-term socio-economic marginal costs for the external effects of traffic

[23](Transportsektorns samhällsekonomiska kostnader Rapport 2019:4)
https://www.trafa.se/etiketter/transportovergripande/transportsektorns-samhallsekonomiska-kostnader---rapport-2019-8236/

and transport policy justified variable taxes and charges for each type of transport. The report shows that marginal costs vary not only by vehicle type but by geography (urban versus rural areas).

"Negative externalities" from traffic come from emissions, traffic accidents, noise and congestion/scarcity that affect others negatively both in and outside the traffic system. Wear and tear and deformation of the infrastructure are external from the road user or carrier's point of view unless usage is priced (on a marginal cost basis). The principle that transport should be priced according to their socio-economic costs underlies Swedish transport policy and applies to all modes of transport.

The summary tables below show the relationship between externalities and costs in terms of taxes and levies that are raised for passenger and freight transport.

	Costs per passenger km (SEK)				
	Car (petrol)	Car (diesel)	Bus (diesel)	Passenger train	Ferries
Infrastructure	0.03	0.03	0.05	0.053	0.01
Accidents	0.06	0.06	0.02	0.01	0.04
Carbon dioxide	0.13	0.10	0.08	0.001	0.25
Other emissions	0.01	0.02	0.02	0.001	0.1
Noise	0.03	0.03	0.02	0.01	0
Total external marginalised cost	0.25	0.23	0.18	0.08	0.40
Internalised taxes / fees	0.31	0.19	0.14	0.09	0.28
Non-internalised costs	-0.06	0.04	0.04	-0.01	0.12
Internalisation level	123%	80%	79%	106%	70%

Table 8 - internalisation of passenger costs in Sweden

	Costs per tonne km (SEK)				
	Light lorry (diesel)	Heavy lorry (without trailer)	Heavy lorry (with trailer)	Goods train	Shipping
Infrastructure	0.04	0.14	0.06	0.042	0.006
Accidents	0.10	0.07	0.01	0.002	0.003
Carbon dioxide	0.21	0.18	0.06	0.002	0.02
Other emissions	0.06	0.03	0.01	0.001	0.007
Noise	0.05	0.04	0.02	0.008	0
Total external marginalised cost	0.46	0.47	0.16	0.055	0.036
Internalised taxes / fees	0.39	0.33	0.10	0.025	0.03
Non-internalised costs	0.07	0.13	0.06	0.03	-0.007
Internalisation level	84%	72%	65%	45%	120%

Table 9 - internalisation of freight costs in Sweden

This analysis is interesting for the process that it illustrates of creating a comparable measurement framework for different types of transportation use, in the composition of those costs and in the extent to which they are internalised through the charging structure.

In passenger travel, for example, we see that CO_2 emissions account for 52%, 43% and 44% of the external costs of a petrol car, a diesel car and a bus respectively. Perhaps surprisingly, there is not a great deal of difference in wear on infrastructure between cars and buses (SEK 0.03 per passenger km compared with SEK 0.05).

The level of internalisation is highest for petrol cars (123%) and trains (106%). In effect, the fees and taxes levied exceed the assessed external costs, while for diesel cars, buses and ferries, these fall below the assessed external costs.

In terms of freight transportation, we see that the external marginalised cost is "underfunded" for all forms of transportation except shipping. So while heavy lorries per tonne km are relatively low compared with other forms of road transportation (SEK 0.16 compared with SEK 0.46 for light lorries, for example), the internalised costs are also low, leaving a 35% shortfall against assessed external costs.

Further analysis is undertaken of the differences in externalised cost between urban and rural settings. This shows that both the cost of accidents and the cost of CO_2 emissions per unit vary significantly between urban and rural settings – on the other hand, the infrastructure cost does not. Costs per unit per transportation type are consistently higher for urban rather than rural settings, with the widest variances coming from cars and light vans, as illustrated in Table 10 below.

	% Variances Urban / Rural across transportation types				
People	**Car (petrol)**	**Car (diesel)**	**Bus (diesel)**	**Passenger train**	**Ferries**
	283%	294%	173%	123%	116%
Freight	**Light lorry (diesel)**	**Heavy lorry (without trailer)**	**Heavy lorry (with trailer)**	**Goods train**	**Shipping**
	253%	165%	190%	116%	112%

Table 10 – Urban / Rural variances in externalised costs

The detailed urban / rural tables are provided in Appendix D.

Study 8: Gender equality analysis of trends in the transport sector[24]

The trends discussed in this survey are automation, digitisation, the sharing economy, climate change adaptation, urbanization, increased affluence, deglobalisation, and population change. The study concludes that none of the analysed trends would unambiguously make it easier or harder to achieve gender equality policy goals.

Taken together, technological advances, digitalisation, and climate challenges may challenge historic transport sector norms which emphasise car ownership and travel patterns that are more closely tied to the traditional travel patterns of men. These trends could create greater opportunities to address climate challenges and to achieve a more gender-equitable transport system.

The following indicators are used to evaluate the development towards improved equality in terms of transportation:

Travel patterns of women and men by mode of transport and subject: Men travel almost 25% further than women, but women and men spend about the same amount of time travelling. Men spend more time on working trips and women more time on travel for purchases and visits to friends and relatives. Women' use public transport more than men, but the differences are decreasing.

[24] https://www.trafa.se/globalassets/rapporter/summary-report/2016/summery-report-pm_201616_gender-equality-analysis-of-trends-in-the-transport-sector.pdf

Attitudes regarding road safety: indicators suggest that women are less likely than men to expose themselves and others to risks in the traffic system.

Commuting: Women have access to fewer jobs in their local labour market region than men have. A local labour market region is easily expressed as an area in which commuting is taking place.

Access to a car: more men than women have a driving licence and access to a car.

Equal decision-making processes: at national level in the public sector of transport (in Sweden), women and men are roughly even represented in decision-making assemblies, but at regional and local level the share of women is under 40%.

An ageing population increases the need for public transport. Older people keep health ever longer and will be an increasingly important part of travellers. At the same time, older people can be seen as a more socially vulnerable group, where a relatively high proportion does not have the same opportunities as others to move around in the transport system. This is particularly true of women.

Vehicle automation and increased digitisation could either make violence towards women easier or more difficult to prevent:

- If vehicles are autonomous, it may be more difficult to use them to frighten, injure, or disturb others.
- Where autonomous vehicles replace public transport and travel by taxi, they could also help prevent sexual harassment by fellow passengers or drivers.
- On the negative side, digitalisation and autonomous vehicles could make stalking easier. Both digitalisation and autonomous vehicles could also create new opportunities for more dubious or illegal activities such as stalking and prostitution.
- Autonomous vehicles could make it easier for more people to travel where they want to, and to participate in public life more than at present.

Digitisation and the sharing economy could provide greater accessibility through options such as shared mobility services.

However, this assumes that those wishing to use such services can access the requisite technical help and know how to use them. There could be economic barriers or challenges in terms of being able to learn new technical systems and understand the associated language and symbols. I.e. it is not self-evident that the positive effects will accrue to everyone.

Because women generally have lower incomes than men and assume greater responsibility for managing trips made for healthcare, school, and personal care purposes, the report emphasises the need to consider potential equality-related obstacles to using these new technologies.

Climate change adaptation and urbanization will lead to greater demand for bicycle use, which could lead to reduced congestion and more efficient urban land use in the long run. Certain barriers to cycling, such as perceived risks, affect women in particular. Studies have shown that cycling is less prevalent among foreign-born women. If the

potential benefits of greater opportunities for cycling are to accrue to as many as possible, these factors must be taken into account.

The research argues that in order to achieve socio-economic efficiency in the long term, the external effects of traffic can and should be reduced by further measures that contribute to reduced environmental effects, reduced accidents and reduced wear per kilometre.

In the short term, it is not possible to expect to influence the external effects per kilometre (vehicle kilometres, passenger kilometres or tonne-kilometre) to any great extent, so the objective is primarily to focus on increasing socio-economic efficiency by using the most suitable vehicles for the task or reducing the volume of traffic, for example by increasing the load factor. Environmental differentiation can also affect technology choices in the short term and thus also external effects.

Environment & Sustainability

Study 9: Adapting to climate change[25]

The study examines how roads are influenced by changes in society (population growth and climate change)? It expects volumes of traffic on roads to increase. At the same time, climate change increases the risk of weather events such as flooding and landslides. This requires robust infrastructure.

For roads infrastructure, potential future problems caused by climate change must be considered, for example:

- areas where e.g. the risk of flooding or the risk of trees falling is especially large
- the negative effect on roads of rises in ground water levels.
- need to rebuild to avoid flooding.

Winters will change. They will get warmer. The amount of salt used on roads will probably decrease, as well as the need to remove snow from the roads. Temperature changes around 0° might become more frequent, giving rise to traffic accidents and problems which block roads.

Study 4: A "transport efficient" society[26]

The study examined how to make the transport system more efficient.

Fuel-efficient vehicles, electrification and renewable energy are important elements in reducing the climate impact of transport. But these are not enough on their own. We need to use the transport system itself more efficiently. This requires community planning for attractive and accessible cities to improve accessibility for walking, cycling

[25] Hur påverkar autonoma vägfordon framtida tidsvärdering? PM 2015 http://www.klimatanpassning.se/hur-paverkas-samhallet/kommunikationer/vagar-och-jarnvagar-1.107430
[26] https://www.trafikverket.se/for-dig-i-branschen/Planera-och-utreda/samhallsplanering/samspel-mellan-trafik-och-bebyggelse/Planera-for-hallbara-stader-och-attraktiva-regioner/transporteffektivt-samhalle/

and public transport (including more attractive and efficient public transport, which includes reliability, frequency, convenience and speed).

Technology

Study 5: How autonomous vehicles will affect the valuation of time[27]
Autonomous vehicles could provide benefits in terms of increased capacity, improved safety, more environmentally friendly driving style, increased accessibility for people unable to drive today and reduced resource sacrifice through release of time that today must be spent driving the car.

Autonomous vehicles also offer the possibility of car travel for people who do not currently have a driving licence.

It is uncertain what effect autonomous vehicles will have on the socio-economic rationale for road infrastructure investment. The likely lower valuation of avoided travel time value may to a greater or lesser extent, be offset by higher numbers of passengers.

Study 6: Self-driving cars – potential development and impact on road capacity[28]

Self-driving vehicles should help increase the capacity of the transport system. However, for this to occur, the time intervals between vehicles must become smaller than they are now.

If vehicles are simply self-driving, but otherwise behave as regular vehicles do today, then the capacity gains will be minor, resulting mainly from more uniform traffic flows and fewer accidents.

To achieve truly sizeable capacity gains, it would be necessary for vehicles to form convoys and for the time intervals to decrease from the current 1.5 seconds to 0.1 seconds. For this to be possible in practice, vehicles and infrastructure will need to communicate with one another.

The results of a traffic simulation indicated that:

- The capacity of an inner-city environment could be doubled if all the vehicles are self-driving.
- The through-flow on motorways (e.g. an important and heavily trafficked stretch of motorway in downtown Stockholm) could increase by roughly 70% if 100% of the vehicles were self-driving.

This would permit significant increases in traffic without major investments in new infrastructure.

[27] https://www.trafa.se/globalassets/pm/2011-2015/2015/pm_2015-hur-paverkar-autonoma-vagfordon-framtida-tidsvardering.pdfhttps://www.trafa.se/globalassets/pm/2011-2015/2015/pm_2015-hur-paverkar-autonoma-vagfordon-framtida-tidsvardering.pdf
[28] https://www.trafa.se/en/road-traffic/self-driving-cars---potential-development-and-impact-on-road-capacity-3583/

The report suggests that the nature of car ownership in the future will probably play an important role in shaping how self-driving technology affects the capacity of the transport system.

On the basis of the current ownership model, increased mileage and a dramatic increase in demand for parking space seem likely. On the other hand, if the technology leads to more shared ownership, then it may be possible to reduce the demand for parking space and the number of vehicles, despite any increase in the number of person/kilometres driven.

New Zealand

Study 10 - Planning for local roads[29]

Local roads (administered by city and district councils) make up about 80,000 kilometres (88%) of all New Zealand's roads. Local roads are seen as vital to the economic and social wellbeing of communities. The transport agency works alongside councils to improve New Zealand's overall road and transport system and to ensure that the state highway network links seamlessly into local road networks.

