



Department
for Transport



Intelligent Transport Systems: Evaluation Guidance

Moving Britain Ahead

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Introduction

This ITS Evaluation Guidance complements the work that the Transport Technology Forum does to support local highway authorities to deliver innovation and data-led services for their road networks.

Investment in transport is critical to delivering the Government's economic agenda. Technological developments and new data models increasingly play a significant role in determining how people and goods move around the UK, and the development of intelligent transport systems (ITS) is at the forefront of the Government's "Future of Transport" programme. But these interventions do not lend themselves to the monitoring and evaluation processes designed for traditional major transport investment.

Evaluation is an essential part of ensuring that the best use is made of limited resources. The Guidance is intended to provide greater assurance and accountability, in times of constrained resources, and to demonstrate that local highway authorities are making the right decisions, capturing benefits and providing a strong evidence base for future investment.

The Guidance is also designed to create a nationally consistent approach to the collection of evidence about ITS investments in order to measure their success. The expectation is that it will be adopted by local authorities to inform decision-making about changes to existing interventions as well as potential future investment.

Traffic and Technology Division, Department for Transport



Summary

1. About this guidance

- This guidance aims to provide scheme managers of Intelligent Transport Systems (ITS) with a framework of questions to consider when planning an evaluation.
- Evaluation can provide evidence about the effectiveness of a scheme which can be used to improve it and future schemes.

2. What is the theory of change?

- A theory of change captures the underlying logic of a scheme; why it exists, the necessary resources and inputs, the actions it will take, and what it will achieve. It can support scheme planning and highlight what evaluation evidence is required.
- Logic mapping is a visual way to show the theory of change. It takes the form of a causal chain running from inputs and activities to outputs, outcomes and impacts.

3. What do we need to learn?

- Technical learning is the default requirement. Also consider behavioural learning whenever a scheme requires an interaction between technology and people.
- Aim to set SMART (specific, measurable, achievable, realistic and time-limited) objectives for your scheme as these will be most suitable for evaluation.
- Plan the evaluation to meet the information needs of scheme stakeholders. Outputs should be scheduled to inform foreseeable future decisions.

4. What sort of evaluation is required?

- Impact evaluation measures what difference the scheme has made and to what extent it meets its objectives. Process evaluation examines the delivery of the scheme to see what can be learned from it.

5. Evaluation design checklist

- A checklist of points to consider in evaluation design: 1) embed evaluation in scheme design; 2) decide what data is required; 3) look for baseline data; 4) use official statistics; 5) use other secondary data; 6) plan monitoring and other primary data; 7) consider comparisons; 8) plan for data transfer, management and storage; 9) develop an evaluation framework; and 10) involve stakeholders.

6. Typology of schemes

- Details characteristics and evaluation issues for four types of scheme.

7. Example evaluation framework

- For a smarter parking scheme

1. About this guidance

1.1 Introduction

This guidance aims to provide scheme managers of Intelligent Transport Systems (ITS) with a framework which highlights questions to consider when planning an evaluation.

This begins by introducing evaluation - what it is and why we evaluate. It shows how a theory of change is used for evaluation planning. It considers what we need to learn from an evaluation and what sort of evaluation is required. It provides a checklist of points to consider in designing and delivering and evaluation.

This guidance then leads on to 'typologies of schemes' which share common evaluation questions. There will remain a need for specialist input in design and delivery.

This guidance has been produced because:

- There is increased emphasis within government on the need to evaluate its interventions to understand what outcomes they deliver;
- There are many current and planned ITS but a relatively limited evidence base for what outcomes they deliver; and
- In the Department's Science Plan, evaluation is identified as one of the areas where we aim to improve our practice.

ITS vary considerably in their scope and objectives. Some directly support departmental policies while others support innovation in local authority partners or encourage commercial organisations to develop new products and form new markets.

Given this variation, the guidance does not attempt to set out a one-size-fits-all evaluation approach. What it does raise is a series of questions about evaluation which managers should consider when planning their schemes.

1.2 Intelligent Transport Systems

Intelligent Transport Systems (ITS) are a portfolio of schemes with the objective of supporting the co-operation between vehicles and road infrastructure, and between road authorities, industry and users.

This co-operation benefits all road users through smarter parking, by using new data to address problems such as road maintenance, better ways to set traffic signals to reduce emissions and congestion and the provision of better information and intelligence.

In total to date, over £6m has been invested in 44 separate Pilot ITS in 6 thematic groups:

- GLOSA
- Asset Management (e.g. [RoadAI](#))
- Connected Technologies and Data (e.g. [UK Autodrive project](#))
- Smarter Parking
- Opening Local Authority Transport Data
- GovTech Catalyst Congestion Challenge Projects

State of the connected nation (ttf.uk.net) lists various examples of ITS

These ITS sit in a wider portfolio of Connected and Autonomous Vehicles (CAV) with larger schemes such as the A2/M2 Connected Corridor, UK CITE, Flourish Car Trials and the Zenic.

The background for this work is the Government's Industrial Strategy. A key part of it is the movement of the people and goods industry needs to aid Gross Domestic Product and improve local productivity. The Future of Mobility Grand Challenge was established in 2017 to make the UK a world leader in the way people, goods and services move now and in the future.

The UK government sees Connected Autonomous Vehicles (CAVs) as an important strategic opportunity as it is felt that connected vehicle technology and data has recently become ready for exploitation. For this reason, the government continues to invest heavily in their development and introduction.

1.3 What is evaluation?

In its simplest terms, evaluation produces clear impartial evidence that measures how well your scheme meets its objectives.

Impact evaluation measures what difference the scheme has made and to what extent it meets its objectives. This provides summative learnings - lessons on how effective the intervention is, which measure an intervention's success and assist in

understanding whether to continue with the intervention. These can be used for measuring the scheme's success and understanding whether to continue with it.

Process evaluation examines the delivery of the scheme to see what can be learned from it. This provides formative learning about delivery processes, which are lessons that can be acted upon within an intervention to course correct and optimise implementation. They heighten chance of success as they allow for evidence-based optimisation decisions to be made during implementation

1.4 Why evaluate?

There are various benefits to obtaining good evaluation evidence.

For the project team:

- To justify continued funding of your scheme
- To demonstrate achievements in performance reviews

For the scheme:

- To inform evidence-based decisions that will improve it
- To recognise areas of least success and concentrate efforts to improve these or redirect resources to improve these
- To identify areas of greatest success and take lessons from these to apply to other areas
- To avoid unintended negative consequences for those who could be adversely affected by the scheme

For stakeholders / senior staff / ministers:

- To enable celebration of the scheme's success and promotion of it to others
- To enable defence of the scheme when it comes under scrutiny

For the taxpayer and wider government:

- To enable the Government to distribute resources optimally
- To give taxpayers confidence that resources are being used to good effect and where they are not they are redistributed

2. What is the theory of change?

2.1 Why conduct a Theory of Change?

A *theory of change* captures the underlying logic of a scheme; why it exists, why it is important, the necessary resources and inputs, the actions it will take, and what it will achieve in the short and long term.

A good theory of change can:

- Support effective planning and delivery of the scheme and communication with its stakeholders by establishing a shared understanding of how it is intended to work.
- Examine the wider political, economic, social, environmental context for the scheme and how they affect it.
- Examine the immediate context for the scheme in terms of stakeholders and locations. A scheme might work well for some individuals/groups in some contexts, but not for others. It might be more effective in certain local authorities, in certain cities, or with certain vehicles than with others.
- Provide a basis for planning evaluation of the scheme by highlighting what evidence will be required to understand its effectiveness.

2.2 Begin by reviewing the existing evidence

A starting point for considering the theory of change of an intervention is to review available documentation of its approach and objectives such as its business plan and any subsequent implementation plans.

Evidence can be drawn from documentation for previous schemes, in the UK and internationally. Evaluations of past schemes providing evidence on their outcomes are particularly helpful.

Your review of evidence should:

- Identify past learnings about what works in ITS which can inform scheme design.
- Highlight the strength or weakness of the supporting evidence for the scheme's assumptions. Those which are poorly evidenced or contested will need particular attention in delivery and evaluation.

- Identify evidence gaps which evaluation of the new scheme must address. For example, are the main evidence gaps about the impacts of a ITS on journey times, on road casualties or on road conditions?

2.3 Collect information from stakeholders

In developing your theory of change you should also talk to stakeholders who are responsible for delivering the scheme or who manage activities that will be affected by it. It is helpful to collect a range of perspectives about how the scheme is expected to work.