Local streets provide many social and recreational functions. The planning concept 'living streets' recognises these functions. It encourages the design of streets and speed limits to embrace living and community interaction to achieve a better and safer quality of life and views streets as spaces shared by pedestrians, cyclists and low-speed vehicles. While cars are not excluded, guidelines for local streets are designed so that drivers recognise the importance of pedestrians and other users.

Neighbourhood accessibility planning involves collecting data and consulting with communities to identify safety and access issues (including perceived barriers) in spaces shared by pedestrians, cyclists and vehicles. The types of solutions developed will vary, but expected actions would include:

- improving **safety** for pedestrians and cyclists
- improving the **environment** (including providing greater access) for pedestrians, cyclists and those accessing shared modes of transport
- increasing the use of **active and shared forms of transport** in the area.

Community programmes provide funding from the transport agency to undertake activities that encourage transport choices.

[29] https://www.nzta.govt.nz/planning-and-investment/planning/transport-planning/planning-for-local-roads/

5.0 Consultation Summary

5.1 Our approach

There were three components to our consultation approach:

1. **Structured one-to-one interviews** (a mix of face-to-face and telephone interviews) with a number of key national and regional stakeholders with an interest in the effective operation of the local roads network. This included organisations such as Transport Scotland, the Institution of Civil Engineers, the British Haulage Association, the Timber Transport Forum, Scottish Renewables, Sustrans, MACS[30], Scottish Power Networks, regional transport partnerships, trunk road operating companies, and individual members of local authority planning and economic development networks.
2. **Regional workshops** with SCOTS members, drawing further input from a roads-specific perspective from both regional transport partnerships and local authority roads teams
3. **A web-survey of community council perspectives** as to issues affecting members in their areas, and their perceptions as to how issues may evolve over time. In excess of 250 individual responses were received from regions across Scotland, providing additional user views to supplement the planning and delivery perspectives from the interviews and workshops.

While we sought to standardise questioning as far as possible, we allowed a free-form element in all of these exchanges. This was particularly important to us as we wanted to leave open the potential for unpredictable contributions. A key objective in the questioning process was to ensure that the ambit of the responses was broad enough to test people's perspectives on the linkages between local roads and socio-economic drivers both now and in the future. Overall, we found respondents generally willing to engage in this wider debate about the value of local roads, which was encouraging.

Notwithstanding the wider reach of the web-based survey, this exercise was structured very much with qualitative (as opposed to statistical data) in mind. While we were looking for a reasonable cross-section (see 5.3 below), the sample sizes are relatively small and the web-based survey carried with it a risk of bias in terms of the demographic and sociological profiles of the respondents.

5.2 Lines of enquiry

We developed three main key lines of enquiry for the survey, with a number of more detailed considerations under each. These were used as discussion prompts for the interviews and workshops:

Line of enquiry	More detailed considerations
How would you define an effective local roads network, and how it might contribute to economic and social value?	• Definitions of 'effectiveness', 'local roads', 'economic benefit' and 'social value' • Connections within a wider transport system • Perceptions and evidence of economic and social impact

[30] Mobility and Access Committee for Scotland

	• Current issues (such as safety, congestion, emissions, asset condition, and accessibility) • Key opportunities to improve the network and its potential impact • Geographical variations across Scotland • Effective models from other places or sectors
What are your experiences of changing drivers/trends impacting on the network, and the forward impact of these changes moving forward?	• Policy and regulatory developments • Emerging thinking on place(s) and space(s), connectivity, and mobility as a service • City Deals and the push for inclusive growth • Social and environmental expectations • Economic circumstances/pressures • Demographic change • Evolving technologies and innovations • Logistics and distribution • Behavioural changes (on roads and more generally) • User expectations (as a whole and by group)
Where do we need to be in 10 years time (and why), and what are the barriers to getting there?	• Private road user, public transport and active commuter balance • User diversity and traffic volumes • Networks suitability and sustainability • Connectivity • Inclusion and accessibility • Affordability

Table 11 – lines of enquiry for stakeholder consultation

5.3 Stakeholder Types

Everyone is a stakeholder in the local roads network. The challenge was to arrive at a stakeholder typography which enabled us to incorporate a representative cross-section of voices into the analysis. Within the scope of this work, however, it was inevitable that much of the discussion would take place with identified sector experts and representative groups.

The voice of communities in their local roads networks is an interesting area for further work, although that would fall outside the scope of this report. How to factor authentic community voices into a future process for evaluating investment decisions in local roads network is a key question and we suggest that factoring this community voice in effectively is one element of our layered evaluation model (see Chapter 6).

The ubiquity of local roads means that there are no clean delineations. Each stakeholder group has its own specific priorities and concerns in terms of the effectiveness of the local roads network but between the individual priorities of each group, there is potential for both complementarity and conflict – and the nature of this dynamic interaction changes within a day, week, month and year. To complicate matters further, some individuals fall into more than one of the stakeholder groups. For instance, a delivery driver might drive to work in her personal vehicle to pick up her transit van at the depot, dropping her child off at the nursery and cycle to the park at weekends.

Understanding both the specific interests that stakeholders have in the network and the key inter-dependencies between these groups is important to the assessment of

the value of the network. Different groups have different views as to the main purpose of the network, about levels of required access, around prioritisation, and about the criteria that should be given most prominence in making decisions about investment/dis-investment. Some of their needs and expectations are direct and immediate; others are less direct and longer term.

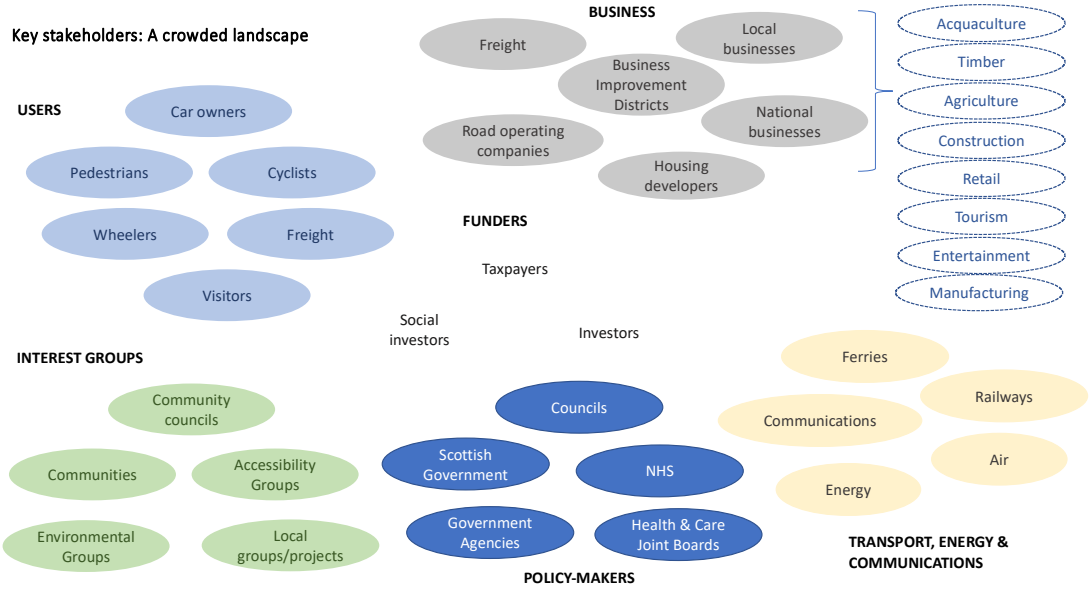

Figure 8: the crowded stakeholder landscape

5.4 Key consultation themes

A number of key themes emerged from discussions with this broad and dynamic landscape of individuals, groups and communities. These are summarised below.

Theme	1. Definitions of effectiveness
Headlines	Many of the traditional definitions of local roads effectiveness are based on concepts of network performance and asset management. This was echoed in the consultation, though expressed in terms of safety, reliability, accessibility (for different user groups), and sustainability (both financial and environmental).
Detail	Respondents regularly referred to the importance of local roads as a means of getting people and goods to and from markets, highlighting the key role of local roads in providing 'the first and last mile' in a wider network of trunk roads, rail and air travel. This went beyond private car users, with roads providing a platform for pedestrians, cyclists, public transport, public service delivery (from refuse collection to social care) and freight. Others pointed to the links between local roads and wider utilities and drainage systems, with an effective network supporting connectivity and accessibility beyond that provided by a simple roads surface.

Theme	2. Geography
Headlines	Unsurprisingly, many respondents pointed to the importance of geography or location as a factor determining the value of the local roads network. Variations in the relative importance of local roads in very rural areas versus very urban ones was a recurring observation. Further discussions, however, suggested that these observations were often around the relative need for private cars in different settings, rather than the importance of local roads per se.
Detail	Fewer public transport options in less urban areas were seen to increase the importance of access to private cars; disincentives such as congestion and expensive parking was seen to increase the attraction of other modes of transport in more urban areas. Rurality was a recurring issue. In some instances, local roads are seen to be of disproportionately strategic importance in rural communities as a result of the absence of adjacent (trunk road, rail or air) alternatives, or because of a lack of local roads alternatives to one key local arterial road (such as the A82 in Argyll). Particular local roads are disproportionately critical for freight, with disruption impacting more significantly on economic and social objectives. The picture is complex: the majority of Scottish roads authorities are neither very urban nor very rural. While geographical factors (distance, topography and population disparity) impact on network and asset management, respondents stressed that the value of local roads remains high in all areas irrespective of these challenges.

Theme	3. The importance of place, and spaces within places
Headlines	Much of the discussion was about places as destinations versus places as connection points to other places. Understanding the purposes of places – and the relationships between different places – was seen by many as impacting directly on judgements about the effectiveness of local roads.
Detail	Many examples were given of purposes themselves being dynamic (from city centres over the course of a day, towns when events are organised, and national parks when the weather conditions are right). Put simply, local roads are seen to play a key role in defining the profile of a place. Decision-makers – not least in Planning, Economic Development, Regeneration and Roads – are developing their understanding of these purposes and the associated interdependencies when making decisions about investment and change. Changes in traditional purposes are a key consideration here, with evolving behaviours around how we work, shop and socialise changing the role of places moving forward.

Theme	4. The need to take a "whole system" perspective
Headlines	Most respondents pointed to the importance of taking a whole system perspective in judging effectiveness and value. This worked at a number

	of levels. The local road network was seen to be a key strand of any local transport system. This was then seen to be part of a wider regional and national system of transport and connectivity and in turn provided a crucial platform to support delivery of wider economic and social outcomes, with local infrastructure a key enabler in securing outcomes across a breadth of public policy objectives.
Detail	Certain factors affected the application of this "whole system" thinking. The condition of some parts of the network – particularly key structures (particularly bridges) on important local roads – could severely affect network management and the costs of resolution were often prohibitive. Variations in links between local roads/transport and the more strategic transport network (trunk roads, rail, ferries and air) were seen as decisive factors. Local economic circumstances, from the decline of some traditional industries or conflicts between different industries (such as tourism versus aquaculture) could further alter the picture.

Theme	5. How economic value supports sustainable communities/social value
Headlines	Respondents were keen to emphasise the links between economic and social value. The concept of inclusive growth was a recurring theme, both in terms of a policy ambition and as a lived reality in many communities across Scotland. While economic activity did not *wholly* drive social value, the importance of employment, learning/employability, local economic vibrancy, and the need to sustain economic competitiveness of different industries were seen to go beyond purely economic outcomes.
Detail	Regular references were made to the potential for conflict between economic and social objectives. This included conflict between different users (pedestrians, cyclists, cars and lorries), conflict between different industries (leisure, agriculture, forestry), and the impact of economic vibrancy on congestion and emissions. Collaboration and engagement were seen to be crucial in reducing the impact of this. Finally, while economic and social cohesion – inclusive growth - was a common ambition, others pointed to the importance of investing particularly in City Region competitiveness within wider national and global markets as a critical objective to securing this ambition.

Theme	6. Sources of network funding (rather than simply levels of funding)
Headlines	A large number of respondents pointed to the level of spend required to make a positive impact on the local roads maintenance backlog, and the challenge of securing any additional funding at a time of pressure on the public purse.
Detail	Identified opportunities included the need to ringfence an element of current local authority spend for roads investment, the potential for more radical approaches to road user charging moving forward (whether revenues from parking or direct payments to access particularly pressured routes at busy times), and scope to introduce an industry levy where levels of road usage and impact were seen to be high. Challenges included a drop in fuel duty revenue as carbon-based fuels reduce (in any widespread move to electric vehicles), national and local

	political opposition to charging, the impact of levies on low margin industries, and the particular impact of user charging on accessibility for people with disabilities or low incomes.

Theme	7. The need to prioritise finite investment/spend as part of a coherent strategy
Headlines	Funding for improvement and maintenance was consistently seen to be an enduring and widespread issue.
Detail	Some respondents stressed the opportunity to revisit how existing investment/spend was allocated across the local network in each area. This might be part of a more pro-active strategic asset-wide approach to investment and disinvestment, potentially with reclassification of roads or in extreme cases dropping them from the adopted network. This could involve revisiting existing hierarchies and classifications within the local network, perhaps based on a broader set of economic and social criteria in addition to safety, network performance and asset condition. While potentially attractive in principle, some respondents pointed to challenges in applying this in practice. These included political pressures to maintain links to all communities, the (financial and connectivity) impact of a small number of key structures (typically older bridges) on overall network performance, reductions in safety and accessibility as a result of declassification, and the potential for changes to have minimal impact on the wider deterioration of the asset. The loss of expertise and capacity at a local level provides a further challenge in the application of more innovative and strategic approaches.

For the future, both technology and behavioural change were seen in the consultation as factors that could affect the demands on the network.

Theme	8. Technology change
Headlines	In terms of technology, innovations were seen as fourfold: i. the emergence of electric and autonomous vehicles ii. the development of more 'connected vehicles' iii. the improved use of data and social media iv. innovation in the way the network is designed, managed and maintained
Detail	The emergence of electric and autonomous vehicles creates both opportunities and challenges. On the plus side, reductions in emissions and noise pollution, improved traffic management, and increased network capacity. Potential problems were seen largely to be about managing the transition from the status quo, whether designing and delivering the charging and sensor technologies, or managing the transition in a sufficiently coherent manner to allow the potential to be realised. The development of more 'connected vehicles' was seen as better informing driver decisions as well as managing driver behaviour. This applied to all types of vehicles, private car, freight and public transport

	with exchanges of data and information helping to improve safety, minimise emissions, reduce congestion and improve traffic flows. The improved use of data and social media was seen to support the further roll-out of mobility as a service, allowing better and more joined-up journey planning. Such developments allowed more informed choices about transport modes, as well as providing opportunities to avoid and reduce bottlenecks. Together, this could allow more effective use of the network for all users. Finally, technology is supporting innovation in the way the network is designed, managed and maintained. This allows more effective, efficient and environmentally sustainable network and asset management moving forward.

Theme	9. Behavioural change
Headlines	Perceived behavioural changes went beyond developments linked to new technologies. They fell into two categories: i. The nature of road use by individuals is changing ii. Developments in logistics and distribution are driving a growth in light goods vehicles and delivery-oriented traffic
Detail	Individual use is changing through increases in both remote and flexible working, changes in retail preferences, increased leisure tourism, modal shift to more active commuting, the potential growth of electric bikes and scooters, and changing views as to the purpose and nature of our town and city centres. It manifests itself differently in different areas, but developments include the emergence of shared spaces, reductions in car ownership and car journeys amongst younger people (and an increase in older road users), and greater competition for access to the networks at different times. 'Just in time delivery' expectations and the emergence of Uber and Deliveroo are driving a growth in light goods vehicles and delivery-oriented traffic on the network in many areas. While less damaging to local roads than heavy goods vehicles, this does impact on congestion, with potential for knock on impacts on emissions and safety.

Theme	10. Local roads supporting equity
Headlines	Respondents were split over the directness of the link between the effectiveness of the local roads network and the underlying prosperity of an area.
Detail	However, there was a common reflection that local roads are essential to connecting communities in areas across Scotland, and that such connectivity is particularly important to individuals and communities in more peripheral areas (whether at the edge of settlements or in more rural areas). Connectivity should reduce exclusion and ensure that individuals have access to interaction, mobility and services. As such, local roads play a crucial role in enabling equitable access to wider economic and social benefits.

5.5 Community Council survey

The community council survey was an online survey drafted by the report team and hosted by the Improvement Service containing 14 questions, predominantly in a multiple-choice format but with the ability in many questions to provide further comment or choose a non-specified option. A link to the questionnaire was mailed to all of the 1200-odd community councils in Scotland and around 250 responses were received. Rather than responding as community councils, recipients opted to respond as individuals.

The questionnaire wording and the main results are included in Appendix A. The main points of note are summarised below.

Q3 The main issues in your area on the local roads networks:

There was a high level of consensus about the main issues. "Quality of the road surface" (87%) was closely followed by "Safety for all users" (72%), "Ease of use for cyclists" (70%), "Impact of maintenance works" (68%) and "Ease of use for pedestrians" (67%).

Q6 Assuming that you believe more investment is needed in the network (91% of respondents did), what should this investment aim to deliver?

"Increased safety and security" (65%) was a clear leader, with "Reduced environmental impact" (54%), "Support for the local economy" (50%) and "Reduced congestion" also scoring relatively highly.

Q11 What changes will impact most in the next 10 – 20 years?

Here there was a dominant response: "Increase in number of older people" (65%). Other relatively high scoring responses were "Changes in the number of heavy vehicles" (47%) and improvements in connectivity (30%).

Overall these responses show (perhaps unsurprisingly) a preoccupation with the day-to-day operational aspects of the network that suggests there will be challenges with any democratic process that seeks to have more strategic long-term discussions about the function (and even scope) of the local roads network. However, there is also a clear understanding of the main demographic trend that Scotland will have to deal with.

5.6 Summary remarks

Overall, we saw a broad consensus on the criticality of local roads infrastructure and the need to frame this in broader socio-economic terms, recognising the systemic nature of the network. Most encouraging was the willingness to enter into a debate about the strategic drivers for the network, both now and in the future, which we felt provided an endorsement of the need to reframe the discussion on local roads within a broader context.

6.0 Local Roads Evaluation Model (LREM)

6.1 Key principles

This chapter proposes a framework model for assessing the value of the local roads network. As we have said previously, we see "value" in this context as a relative concept – one that can be used to assess proposed or actual change. In this sense, therefore, it is an evaluation tool – hence the name.

Before we set out the proposed framework, we should start by recapping on the key principles that we think should feed into the LREM, drawing on our preliminary thinking, our research and the results of the consultation process. These can be summarised in the following principles:

The LREM should:

- Reflect the core function and purpose of roads as physical connectors for people, businesses and communities
- Be sensitive to variances in geography and place
- Treat the road as a network (or system) and a network within and connected to other networks
- Align with strategic policy objectives and drivers
- Be responsive to need at a community level
- Reflect expected future trends and changes in need

6.2 Value as a measure of change

Just working out how to ask the question of how to value the local roads network was a challenge in itself, even before we started to develop a possible approach. As we have seen, the local roads network is such a fundamental part of Scotland's infrastructure (through its "ubiquity"), that trying to "monetise" this to derive a universal value has no meaning, because monetisation implies an exchange. The idea, for instance, that it is possible to generate a universal value expressed as a monetary amount for every £1 of investment in roads only holds if it is possible to substitute one asset for another (and if this is the price at which the substitution can take place).

For local roads, the potential to "exchange" is valid only at the margins. In general, they can't be replaced with something else and this seems likely to continue for the foreseeable future. For the concept of "value" to be useful in describing the functions of local roads, therefore, it needs to be seen as a measure of change, not exchange.

We are interested in measuring change (how value shifts in relative terms) over time, or between scenarios and options because that helps shape policy and strategy. "Value" as a measure of observed change or potential change can help us to understand at what point, for example, underinvestment starts to erode the value of the network, or what marginal changes in delivered benefits could result from targeted future investment.

6.3 Bridging the gap

From our research and consultation, we believe that there is widespread recognition of the need for a broad (economic, social, environmental) canvas in assessing the value of the local roads network, but there is limited work to date on this subject in relation to roads, as well as general uncertainty as to how such an approach might work in practice.

Nevertheless, a methodological framework that measures actual and potential changes in value as the basis for effective decision-making in public spending choices around local roads would be very useful for policy-makers, decision-makers and funders at local and national government levels. As our report shows, the factors that would need to be taken into account are broad, reflecting the status of local roads as critical "enabling infrastructure" at all levels of social and economic activity in Scotland.

Helpfully, there is data. Statistical datasets for Scottish Transport are readily available to provide a solid basis that enables us to place local roads in a wider systemic context[31].

We can therefore start to bridge the gap by approaching this question in a way that is systemic, evidence-led and geospatially sensitive.

6.4 Value from being part of a system

The key perspective is to see roads both as networks and parts of larger networks. Their value lies in the functions that they perform as part of a network. Both trunk and local roads need to be assessed in terms of their impacts on the roads that feed them and that they in turn feed.

The underlying logic is that such a model should apply to the entire roads network (and perhaps ultimately to all systems of transportation), to ensure both comparability of assessment metrics and recognition of the interconnectivity of these systems. The World Economic Forum has identified 12 pillars for competitiveness. Pillar 2 is infrastructure, which it describes as "The quality and extension of transport infrastructure (road, rail, water and air) and utility infrastructure."[32] It puts the value of infrastructure quite simply: "better-connected geographic areas have generally been more prosperous", the report says.[33] There are 12 indicators that make up the infrastructure pillar – the first two are road connectivity and quality.

Every part of the roads infrastructure should be seen as part of a system and its function and utility as depending on the role that it plays within this wider system. And as we see later in this section, that function and utility can be defined in terms of the people and assets that it serves to connect.

This also means that structural components of the network (bridges, tunnels, etc.) can be viewed in similar terms – by examining the effects of their positioning on segments

[31] See: Scottish Transport Statistics No 37 2018 Edition
[32] World Economic Forum, The Global Competitiveness Report 2018, p39
[33] Ibid

of the network and the functions that these segments perform within the wider system.

It means that all roads are part of the same system. Scotland doesn't have two distinct roads systems. The separation into a trunk network and a local network is an administrative distinction which does not of itself define function.

Similarly, roads themselves can be seen as part of a wider transportation system (with rail) or even "connectivity" (including fibre, wireless and energy systems, for example). What happens in these wider connectivity networks will affect the value of the roads network over time.

We propose a contextualising of this value within wider social, economic and environmental systems, because roads are "enabling infrastructure". They make other things that we value happen. They are not an intrinsic good: their value rests on the extent to which they are the route to other activities (trade, social services, community activities, cultural exchanges, etc.).

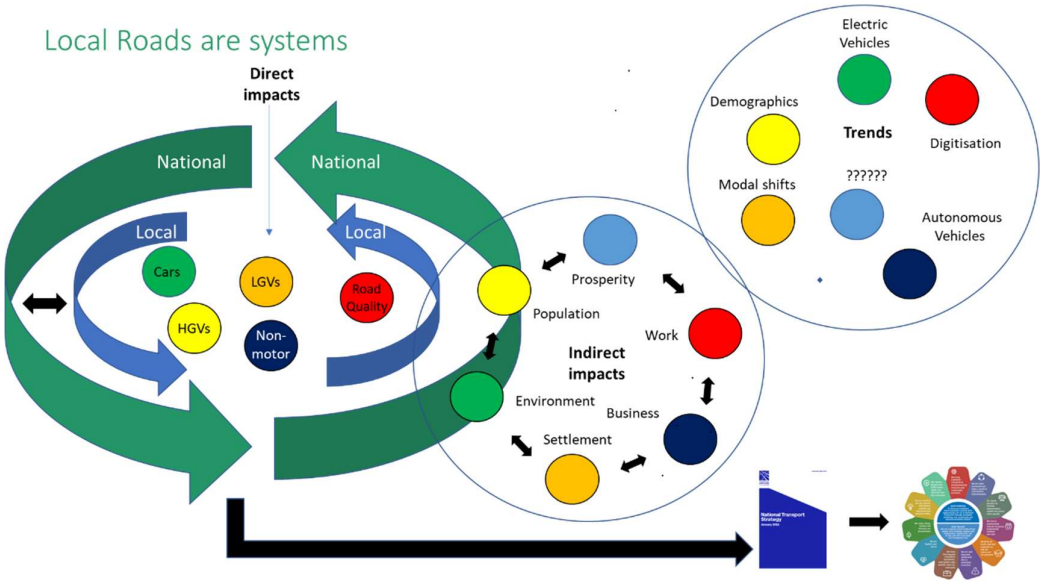

Figure 9 – Local roads as systems

6.5 The LREM "prototype"

At this stage we have developed a preliminary conceptual model to show how this approach might work, which is outlined in the further paragraphs of this chapter below. The LREM is designed to be flexible and adaptable – capable, for example, of incorporating new datasets as they become available at different levels of evaluation, and responsive to localised need.