Stakeholder workshops are commonly used to map out a theory of change. Stakeholders invited to participate may include:

- Those involved in designing and delivering the evaluation (scheme stakeholders)
- Those who will participate in the evaluation (wider stakeholders)
- Beneficiaries/interest groups, and potential users of the evaluation results (e.g. local authorities)

However, pressure on resources may warrant that only the most essential stakeholders are involved in the process

When developing the theory of change with stakeholders, it is important to gather concrete, specific statements about the processes. If scheme outcomes may work differently for different individuals/groups and in different contexts, this should be captured.

Development of the theory of change can be a continuous process throughout the life-cycle of the scheme and its evaluation, with the theory being modified to reflect changes in the design and implementation of the scheme and as further evidence arises.

2.4 Systems thinking: how does the scheme fit within a system

Systems thinking¹ focuses on the system into which an intervention will be introduced. It works by identifying and mapping the relationships between different elements in a system.

It is particularly helpful where a system is complex and dynamic, with multiple elements that interact. Where the relationships between different elements can be quantified, a systems map may form the basis for development of a model.

This approach can support the design of an intervention by exploring what potential impacts it might have on existing elements in the system. It is complementary to a theory of change and logic mapping which focus on the intervention itself.

¹ This Government Office for Science paper provides a helpful introduction to Systems Thinking: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/285442/12-1043-introduction-to-systems-thinking-gse-seminar.pdf

2.5 Logic mapping: visually mapping out how the scheme is expected to work

Logic mapping² is a visual way to show the theory of change of an intervention. It sets this out in the form of a causal chain running from inputs and activities to outputs, outcomes and impacts. A completed map comprises multiple interacting causal chains.

An example logic map for GLOSA³ is shown on Table 2.1.

Table 2.1 GLOSA – Theory of Change example

Context	Input	Output	Outcomes	Impact
<i>What is the problem?</i>	<i>What is invested?</i>	<i>What has been produced?</i>	<i>Short and medium-term results</i>	<i>Long term outcomes</i>
Lack of technology adoption which: • Could improve traffic flows • Reduce pollution • Reduce driver stress caused by not knowing time to be green	Investigation into compatibility with A-TLCs	Publishing a feed of these predictions to onboard units or apps that show when a signal will turn green, or the speed needed to follow a “green wave”	Increase in traffic flow at junctions	Economic: Reduced congestion and the resulting delays, benefits: 1. Business users 2. Transport providers 3. Highway authorities (Reduced infrastructure & maintenance costs)
	Funding for the app and other equipment, encouragement of technology adoption		Reduced driver stress, increased driver comfort	Environment: Greenhouse gases
	Accurate digital mapping	Information about current and predicted traffic signal stage via a public web API available to all developers and OEMs	Better speed compliance	Social: More enjoyable driving experience for road users
	Awareness campaign		Less stopping of vehicles	Reduced accidents, fatalities, and injuries

Note: this example has been based on a user case for GLOSA scheme managed by Capita

² The better Evaluation website provides useful advice for developing and representing a Theory of Change: https://www.betterevaluation.org/en/rainbow_framework/define/develop_programme_theory

³ Green Light Optimized Speed Advisory

A logic map can also be used to show contextual factors and external influencers which are expected to affect the intervention, key assumptions on which the theory of change rests and any identified risks to success. All this information which can be captured in a logic map is useful both for programme development and evaluation planning.

By its nature, a logic map is a high-level and summarised representation of a scheme. It does not need to be completely accurate, and if it becomes detailed this may be unhelpful.

Suggested steps for developing a logic map are set out below.

Step 1: Identify the issue

- **Context** (the problem: e.g. road casualties, current technology no longer delivering traffic benefits)

Step 2: Identify final impacts

- **Impacts** (final or long-term outcomes: e.g. increased productivity, decarbonisation, sustainability, equality, savings for local authorities, improved well-being of transport users, co-operation across local authorities and more intelligent use of data).

Step 3+: Analysis of the logic of the intervention

- **Input** (what needs to be invested: e.g. money, skills, people, activities; data from vehicles, traffic signs and street lights on their condition)
- **Output** (what is produced: e.g. smart sensors, autonomous vehicle pilots, LIDAR; light detection and ranging to alert vehicles to other objects)
- **Outcomes** (short and medium-term results; should be specific, measurable, achievable, realistic, and time bounded e.g. reduced journey times, less stopping of vehicles, modal shift, quicker identification of road defects, more reliable and accurate updates to journey times, standardisation of data systems across local authorities)

The Tavistock Institute guidance document *Logic mapping: hints and tips for better transport evaluations*⁴ provides further guidance on this process including a useful section of how to run a logic mapping workshop, which is reproduced in full below.