Any valuation model for roads must be conceptually easy to understand, transparent, flexible and adaptable. The needs that a roads network addresses are in a constant state of evolution and a model, however robust and intellectually rigorous, will gain no traction unless it can be understood and applied in practical situations by non-specialists.

The key principles to our approach are that it is based on:

- Evidence – where relevant datasets are available, these should be used to support analysis and decision-making. The first two levels of the model are evidence-based.
- Consensus – at different points in the model process, stakeholders will need to use their judgement to supplement the evidence available. This could include communities providing primary evidence to support an assessment of need at a hyperlocal level, or policy-makers identifying and prioritising the relevant drivers – or both.
- Evolution – while we think there is enough publicly available data to develop the first iteration of a tool, we would expect the model to evolve as greater consultative input and richer datasets emerge.

Within the scope of this report we have undertaken some initial modelling to illustrate the broad lines of our approach, so that it can be discussed further by key stakeholders and a decision made on whether to take it or a variant forward. We also discuss below how our approach can be developed further if there is a positive decision on this prototype.

We have in mind a toolkit that is easy to use at a regional and local level, but with the appropriate governance to ensure that clear guidance is developed and maintained, with expert and centrally coordinated input on the appropriate use of datasets to support the analysis.

6.6 Data and analysis

Evidence can look forwards or backwards. It may consist of historic statistical data, or be based on expected or predicted outcomes. Deriving a value from historic data gives a (relatively) reliable result, but it is likely to be inadequate because much (if not most) of the time people want to know about what is going to happen in the future.

A company balance sheet, for example, is relatively reliable, but it only tells people a fraction of what they probably want to know about the company.

It follows that for a value framework to be both robust and meaningful, it will need to achieve a balance between data and analysis (through a series of reasoned assumptions). Over time, if the framework is supported by a mechanism to gather specific relevant data on its own terms, the balance could shift to more evidence and fewer assumptions.

We consider that the best way of balancing these considerations is to take a "layered" approach, where historic datasets can provide a robust first layer that is both comparable and capable of interrogation, to which additional layers can then be added.

Breaking the process into a number of stages will allow a governance framework to be developed around the process, managing the datasets used and the basis on which assessments of value are made. In broad terms, this approach is similar to the principles that underly good practice in public procurement, which are segmented to allow qualitative and quantitative assessment based on transparency and standardisation.

Our prototype LREM valuation model incorporates three "levels" of analysis:

- Level 1 - Utility Ratio - which applies readily available attributable roads data;

- Level 2 - **Social Value** - which is also evidence-based but draws on wider non-roads specific datasets; and
- Level 3 - **Future Value** - which is essentially predictive and responsive to policy and future trends.

One of the challenges in an evidence-based approach is that there is a trade-off between currency and certainty. In other words, there is a risk of a greater time lag in datasets that are regarded as most reliable (e.g. census data), while recent (and therefore potentially more current) data and forecasts carry greater risk of inaccuracy. The LREM combines both, in an effort to create a composite picture that is robust, nuanced and meaningful. Levels 1 and 2 in the LREM are built on historic datasets; Level 3 is predictive and based on articulated needs or aspirations at local and national level. It provides the ability to test the roads/transport and socio-economic impact of different investment scenarios within and between geographies.

These levels are illustrated in the diagram below and described in the subsequent sections of this chapter.

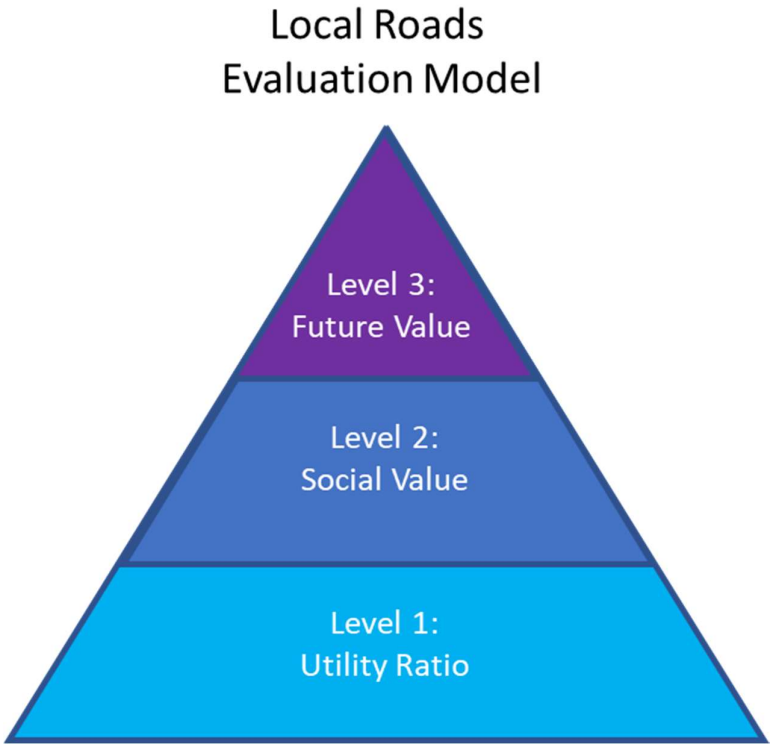

Figure 10 – Local Roads Evaluation Model

6.7 Level 1: "Utility Ratio"

The first level looks at value based on cost - through what road users actually spend to use the roads as a measure of their willingness to pay. These costs can be described as "internalised" – in other words, expenditure that road users themselves absorb, in order to enable them to make use of the network.

For **personal users**, this includes the cost of a car, associated insurance and maintenance costs, etc. Or the cost of travelling by bus.

For **business users** this includes freight costs, or the cost of running their own fleet.

There are also what we might term "social" users – users who are public service providers; emergency services, for example, who spend a significant proportion of their budgets on their fleet, and local authorities who subsidise public transport and provide services such as school buses.

Taken as a whole, this aggregate expenditure can be seen as a proxy for how much Scotland "values" its roads network in the sense that it describes what Scotland is willing to pay for its network.

We can then derive an aggregate User Spend figure from the key data - drawn from business data[34] and Scottish Transport statistics[35] such as the number of car journeys, distance travelled, the volumes of goods moved by HGV and the purposes for which journeys are made.

Importantly, we can segregate (in broad brush terms at least), data for trunk and non-trunk usage. We know, for instance that local roads account for 61% of roads usage across Scotland.

Scottish Transport statistics also provide data at local authority level, allowing us to build a variable picture of local roads usage across Scotland. For each local authority, we can understand how intensively both the trunk roads and the non-trunk roads are used per head of population (million vehicle km divided by km of road network per head of population) and how these two categories of road compare with one another and with the national average.

In West Lothian, taking one example, we see that the ratio of trunk road use is over 3 times higher than the national average, suggesting that the trunk road use may be used more for shorter, local journeys, while Perth & Kinross has the highest roads use per person (over 17,000 km per person per year).

Business Use

Separately, we also need to consider business use. There are a number of possible ways of coming to an estimate of the value of business use. We could look at transportation as a "sector", for example, and assess the Gross Value Added from businesses in this "sector" (which we would have to form a view on by combining a number of SIC codes – such as warehousing, freight operators etc).

Alternatively, we can estimate the share attributable to transportation in the wider economy, focusing on sectors where transportation is likely to be a material cost component (excluding, for instance, sectors such as financial services). We think that the latter approach is probably more consistent with the broader concept of value that we are seeking to develop.

We will need to estimate a percentage attributable to transportation in these sectors. For this report we have assumed it to be 10%. Further research or consultation could potentially make this assumption more robust. This would include, for instance, specific consultation with commercial road user groups and more detailed examination of reported costs of transportation.

[34] See Scottish Annual Business Statistics 2016
[35] See Scottish Annual Transport Statistics No 37 2018

Social Costs

Finally, we looked for data to support an estimate of the "social" cost element of the Utility Value. This requires examination of various data sources (such as the annual report and accounts of the various emergency services). Some of this information is not readily accessible (such as NHS Scotland's non-emergency spend on transport) but in terms of order of magnitude, the effects of these "social" spend items on the overall "Utility Value" look as if they are relatively small – at the national level at least[36].

It is important to stress that the figure that results from this analysis is not the "answer" in itself. The purpose of this figure is to provide an intelligible "baseline" for the remainder of the evaluation model. It should be treated as an approximation whose primary purpose is to establish a level of consistency across geographies and types of use.

Aggregating this information and attributing value to the local as opposed to the trunk roads network by following the 61% / 39% split provided by the Scottish Transport statistics, we estimate the "User Spend" of local roads in Scotland to be around £6.4bn per annum, which is broken down in the table below.

User spend estimate for local roads		
Business	£	2,121,786,608
Personal	£	4,205,832,210
Social	£	30,306,962
Total user spend	**£**	**6,357,925,780**

Table 12 – Estimate of User Spend for Local Roads across Scotland

The supporting tables for the User Spend Analysis are provided at Appendix E.

Hidden Value

Roads often perform an important unseen function as the hosts for a variety of infrastructure networks – water, sewerage gas, electricity, communications, etc. We know from our discussions with Scottish Power Networks, for instance, that 60% of their network is underground (although we don't know how much of this is specifically under the surface of roads). It would require considerable additional research and analysis to determine this element of value; at this stage we can only state that the User Spend is likely to be understated because of this omission.

External costs

Table 12 shows the "internal costs" of the network – in other words, what the users collectively pay.

We can then examine how this User Spend compares with the costs of supporting the network – in other words, the costs that other "actors" sustain in order to keep the network running. One very significant actor is the local authority sector, which funds the ongoing maintenance and infrastructure costs of the network. However, there are

[36] At a local or sub-local level they may become more important, for instance, in remote areas, but it is also likely that there will be supporting data as a result

also other externalised costs sustained by third parties, such as the cost to the environment of the CO_2 emissions generated and the particulates emitted (which result, for instance, in costs to the health sector as well as to individuals and the planet). External costs can thus be broken down into two parts:

- Costs to local authorities of maintenance and investment
- Other costs that are absorbed by communities and more widely by society, such as the cost of road accidents, emissions (CO_2 and air pollutants) and noise[37].

Drawing on Scottish Transport Statistics 2018, we estimated this broader definition of aggregate local roads network costs ("Network Costs") as follows:

Costs of the local roads network	
Capital expenditure	326,483,000
Maintenance expenditure (net)	305,433,000
Sub-total: local authority expenditure	*631,916,000*
Road accidents on local roads	617,930,000
Emissions & noise costs - cars & LGVs	500,188,679
Emissions & noise costs - HGVs	86,127,484
Sub-total: externalised costs	*1,204,246,163*
Total direct and externalised Network costs	**1,836,162,163**

Table 13 – Externalised costs of the Local Roads Network

Calculating the Utility Ratio

The User Spend can then be converted to a ratio by using the User Spend as the numerator and the externalised costs as the denominator.

This creates a form of input : output multiplier or economic proxy as a measure of value for the local roads network, using what users of the network collectively spend in order to be able to make use of it. From this, we derive a "Utility Ratio" by dividing it by the accumulated cost or expenditure required to sustain the network, including, but not limited to local authority expenditure. This ratio shows that what users are prepared to spend to use the local network is significantly greater than what is spent on making it available. In this sense, the network is beneficial in net terms.

Based on the data available for this report, we calculated a User Spend of **£6.4bn** for Scotland's local roads network and a "Utility Ratio" for Scotland of **3.46 to 1**. This is a Scotland-wide ratio but can be adapted regionally and locally, using the relevant data.

Based on the Scottish Transport data, it should be possible to recalculate this ratio for all local authority areas in Scotland. At sub-local authority (e.g. ward) level, where there

[37] There may be other cost headings that should be included. While Scottish Transport statistics have data for the cost of road accidents, they do not seek to provide a cost for emissions and noise. At this stage we have used unit costs provided by a Swedish study: "Transportsektorns samhällsekonomiska kostnader Rapport 2019:4" and converted from SEK to £. This area would require further research at a later stage.

is known sub-local data for this level, this could be used to modify the Utility Value further.

The Utility Ratio can then be applied for a number of purposes, for instance to evaluate:

- local authorities against the national ratio
- change over time (e.g. spend from one financial year to the next) at local authority level
- proposed investment (or disinvestment) in specific areas within local authorities
- the implications of spending decisions across local authority boundaries (e.g. through City Region plans).

This is a measure of how users value the network relative to its cost. It is a snapshot, based on historic data. One would expect the ratio to be greater than 1:1, but it is likely to vary geographically and over time. As with all cost/benefit ratios, it is important to put this ratio in context and treat this as a relative measure of value rather than an absolute one. Nor should it be used in isolation. However, it provides an essential link with direct roads usage data and a useful point of departure for a broader socio-economic framework for assessing the value of the roads network. What we are principally interested in is how a Utility Ratio can be used as building block in a broader set of tools for measuring change.

However well researched, a ratio should be seen as just one tool in the box. As a general principle, analysis should never be reduced to a single indicator. It should also be borne in mind that a high figure is not automatically good, nor is a low figure automatically bad. A high Utility Ratio could equally denote efficiency (maximum output for lowest cost) or under-investment (storing up problems for later on).

Where the Utility Ratio is being used for a specific project, investment or disinvestment, the first level of analysis will consider the expected change in utility that would result from the proposals.

6.8 Overview of Levels 2 & 3: Social Value, Needs Analysis and Policy Drivers

The strength of the Level 1 analysis is in its direct link back to publicly available statistical data about roads. However, even at sub-local level, it only provides an assessment based on generic user types. So, while it has a high degree of robustness, it does not consider how variations in the circumstances of these users (e.g. levels of deprivation in the area) might affect the decision-making process and ultimately change socio-economic circumstances for better or for worse over time.

We therefore propose two further levels of analysis beyond Level 1, where analytical judgement needs to be exercised as to the significance and the strength of the relationship between the available data, expected outcomes and a proposed investment or disinvestment, but where the process can be managed by defining the applicable data-sets and other factors that need to be taken into consideration.

Over these two further levels, the appraisal would lead to a form of weighted score which would apply to the baseline Utility Ratio. Recognising that the core function of a roads network is to get people, goods and services from one place to another, the baseline Utility Ratio is likely to remain a significant element of a weighted score, but times of greater and more rapid change in determinants of transport need may require

greater weight to be placed against Levels 2 & 3; but determining the relative weighting of each of the Levels is beyond the scope of this report.

It might be agreed, for example, that Levels 2 & 3 have the potential to generate an upwards or downwards adjustment to the numerator in the Utility Value. This adjustment might be capped to avoid Levels 2 & 3 unduly distorting the outcome.

Certain parameters within the model could be flexed according to location or purpose, but we would expect these particular parameters to be determined on a programme-wide basis to ensure consistency.

Levels 2 & 3 could then be applied, for example, in conjunction with Level 1 to:

- provide a broader "business as usual" assessment than the basic Utility Ratio at regional and local authority level to test the socio-economic criticality of continued investment in roads
- map "hotspots" and areas of need within regional and local authority areas (for instance for local authorities seeking to allocate budgets effectively)
- support planning assessment and sustainable procurement.

6.9 Level 2 – Social Value

The purpose of the Level 2 analysis is to use broader socio-economic datasets to highlight key dependencies at regional, local and sub-local levels with a view to adjusting the baseline Utility Ratio to arrive at a more broadly defined broader measure of value, albeit one which is distinct from the more generic "business as usual" economic Utility Ratio.

Our intention is that the Level 2 analysis would still be data-led but use broader datasets that require a degree of interpretation as to their applicability. In order to make decisions that take account of wider socio-economic factors, it is inevitable that more indirect causal relationships will need to be taken into account, where the condition of the roads network, for example, may be only one factor in a number which affect the economic and social opportunities of people and communities.

Greater importance at the Social Value level would be given to local geography and socio-economic factors and that would be reflected in the weightings or level of detail explored beneath the headline components described below.

However, the component parts of the analysis would be clearly defined, as would the scoring mechanism, which would be kept simple to avoid spurious levels of detailed analysis (for instance, we might adopt a score out of 4: High / Medium / Low / Not applicable).

Importantly, evaluators would need to understand that what they were assessing would be the effect of the proposed change (e.g. investment or disinvestment) rather than the base functionality of the part of the network, which should be covered by the Level 1 analysis.

We suggest the following components for the Level 2 analysis:

- **Redundancy** - this is a measure of the criticality of the network. Lower redundancy – where a route or a structure is the only or one of just two links would have a higher weighting. One particular area for further exploration is the extent to which there is

a correlation between SIMD areas with a low Access Domain score and which have key infrastructure points where the need to divert would cause significant upheaval (i.e. have a high redundancy level) and whether other datasets can provide a more granular picture of the true level of dependency on particular routes.

- Social need – this element would measure inequality and deprivation where the initial primary data source could be SIMD but supplemented by additional place-based datasets as they become available. Social need access could be supplemented by local authority and NHS data for home visits for Health and Social Care, tracking flows of carers and health visitors making journeys to clients. This would seek to pick up frequency of journey as a measure of importance of the local road (and civil) assets. This goes beyond the SIMD methodology for access which splits the Access Domain on journeys out only into:
    - Drive time sub-domain (weight = 2/3)
        - Drive time: to GP, to retail centre, to petrol station, to primary and secondary schools, to post office
    - Public transport subdomain (weight = 1/3)
        - Public transport time to GP, to retail centre, to post office

- "Community capital" – this element would measure provision of access to key community assets (for example, third sector, voluntary organisations, social enterprises). This could be evidenced by geospatial mapping tools. This would primarily seek to pick up voluntary value that is not already picked up in the first level Utility Ratio.

  It will be useful to explore the extent to which the location of the current public estate is taken into account in current road investment and planned maintenance decisions. A sub-set of the education estate that could be worth understanding more deeply for some local authorities is the private provision of nursery education and how important the local roads network is to that key economic enabler.

  We have undertaken some initial work to produce an example of what some of the community capital asset mapping could look like using open source data available, based on third sector assets only.

  The starting point for the example was OSCR data on local charitable organisations. These were categorised by turnover (as a means of sifting scale of the operation) and what type of building was in place) to measure radius of impact.

  In developing the concept of community capital, we would also need to consider how to factor in elements of the public estate that are not covered in the initial Level 1 Utility Ratio definition.

  Understanding the key flows (and the timing of them) around these community assets can provide the Local Authorities with an evidence base of the assets' importance to Social Value creation when making investment decision.

- **Business innovation** – this element would measure a basket of indices designed to capture the growth potential in the local economy. Appropriate datasets would need to be identified. We could use information from Scottish Enterprise or HIE, or indices of business activity produced by commercial organisations such as Grant Thornton's Vibrant Economies index for example.

- **Natural capital –** this element would measure the quality of the natural environment. Appropriate datasets would need to be identified. A biodiversity index, for example using the SNH Priority Projects[38] list. Natural Capital can also have a directly beneficial impact into **National Performance Indicator H – We are healthly and active –** and therefore key links to Natural Capital assets such as parks, trails, park-runs and SUSTRANS links will also contribute a Social Value that is not already included in the wider Utility measure.

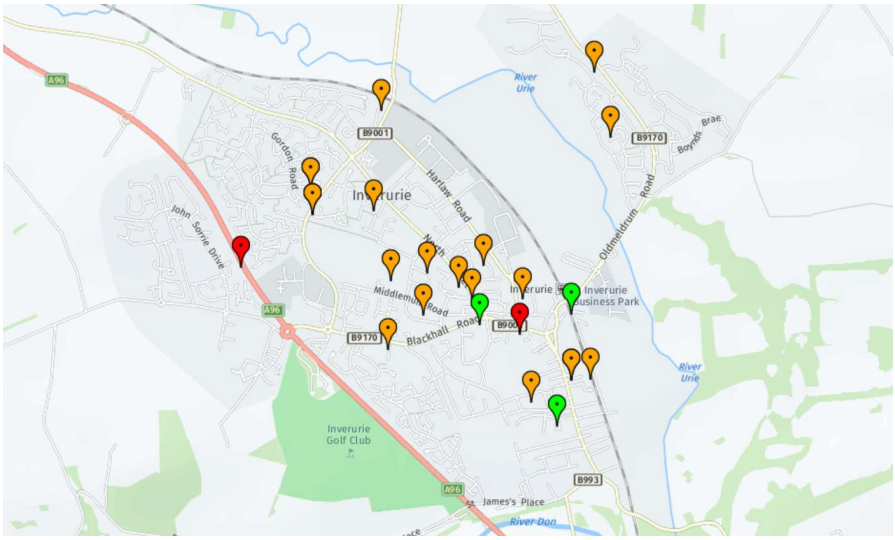

Fig.11 – Mapping the community and voluntary estate

By agreeing what datasets could be taken into account and providing guidance on weighting and application, it should be possible to develop a standardised assessment and evaluation framework.

Additional datasets could include, for example, a development of the pilot work undertaken by Scotland's Centre for Regional Inclusive Growth[39].

It might be appropriate in certain clearly defined circumstances for a proposal to be deemed "non-compliant" at Level 2 – for instance where the environmental consequences are deemed to be unacceptable, regardless of the expected social benefits.

6.10 Level 3 – Future Need

While Level 2 will give the assessment more texture from a socio-economic perspective, it will still be subject to the limitations and timing of data availability. A

[38] See: https://www.nature.scot/sites/default/files/2018-03/Biodiversity-Route-Map-2nd-year-report-29-March-2018.pdf
[39] See: http://www.inclusivegrowth.scot/

critical element of effective policy and service delivery is the collection of primary data through feedback mechanisms, community consultations, etc.

Policy development and implementation can't rely entirely on historic data if it aims to anticipate and meet future need. Level 3 is intended to allow policy-makers to factor in the consequences of intended policy implementation (e.g. behavioural change strategies), test for consistency with broad policy themes and draw on direct input from communities (in the broad sense – so this could entail communities of business, for example).

In Section 3, we undertook an outline alignment exercise with the NPF. We see this as being a core component of the Level 3 assessment. More broadly, Level 3 is likely to be a primarily qualitative assessment, with the onus on the projects sponsors or responsible officers to demonstrate alignment. Reflecting the multiple functionality of the roads network, we would expect to see high-scoring networks or projects at Level 3 demonstrating alignment with a significant number of National Performance Outcomes, not just a few (number to be determined).

6.11 Process summary

In summary, we propose a process that is illustrated in the diagram below:

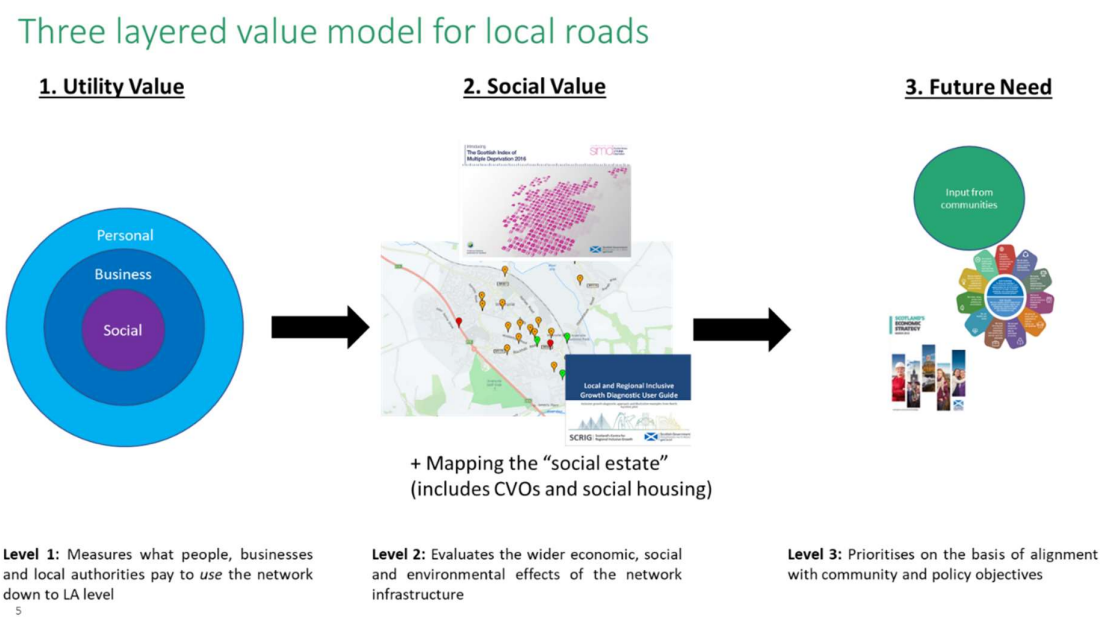

Fig. 12 – LREM concept diagram

Any system of evaluation is only as good as the data that feeds it, so it will be critical to build in effective feedback loops so that the model can evolve over time through use.