Running a logic mapping workshop

- Invite key people involved in your intervention to a workshop meeting - you will need at least three hours. Explain that the purpose of the workshop is to draw up a 'map' of the intervention that will help in the design of an effective evaluation strategy.
- Invite participants to describe all the issues that the intervention will address, encouraging them to explain the underlying rationale and considerations made about the broader social, political and economic context which the intervention will be set against (step one below). This could be done on a flip chart or written on pieces of paper that are then placed on a large sheet of paper, chart or wall. Issues are written down on the far left of the chart.
- Invite them to do similar exercises for impacts – which are placed on the far right of the chart (step two below). Then ask them to write down what outcomes, outputs and activities that will be required in order to achieve these changes (steps two to five below). (Each can be written in different colours or using different coloured paper).
- As each set of notes is completed, invite participants to explain their thoughts on how each step will lead to the next and what 'success' at each step would look like.
- Link or cluster those issues, activities and outputs that appear to relate to different kinds of outcome. (E.g. tackling perceptions of buses being inconvenient is addressed by providing easy to read bus maps and timetables, reducing fear of crime is addressed by increasing use of security cameras).
- One thing that can emerge is a difficulty in reaching a consensus about what are the desired outcomes and how these will be achieved. However, such discussions can be useful in identifying different ideas about how the intervention works, as well as helping to ensure that everyone's views will be represented in the evaluation plan - which in turn will increase interest in the evaluation results.

From: *Logic mapping: hints and tips for better transport evaluations*, Tavistock Institute for DfT, 2010.

⁴ [Logic mapping: hints and tips guide \(publishing.service.gov.uk\)](https://publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/434842/Logic-mapping-hints-and-tips-guide.pdf)

2.6 Future proofing

Because technology is constantly emerging, it is good practice to incorporate future proofing when setting out a scheme's theory of change. When considering the scheme's intended final impacts, what plans should be put in place now to plan for 5-10 years' time?

- Economic (e.g. impact on businesses and transport providers)
- Environmental (e.g. air quality, greenhouse gases, landscape, noise)
- Social (e.g. physical activity, journey quality, road accidents, affordability)
- Public accounts (e.g. cost to broad transport budget, indirect tax revenues)

What do we need to learn

Once you understand the theory of change for an intervention, the next step is to consider what you need to learn from its evaluation. This section provides some prompts about this.

2.1 Technical learning?

Technical learning will be the default requirement for a ITS. For example:

- How well did the technology function?
- To what extent did driving or vehicle performance change in the ways expected e.g. speed levels?
- To what extent were anticipated safety improvements realised e.g. were road casualties reduced?

The evaluation will need to collect performance measures from the scheme. To enable the impact of the scheme to be understood, these measures will need to be compared with data from a situation without the scheme. This could be baseline data for the same location, collected before the scheme operated, or comparative data for a different location that is not influenced by the scheme. This could come from travel statistics, traffic counts and other.

You may need to examine the performance of the scheme against existing standards or use this information to define new standards. This may require interface with standards organisations such as Traffic Open Products and Specifications (TOPAS), The Association for Road Traffic Safety and Management (ARTSM), Institute of Highway Engineers (IHIE) and British Standards Institution (BSI).

2.2 Behavioural learning?

You should consider the need for behavioural learning whenever a scheme requires an interaction between technology and people for it to operate successfully. If you are only monitoring technical outcomes you may miss behavioural responses which are either enablers or barriers to success.

Some examples of behavioural questions include:

- To what extent did drivers understand the technology?
- To what extent did drivers use the technology in the correct way?
- How did the technology affect drivers' decision making?
- What was the impact of the operation of the technology on driver stress?
- Did drivers feel safer using the technology?
- Would drivers choose to use the technology again?

Learnings from these sorts of behavioural and attitudinal questions may not affect the technological specification of the scheme but they can provide important steers for communications with future users about its operation and benefits.