7.0 Conclusions, recommendations and next steps

7.1 A new approach

We believe that local roads are strategically significant for the social, economic and environmental wellbeing, not only of local communities, but Scotland as a whole, and that this needs to be reflected in policy and planning for the sector. There is, therefore, a strong case for adopting a new approach to valuing the roads network. The scope of our work has specifically covered the ***local*** roads network and our proposals are framed accordingly, but a key principle of our approach is that local roads are evaluated on a systemic basis and therefore are seen not only as part of the overall roads network with trunk roads, but also part of wider transportation and connectivity networks.

We make the case for a new evaluation model because we think this will help policy-makers and practitioners to embed the wider social, economic and environmental impacts of local roads in their decision-making and therefore make more informed investment (or disinvestment) decisions going forward.

The new framework should be data-led and evidence-focused but should also recognise and allow structured consultative input, so that key stakeholders – from policy-makers to custodians of the network to user groups to communities – can make qualitative judgements against a robust and transparent decision-making framework.

7.2 How will this help?

We see a number of potential benefits from the adoption of a model along the lines set out in Chapter 6 of this report – both to local and central government:

- The inclusion of economic and social value as core investment considerations, supplementing the traditional focus on safety, roads network performance and asset condition
- The ability to base this model on the approaches and data sources already used to inform service delivery within the wider public sector
- Alignment with overarching Government strategy on inclusive growth and other outcomes through the NPF (that in itself informs Local Outcome Improvement Plans) and the National Transport Strategy and future strategic developments
- The ability to calibrate the model to fit local authorities across the geographic spectrum and to evaluate community impact at sub-local authority level.
- A dynamic tool with building blocks that can be weighted to reflect different priorities and the ability to supplement and periodically update core data.
- A comprehensive and consistent framework for capturing the value of local roads

7.3 A workable model

A key question to be addressed is the practical application and usability of such a model. Complexity in evaluation models comes in two forms – firstly in the design of

the model and secondly in the volume of data that it seeks to gather to support its process. The first can be managed through the framework design; the second is inherent in the model – and if the model is to be data-led, it needs to encourage data complexity in the interests of building a richer picture of value, so minimising data complexity would be undesirable.

The obvious solution is to harness the capabilities of a digital platform, where high volumes of complex data can be stored and analysed. The principle of digitising the model should be relatively uncontroversial, as the technology required to do this is very much in the mainstream; landing on the right solution is clearly the subject of more involved discussion.

7.4 Potential next steps

This research report offers a "concept model". If SCOTS agrees with the proposed "direction of travel", the next steps would involve testing this conceptual approach further with a view to a wider rollout.

It is envisaged that a supplement to this stage of work could be undertaken to see how the concept can be localised, primarily focusing on what datasets are available and how they can be combined within a specific geographical example. We understand that Ayrshire is being considered for this supplementary piece.

Provided that the results from this supplementary exercise are positive, consideration can then be given to developing a "Stage 2", which would very much be an applied research programme.

The main areas of work that we envisage can be split into two elements:

Concept Development

- Detailed evaluation "toolkit" including framework and guidance
- Governance structure for ongoing management of the toolkit
- Databank

Application

- Online solution design
- Mapping and baselining – development of a Scotland-wide "as is" picture.
- Development and launch of the digital platform
- Application of the model to one or more areas across Scotland as pre-launch "pilots"

The key objectives of this testing stage would be to:

- Demonstrate how the model works to embed local roads in wider strategic considerations of prosperity and wellbeing;
- Establish a standardised approach with accompanying guidance to ensure consistency and comparability;
- Test and refine the theoretical model using user feedback to ensure that it works for roads and wider transport planning and management across all of Scotland's 32 local authority areas

Appendix A: Value of the Local Roads Network Community Council Survey April / May 2019 - Headlines

The main headlines from the Community Council survey feedback were as follows[40]:

N = 257

1. Key issues in your area (Q3) – in order – from 12 options

1. Quality of the road surface (87%)
2. Safety for all users (72%)
3. Ease of use for cyclists (70%)
4. Impact of maintenance works (68%)
5. Ease of use for pedestrians (67%)

2. Issues influenced by the network (Q4) – in order – from 5 options

1. Safety and security (46%)
2. Local economic activity (45%)
3. The physical environment (42%)

3. More investment needed (Q5) – 91% said 'yes'. Priorities within this investment (Q6) - in order – from seven options:

1. Increased safety and security (65%)
2. Reduced environmental impact (54%)
3. Support for the local economy* (50%)
4. Reduced congestion* (50%)

4. Major positive developments (Q7) – in order - from seven options

1. More pedestrians and cyclists (clear winner with 62%)
2. Improved traffic flows (35%)
3. Reduction in accidents (28%)

5. Major negative developments (Q8) – in order - from seven options

1. Increased noise (56%)
2. Deteriorating traffic flows (53%)
3. Poorer air quality (47%)

6. Single biggest opportunity (Q9) – top 5

1. Improved surfacing (25%)
2. Better maintenance (20%)
3. Improved traffic management (15%)
4. Improved parking (5%)
5. More active commuting (5%)

7. Main barriers to improvement (Q10) – top 5

1. Available funding (45%)
2. Council attitude/processes (15%)
3. Population growth/pressure (12%)
4. Lack of programmed maintenance (7%)
5. Traffic management challenges (6%)

[40] Note that the missing question numbers were either associated with respondent profiling or points of clarification on earlier questions

8. Changes impacting most in next 10-20 years (Q11) – in order – from nine options

1. Increase in number of older people (65%)
2. Changes in the number of heavy vehicles (47%)
3. Improvements in digital connectivity (30%)

9. Major anticipated changes – INCREASES - more generally over same period (Q12) – in order – from 10 options

1. Private transport (69%)
2. LGVs (67%)
3. HGVs (64%)
4. Electric vehicles (63%)

10. Major anticipated changes – DECREASES - more generally over same period (Q12) – in order – from ten options

1. Public transport (50%)
2. Nothing else above 10%

11. Favoured approaches to reducing traffic (Q13) – in order – from eight options

1. More integrated public transport planning (64%)
2. More joined up travel planning (59%)
3. Greater emphasis on behaviour change (42%)

Appendix B: National Performance Framework mapping

The results from our preliminary mapping exercise are set out below. Respondents were asked to score, for area types that they were familiar with, how they felt the local roads network aligned with the NPF – whether they felt the alignment was Strong, Moderate, Weak or whether it was not possible to say (= "Neutral"). The alignment could be strongly, moderately or weakly positive or negative. For example, the local roads network in an accessible rural area might be seen to have a strong positive alignment with *"We have thriving and innovative businesses, with quality jobs and fair work for everyone"*, while a large urban area might be seen to have a strong negative alignment with *"We value, enjoy, protect and enhance our environment"*. The purpose of the exercise is to encourage people to start to make the connections between roads and the national description of what makes Scotland a good place to live. A further dimension was added by asking people to think not just about the "as is" but what they would expect to be the case in the future.

The outcomes from this exercise are summarised in the two tables below.

Alignment of the local roads network with the NPF: now	Strong		Moderate		Weak		Neutral
	Positive	Negative	Positive	Negative	Positive	Negative	
A. We have a globally competitive, entrepreneurial, inclusive and sustainable economy	1	0	4	0	2	2	5
B. We are open, connected and make a positive contribution internationally	4	0	3	0	0	1	6
C. We tackle poverty by sharing opportunities, wealth and power more equally	0	0	4	1	3	6	0
D. We live in communities that are inclusive, empowered, resilient and safe	1	0	6	0	0	3	4
E. We grow up loved, safe and respected so that we realise our full potential	0	1	6	1	1	5	0
F. We are well educated, skilled and able to contribute to society	0	0	7	0	0	4	3
G. We have thriving and innovative businesses, with quality jobs and fair work for everyone	1	0	6	1	0	2	4
H. We are healthy and active	0	1	2	0	5	6	0

I.	We value, enjoy, protect and enhance our environment	0	1	2	1	2	5	3
J.	We are creative and our vibrant and diverse cultures are expressed and enjoyed widely	0	0	0	0	7	4	3
K.	We respect, protect and fufil human rights and live free from discrimination	0	0	0	0	6	4	4
Totals		**7**	**3**	**40**	**4**	**26**	**42**	**32**

Table 14 – Summary scoring from NPF alignment exercise: "as is"

Alignment of the local roads network with the NPF: in future		Strong		Moderate		Weak		Neutral
		Positive	Negative	Positive	Negative	Positive	Negative	Negative
A.	We have a globally competitive, entrepreneurial, inclusive and sustainable economy	1	0	5	0	1	2	5
B.	We are open, connected and make a positive contribution internationally	2	0	3	0	2	3	4
C.	We tackle poverty by sharing opportunities, wealth and power more equally	2	0	1	0	4	4	3
D.	We live in communities that are inclusive, empowered, resilient and safe	3	0	4	0	0	2	5
E.	We grow up loved, safe and respected so that we realise our full potential	0	0	6	0	1	4	3
F.	We are well educated, skilled and able to contribute to society	0	0	5	0	2	2	5
G.	We have thriving and innovative businesses, with quality jobs and fair work for everyone	4	0	3	0	0	2	5
H.	We are healthy and active	1	0	4	0	2	4	3
I.	We value, enjoy, protect and enhance our environment	0	0	5	1	2	6	0
J.	We are creative and our vibrant and diverse cultures are expressed and enjoyed widely	0	0	0	0	7	3	4
K.		0	0	5	0	2	3	4

We respect, protect and fufil human rights and live free from discrimination							
Totals	13	0	41	1	23	35	41

Table 15 – Summary scoring from NPF alignment exercise: "to be"

We can see a predominance of positive "Moderate" and "Strong" scores over weak "Moderate" and "Strong" scores, underpinning the perceived significance of the local roads network, although the respondents only used the term "Strong" in a limited number of circumstances, suggesting a degree of uncertainty about the purpose of local roads. Overall, positive scoring improved in the "to be" scenario, which may in part be down to the innate optimism of the respondents, but possibly also to some of the trends that have been identified elsewhere in this report.

The "Moderate" scores with the broadest "reach" across categories were seen in:

- D. We live in communities that are inclusive, empowered, resilient and safe
- E. We grow up loved, safe and respected so that we realise our full potential.
- F. We are well-educated, skilled and able to contribute to society
- G. We have thriving and innovative businesses, with quality jobs and fair work for everyone

Overall, positive scores outweighed negative scores, while negative scores were predominantly at the weaker end.

Using a scoring system, where Strongly positive = 3, Moderately positive = 2, Weakly positive =1 and the negative scores are negative equivalents, gave scores by urban-rural type, both now and in the future and are shown in the table below.

Weighted scores	Large Urban	Other Urban	Access. Small Towns	Remote Small Towns	Access. Rural	Remote Rural	Island
Now	0	11	11	16	13	11	8
In Future	17	15	16	10	8	8	13

Table 16 – Summary scoring from NPF alignment exercise by urban-rural type

In the "now" assessment, "Large Urban" stood out because positive and negative scores cancelled each other out, respondents' views on the challenges perhaps highlighting perceptions over the challenges faced particularly in these areas over congestion, air quality and multiple use.

Between the extremes, there are variations of alignment across geographical types, but within a relatively narrow band. This may be because the core function of a roads network remains the same across the country – namely to move people and services from A to B.

It is interesting to see how perceptions can shift when it comes to predicting the future, with local roads acquiring a much greater perceived alignment in the Large Urban context in particular, perhaps because they are seen as becoming more multi-functional public spaces.

Spider charts for each of the urban-rural types also bring out some of these variations. For instance, Large Urban shows a big shift from now to the future, with an expectation that roads will become important positive influences on most, if not all indicators :

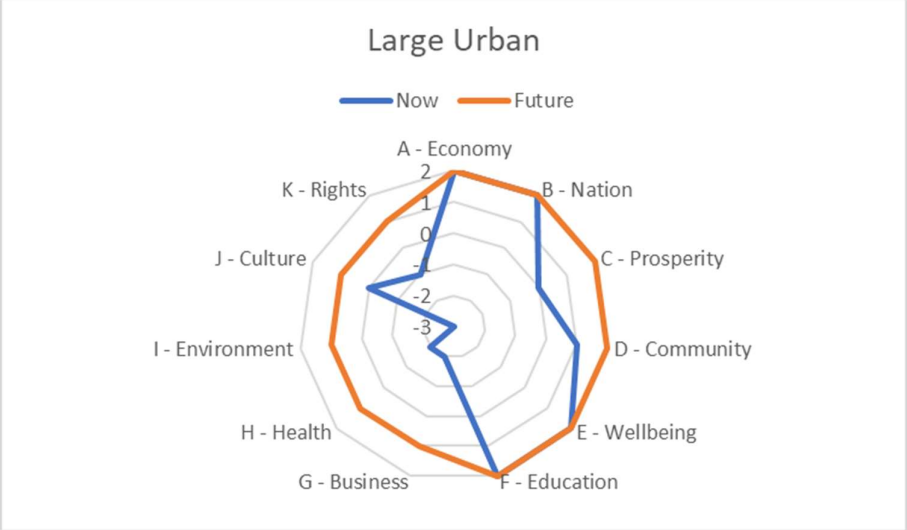

Fig. 13 – Large Urban NPF Alignment spider

On the other hand, Accessible Small Towns shows relatively little change:

Fig. 14 – Accessible Small Towns NPF Alignment spider

Clearly this kind of exercise needs a reasonable sample size or a structured focus group approach to derive meaningful evidence. It is potentially a useful tool but may need some kind of "hidden preference" type questionnaire to facilitate responses.

However, this initial work above, we can see:

- The ubiquity of the local roads network in the life of Scotland and its people
- Both the variability and the common themes across different geographical types in Scotland

- The strategic underpinning that the local roads network provides for the delivery of policy objectives, which can be evidenced by the kind of mapping exercise described above.

Appendix C: Road Use Data

Scotland's Roads Network by type (Transport Scotland)

Table 4.1 Public road lengths by class, type and speed limit [1,2]

	2017	%
Trunk roads [3,6]		
Motorways	*Kilometres*	
Excluding slip roads	449	
Including slip roads	645	
A roads		
Dual carriageway	510	
Single carriageway	2,320	
Other inc slips/roundabout	205	
Total	3,036	
by speed limit:		
up to 40 mph	248	
over 40 mph	3,433	
All trunk roads [3,4]	**3,681**	**7%**
Local Authority major roads [7]		
Motorways		
Excluding slip roads	-	
Including slip roads	-	
A roads		
Dual carriageway [5]	271	
Single carriageway [5]	7,156	
Total	7,427	
by speed limit:		
up to 40 mph	1,642	
over 40 mph	5,785	
All LA major roads [4]	**7,427**	**13%**
Local Authority minor roads [7]		
B roads		
limit up to 40 mph	1,235	
limit over 40 mph	6,255	
Total	7,491	
C roads		
limit up to 40 mph	1,658	
limit over 40 mph	9,043	
Total	10,701	
Unclassified roads		
limit up to 40 mph	15,379	
limit over 40 mph	11,686	
Total	27,065	
All LA minor roads	**45,257**	**80%**
All roads (trunk and LA) [3]		
Motorways		
Excluding slip roads	449	
Including slip roads	645	
A, B and C roads		
Dual carriageway [5]	781	
Single carriageway [5]	27,668	
Total	**28,654**	
by speed limit:		
up to 40 mph	4,783	
over 40 mph	24,516	
Unclassified roads		
limit up to 40 mph	15,379	
limit over 40 mph	11,686	
Total	**27,065**	
All roads [3,4]	**56,364**	**100%**

Scotland's Roads Network length and usage by local authority (Transport Scotland)

Summary Road Data by Scottish Local Authority	Road Networks (kilometres)							Traffic (million vehicle kilometres)					
	Trunk		Local		Check	Total		Trunk	Non-			Total	
	km	% area total	km	% area total		km	% nat.	mkm	% area	mkm	% area	km	% nat.
Aberdeen City	31	3%	920	97%	100%	951	2%	267	19%	1118	81%	1385	3%
Aberdeenshire	192	3%	5529	97%	100%	5721	10%	1040	33%	2106	67%	3146	7%
Angus	53	3%	1814	97%	100%	1867	3%	372	32%	803	68%	1175	2%
Argyll & Bute	296	11%	2285	89%	100%	2581	5%	419	43%	566	57%	985	2%
Clackmannanshire	3	1%	291	99%	100%	294	1%		0%	334	100%	334	1%
Dumfries & Galloway	352	8%	4167	92%	100%	4519	8%	1466	65%	777	35%	2243	5%
Dundee City	19	3%	563	97%	100%	582	1%	171	19%	712	81%	883	2%
East Ayrshire	70	6%	1157	94%	100%	1227	2%	350	32%	761	68%	1111	2%
East Dunbartonshire	0	0%	518	100%	100%	518	1%		0%	581	100%	581	1%
East Lothian	59	6%	931	94%	100%	990	2%	414	41%	588	59%	1002	2%
East Renfrewshire	22	4%	483	96%	100%	505	1%	234	29%	572	71%	806	2%
Edinburgh, City of	67	5%	1417	95%	100%	1484	3%	776	25%	2291	75%	3067	6%
Eilean Siar	0	0%	1191	100%	100%	1191	2%		0%	230	100%	230	0%
Falkirk	58	6%	979	94%	100%	1037	2%	639	38%	1028	62%	1667	3%
Fife	124	5%	2426	95%	100%	2550	5%	896	29%	2206	71%	3102	6%
Glasgow, City of	108	6%	1830	94%	100%	1938	3%	1572	42%	2206	58%	3778	8%
Highland	959	12%	6749	88%	100%	7708	14%	1720	60%	1165	40%	2885	6%
Inverclyde	28	7%	370	93%	100%	398	1%	67	12%	474	88%	541	1%
Midlothian	39	5%	686	95%	100%	725	1%	143	20%	574	80%	717	1%
Moray	98	6%	1556	94%	100%	1654	3%	286	36%	511	64%	797	2%
North Ayrshire	68	6%	1036	94%	100%	1104	2%	320	40%	487	60%	807	2%
North Lanarkshire	103	6%	1567	94%	100%	1670	3%	1289	39%	2008	61%	3297	7%
Orkney Islands	0	0%	985	100%	100%	985	2%		0%	148	100%	148	0%
Perth & Kinross	261	9%	2496	91%	100%	2757	5%	1608	61%	1011	39%	2619	5%
Renfrewshire	55	6%	824	94%	100%	879	2%	771	48%	828	52%	1599	3%
Scottish Borders	167	5%	2975	95%	100%	3142	6%	404	31%	896	69%	1300	3%
Shetland Islands	0	0%	1049	100%	100%	1049	2%		0%	223	100%	223	0%
South Ayrshire	93	7%	1173	93%	100%	1266	2%	410	40%	620	60%	1030	2%
South Lanarkshire	142	6%	2271	94%	100%	2413	4%	1395	51%	1360	49%	2755	6%
Stirling	144	12%	1017	88%	100%	1161	2%	544	41%	782	59%	1326	3%
West Dunbartonshire	23	6%	378	94%	100%	401	1%	220	33%	455	67%	675	1%
West Lothian	47	4%	1052	96%	100%	1099	2%	730	38%	1175	62%	1905	4%
Total	**3681**		**52685**			**56366**	**100%**	**18523**	**38%**	**29596**	**62%**	**48119**	**100%**

Summary Road Data by Scottish Local Authority	Density of road use (distance travelled / network length)				Road use per person (km)				
	Trunk	Non-trunk	Var. from Nat. diff.	All roads density	Est. population	Trunk km	Non-trunk km	Total	Var. from median
Aberdeen City	8.61	1.22	165%	1.46	228,800	1,167	4,886	6,053	-47%
Aberdeenshire	5.42	0.38	113%	0.55	261,800	3,972	8,044	12,017	6%
Angus	7.02	0.44	147%	0.63	116,300	3,199	6,905	10,103	-11%
Argyll & Bute	1.42	0.25	26%	0.38	86,800	4,827	6,521	11,348	0%
Clackmannanshire	0.00	1.15	-26%	1.14	51,500	-	6,485	6,485	-43%
Dumfries & Galloway	4.16	0.19	89%	0.50	149,200	9,826	5,208	15,034	32%
Dundee City	9.00	1.26	173%	1.52	148,700	1,150	4,788	5,938	-48%
East Ayrshire	5.00	0.66	97%	0.91	121,900	2,871	6,243	9,114	-20%
East Dunbartonshire	0.00	1.12	-25%	1.12	108,100	-	5,375	5,375	-53%
East Lothian	7.02	0.63	143%	1.01	104,800	3,950	5,611	9,561	-16%
East Renfrewshire	10.64	1.18	211%	1.60	94,800	2,468	6,034	8,502	-25%
Edinburgh, City of	11.58	1.62	223%	2.07	513,000	1,513	4,466	5,979	-47%
Eilean Siar	0.00	0.19	-4%	0.19	27,000	-	8,519	8,519	-25%
Falkirk	11.02	1.05	223%	1.61	160,100	3,991	6,421	10,412	-8%
Fife	7.23	0.91	141%	1.22	371,400	2,412	5,940	8,352	-26%
Glasgow, City of	14.56	1.21	299%	1.95	621,000	2,531	3,552	6,084	-46%
Highland	1.79	0.17	36%	0.37	235,200	7,313	4,953	12,266	8%
Inverclyde	2.39	1.28	25%	1.36	78,800	850	6,015	6,865	-40%
Midlothian	3.67	0.84	63%	0.99	90,100	1,587	6,371	7,958	-30%
Moray	2.92	0.33	58%	0.48	95,800	2,985	5,334	8,319	-27%
North Ayrshire	4.71	0.47	95%	0.73	135,800	2,356	3,586	5,943	-48%
North Lanarkshire	12.51	1.28	251%	1.97	340,000	3,791	5,906	9,697	-15%
Orkney Islands	0.00	0.15	-3%	0.15	22,000	-	6,727	6,727	-41%
Perth & Kinross	6.16	0.41	129%	0.95	151,100	10,642	6,691	17,333	53%
Renfrewshire	14.02	1.00	291%	1.82	176,800	4,361	4,683	9,044	-20%
Scottish Borders	2.42	0.30	47%	0.41	115,000	3,513	7,791	11,304	0%
Shetland Islands	0.00	0.21	-5%	0.21	23,100	-	9,654	9,654	-15%
South Ayrshire	4.41	0.53	87%	0.81	112,700	3,638	5,501	9,139	-20%
South Lanarkshire	9.82	0.60	206%	1.14	318,200	4,384	4,274	8,658	-24%
Stirling	3.78	0.77	67%	1.14	94,000	5,787	8,319	14,106	24%
West Dunbartonshire	9.57	1.20	187%	1.68	89,600	2,455	5,078	7,533	-34%
West Lothian	15.53	1.12	322%	1.73	181,300	4,026	6,481	10,507	-7%
Total	**5.03**	**0.56**	**100%**	**0.85**	**5,424,700**	**3,415**	**5,456**	**8,870**	**-22%**
	Nat. differential		4.47						

Total vehicles in Scotland from 2006 to 2016[41]

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Inc/Dec 2006 to 2016
All vehicles (thousand)	2,564	2,627	2,665	2,684	2,685	2,691	2,717	2,759	2,821	2,863	2,919	355
Cars	2,157	2,201	2,233	2,249	2,255	2,264	2,285	2,319	2,369	2,394	2,433	276
Taxis	4	4	4	4	3	4	4	4	4	4	4	0
Motorcycles	65	69	71	72	69	66	66	66	67	68	70	5
Three wheelers	1	1	1	1	1	1	1	1	1	1	1	0
Light goods	221	234	240	242	240	238	241	247	256	269	283	62
Goods	38	38	38	37	36	36	35	36	36	37	38	0
Buses and coaches	18	18	17	17	16	16	16	15	15	15	15	-3
Agricultural vehicles etc	42	43	44	45	45	47	48	48	49	50	50	8
Other vehicles	19	19	18	18	19	20	22	23	24	25	25	6

Percentage of overall vehicles by vehicle type 2006 to 2016

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Inc/Dec 2006 to 2016
All vehicles %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	13.8%
Cars	84.1%	83.8%	83.8%	83.8%	84.0%	84.1%	84.1%	84.1%	84.0%	83.6%	83.4%	12.8%
Taxis	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%
Motorcycles	2.5%	2.6%	2.7%	2.7%	2.6%	2.5%	2.4%	2.4%	2.4%	2.4%	2.4%	7.7%
Three wheelers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Light goods	8.6%	8.9%	9.0%	9.0%	8.9%	8.8%	8.9%	9.0%	9.1%	9.4%	9.7%	28.1%
Goods	1.5%	1.4%	1.4%	1.4%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	0.0%
Buses and coaches	0.7%	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	-16.7%
Agricultural vehicles etc	1.6%	1.6%	1.7%	1.7%	1.7%	1.7%	1.8%	1.7%	1.7%	1.7%	1.7%	19.0%
Other vehicles	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.9%	0.9%	0.9%	31.6%

[41] https://www.transport.gov.scot/publication/scottish-transport-statistics-no-36-2017-edition/chapter-1-road-transport-vehicles/#Table1.1

Total Cars registered in Scotland 2006 to 2016[42]

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Inc/Dec 2006 to 2016
Petrol	1,748	1,747	1,735	1,701	1,656	1,619	1,592	1,567	1,552	1,522	1,509	-239
Diesel	812	874	923	974	1,018	1,061	1,113	1,178	1,252	1,321	1,386	574
Hybrid Electric	1	1	2	3	4	5	6	8	9	11	14	13
Electricity	0	1	1	2	2	2	3	4	5	6	7	7
Gas Bi-Fuel	2	2	2	2	2	2	2	2	2	1	1	-1
Gas or petrol/gas	2	2	2	2	2	1	1	1	1	1	1	-1
Steam	0	0	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0	0	0
Total (thousands)	**2,564**	**2,627**	**2,665**	**2,684**	**2,685**	**2,691**	**2,717**	**2,759**	**2,821**	**2,863**	**2,919**	**355**

By percentage of total cars 2006 to 2016

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Inc/Dec 2006 to 2016
Petrol	68.20%	66.50%	65.10%	63.40%	61.70%	60.20%	58.60%	56.80%	55.00%	53.20%	51.70%	-13.70%
Diesel	31.70%	33.30%	34.60%	36.30%	37.90%	39.40%	41.00%	42.70%	44.40%	46.10%	47.50%	70.70%
Hybrid Electric	0.00%	0.00%	0.10%	0.10%	0.10%	0.20%	0.20%	0.30%	0.30%	0.40%	0.50%	1300.00%
Electricity	0.00%	0.00%	0.00%	0.10%	0.10%	0.10%	0.10%	0.10%	0.20%	0.20%	0.20%	0.00%
Gas Bi-Fuel	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.00%	0.00%	-50.00%
Gas or petrol/gas	0.10%	0.10%	0.10%	0.10%	0.10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-50.00%
Steam	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Others	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Total (thousands)	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

[42] Source: https://www.transport.gov.scot/publication/scottish-transport-statistics-no-36-2017-edition/chapter-1-road-transport-vehicles/#Table1.1

Change in driving licence-holders in Scotland by age

	2012	2013	2014	2015	2016	2017	2012 / 2017 inc/dec
Age group	%	%	%	%	%	%	%
17-19	28	26	29	26	30	31	3
20-29	58	56	56	54	55	55	-3
30-39	75	74	73	72	73	73	-2
40-49	80	80	82	82	81	81	1
50-59	79	80	79	78	81	81	2
60-69	73	74	74	76	76	77	4
70-79	59	60	61	62	63	67	8
80+	37	41	40	43	43	47	10
All aged 17+	68	68	69	68	69	70	2
Sample size	9,828	9,838	9,720	9,340	9,570	9,760	

Men	2012	2013	2014	2015	2016	2017	2012 v 2017 inc/dec
Age group	%	%	%	%	%	%	%
17-19	35	24	32	28	36	42	7
20-29	59	60	59	55	58	57	-2
30-39	78	78	77	73	78	76	-2
40-49	86	84	85	85	82	83	-3
50-59	85	88	85	84	85	85	0
60-69	83	86	85	83	83	85	2
70-79	79	76	80	76	81	80	1
80+	63	64	66	67	65	66	3

All aged 17+	76	76	76	73	75	75	-1
Sample size	4,377	4,405	4,410	4,210	4,360	4,520	

Women	2012	2013	2014	2015	2016	2017	2012 v 2017 inc/dec
Age group	%	%	%	%	%	%	%
17-19	19	29	27	23	26	22	3
20-29	57	52	54	53	53	54	-3
30-39	71	71	69	71	69	71	0
40-49	74	76	80	79	80	78	4
50-59	75	72	73	72	77	76	1
60-69	65	64	65	68	68	70	5
70-79	43	48	46	52	50	56	13
80+	22	26	23	27	28	34	12
All aged 17+	62	61	62	63	63	64	2
Sample size	5,451	5,433	5,320	5,130	5,210	5,250	

Appendix D – Variances in externalised costs between urban and rural settings in Sweden

	Costs per passenger km (SEK) - Urban				
	Car (petrol)	Car (diesel)	Bus (diesel)	Passenger train	Ferries
Infrastructure	0.03	0.03	0.05	0.053	0.01
Accidents	0.15	0.15	0.02	0.009	0.07
Carbon dioxide	0.15	0.12	0.09	0.001	0.25
Other emissions	0.015	0.032	0.04	0.001	0.1
Noise	0.08	0.08	0.06	0.024	0.0
Total external marginalised cost	**0.425**	**0.412**	**0.26**	**0.091**	**0.43**

	Costs per tonne km (SEK) - Urban				
	Light lorry (diesel)	Heavy lorry (without trailer)	Heavy lorry (with trailer)	Goods train	Shipping
Infrastructure	0.04	0.14	0.06	0.042	0.006
Accidents	0.26	0.07	0.014	0.002	0.004
Carbon dioxide	0.22	0.21	0.07	0.002	0.019
Other emissions	0.1	0.07	0.02	0.001	0.008
Noise	0.14	0.17	0.09	0.011	0
Total external marginalised cost	**0.76**	**0.66**	**0.25**	**0.059**	**0.038**

	Costs per passenger km (SEK) - Rural				
	Car (petrol)	Car (diesel)	Bus (diesel)	Passenger train	Ferries
Infrastructure	0.03	0.03	0.05	0.053	0.01
Accidents	0.006	0.006	0.02	0.009	0.02
Carbon dioxide	0.12	0.09	0.07	0.001	0.25
Other emissions	0.003	0.014	0.01	0.001	0.09
Noise	0.0	0.0	0.0	0.007	0.0
Total external marginalised cost	**0.15**	**0.14**	**0.15**	**0.074**	**0.37**

	Costs per tonne km (SEK) - Rural				
	Light lorry (diesel)	Heavy lorry (without trailer)	Heavy lorry (with trailer)	Goods train	Shipping
Infrastructure	0.04	0.14	0.06	0.042	0.006
Accidents	0.01	0.07	0.014	0.002	0.002
Carbon dioxide	0.20	0.17	0.05	0.002	0.019
Other emissions	0.04	0.02	0.01	0.001	0.006
Noise	0	0	0	0.004	0
Total external marginalised cost	**0.30**	**0.40**	**0.13**	**0.051**	**0.034**

	% Variances Urban / Rural across transportation types				
People	Car (petrol)	Car (diesel)	Bus (diesel)	Passenger train	Ferries
	283%	294%	173%	123%	116%
Freight	Light lorry (diesel)	Heavy lorry (without trailer)	Heavy lorry (with trailer)	Goods train	Shipping
	253%	165%	190%	116%	112%

Source: Transportsektorns samhällsekonomiska kostnader Rapport 2019:4

Appendix E – Analysis of User Spend and Utility Ratio Calculation

User Spend is built up from data showing what different groups of users in society pay to use the local roads network. This is taken as a proxy for value in the LREM. It has the benefit of being evidence-based, but it has the disbenefit of being blind to external factors and constraints that affect free choice or unintended or unforeseen consequences of road use (or lack of it). This is why it is only the first layer of the LREM.

Our estimate of the User Spend is built up from three sectoral components: Business Use, Personal Use. For Business Use, we estimated the share attributable to transportation in the wider economy, focusing on sectors where transportation was likely to be a material cost component (excluding, for instance, sectors such as financial services).

We then estimated a percentage attributable to transportation in these sectors. For this report we assumed that 10% would be a reasonable. Further research or consultation (for example with road freight user groups) could make this assumption more robust. Drawing on Scottish Annual Business Statistics 2016 gave us the following summary:

GVA of sectors significantly dependent on transport	**Employees**	**Turnover (£m)**	**GVA (£m)**
Forestry and logging	3,100	490.8	144.6
Fishing and aquaculture	4,500	984.8	361.4
Mining, quarrying and support services	22500	4488.1	1923.8
Manufacturing	178,800	33,826	12,710
Construction	32,400	17,424.30	7112.5
Wholesale, retail and repairs	353,100	60,498.40	11,935.40
Accommodation and food services	174,700	6,696.10	3,804.50
Total indirect effects	**769,100**	**124,409**	**37,992**
Estimated road transport component	10%	10%	10%
Total indirect impact	76,910	12,441	3,799
Share of non-trunk roads	**42,953**	**6,948**	**2,122**
Business user spend estimate of non-trunk roads			**2,121,786,608**

Table 17 Business Use element of User Spend

The share of non-trunk roads is based on the split in miles travelled between trunk and non-trunk roads from the Scottish Transport Statistics 2018 as follows:

Million kilometres driven in Scotland in 2017	48,000
% driven on trunk roads	39%
% driven on non-trunk roads	61%
Million kilometres driven on trunk roads	18,720
Million kilometres driven on non-trunk roads	29,280

Table 18 Split between trunk and non-trunk mileage

Our estimate of the Personal Use component is based on data from the Scottish Transport Statistics 2018 about average weekly household expenditure on transport and vehicles, excluding rail, tube and

"other travel and transport" (i.e. road only)[43] . The average household spend is shown in the table below. This is split between trunk and non-trunk on the same basis as the business expenditure.

Average weekly expenditure per household vehicles and personal transport	£52.20
Estimated number of households	£2,460,000
Annual spend on vehicles and personal transport	£6,677,424,000

Table 19 Personal Use element of User Spend

The final element of the User Spend is called (for want of a better term) the "Social Element" – in other words the elements that are spent on behalf of individual users by public sector bodies. We identified emergency services and the cost of concessionary fares as being the main components. The latter are drawn from the Scottish Transport Statistics and the former estimated on the basis of publicly available information (such as the report and accounts of the "blue light" services). There may be other elements of "socialised" costs that have not been identified (waste collection, for instance), but overall this element is likely to be relatively small compared with personal and business spend. The spend we identified under this heading is summarised in the table below.

Social use		
Concessionary fares		£7,142,000
Emergency services		
	Police	£8,923,129
	Fire & Rescue	£2,617,833
	Ambulance	£11,624,000
Total social use		**£30,306,962**

Table 20 Social Use element of User Spend

All of these elements combine to make up the User Spend as follows. Business and personal are assumed to follow the same split of trunk / non-trunk. Social use is assumed to be predominantly non-trunk.

User spend estimate	**Overall**	**Local roads**
Business	£ 3,799,220,000	£2,121,786,608
Personal	£6,677,424,000	£4,205,832,210
Social	£30,306,962	£30,306,962
Total user spend	**£10,506,950,962**	**£6,357,925,780**

Table 21 User Spend estimate

[43] See Scottish Transport Statistics p179, Table 10.8