Behavioural learning may require surveys, qualitative interviews and focus groups with stakeholders for the scheme to complement the predominantly quantitative analysis of technical outcomes.

2.3 Scheme objectives?

The learning that is required should follow from the scheme objectives. Below are listed some examples of objectives for ITS: Reduced congestion

- Reduced traffic
- More efficient identification of missing road signs
- Reduced fuel usage and emissions
- Reduced road casualties and increased road user safety
- Reduced maintenance costs
- Help revitalise high streets
- Reduced real-world costs and cash savings for Local Authorities
- Increased productivity
- Economic development
- Increasing inwards investment and manufacturing
- Improved R&D with partners

These sorts of broad objective need to be developed to make them SMART - specific, measurable, achievable, realistic and time-limited. The Green Book⁵ recommends setting Up to 5 or 6 SMART objectives for a scheme. The more objectives you can set which meet the SMART criteria, the more suitable they will be for evaluation.

It is helpful to reference how scheme objectives support wider organisational programmes and strategies, for example the Future of Mobility: Urban Strategy⁶.

⁵ [The Green Book \(2020\) - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/437253/green-book-2020.pdf)

⁶ [Future of mobility: urban strategy - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/437253/green-book-2020.pdf)

2.4 What decisions will be taken using the evaluation findings?

You should plan the evaluation to meet the information needs of scheme stakeholders. Outputs should be scheduled to inform foreseeable future decisions.

The primary stakeholders for evaluation outputs are scheme managers. Evaluation provides them with an evidence-base from which to make decisions on how to develop their schemes. Ideally, the findings should also inform the following stakeholders:

- Local government officials e.g. Mayor, local councillors – who may have an interest in influencing the scope of the scheme, and any future implementation, if impact is demonstrated. Ministers / senior officials – evaluations provide evidence which they can use to support and promote the schemes.
- Stakeholder organisations e.g. highways authorities, vehicle and systems manufacturers – need evidence on to what extent schemes have created positive change.

The public – to show that new approaches are being developed and are effective. In planning your evaluation, you may find it helpful to set out what evidence types will be used, what questions they can answer and what decisions they can inform. The table below provides an illustration of this approach.

Table 1.1 Evaluation types and decisions

Evidence type	Questions that can be answered	Decisions
Management data (monitoring data)	How many projects were initiated? What was the value of the projects? Profile of awardees	
Impact of the Schemes (impact evaluation)	Has the scheme caused change as planned? What is the scale of the change? Where there any unintended outcomes? What factors affected the impacts?	Should we expand on these pilots/schemes? Should schemes be adapted? Should they be rolled out elsewhere? Should they be tested further?
Implementation of the schemes (process evaluation)	Is the scheme being implemented as planned? Is this planned approach to implementation optimal?	Should the implementation of the scheme change? And how?
Value for Money of the Scheme (Value of Money Evaluation)	What is the value for money of the scheme?	Is it too expensive? Is the scheme cost-effective? How does the cost-effectiveness compare to other schemes?

2.5 Consider context and generalisability

You should also consider how learning will take account of the context of the scheme. The location of the scheme will have particular characteristics and driving conditions. How generalisable will its findings be to different locations with different conditions? For example, if it is tested in an urban location, how generalisable will the findings be to rural locations?

Relevant contextual factors which may mediate scheme outcomes include varying congestion levels, population levels, proximity of individuals to the town centre, modes of transport, use of technology and road surfaces.

It is helpful to test these kinds of variation within a scheme pilot but this will not always be possible. So, where there is reason to believe that the context of the scheme may have had an influence on its outcomes, this may qualify your findings and influence decisions about future testing prior to roll-out.

3. What sort of evaluation is required?

4.1 Monitoring

Monitoring seeks to check progress against planned targets and can be defined as the formal reporting and evidencing that spend and outputs are successfully delivered and milestones met. It uses management/operation information collected throughout a programme's life-cycle and typically covers all aspects of its operation.

Monitoring should be an integral part of scheme delivery and should provide important data for whatever evaluation approaches are used.

4.2 Impact evaluation

Impact evaluations are the default requirement when evaluating schemes. This is because an impact evaluation is an objective test of what changes have occurred, the scale of the changes and an assessment of the extent to which these changes can be attributed to the intervention. They are therefore designed to test the intervention's objectives.

The output from an impact evaluation are **summative learnings**, lessons on how effective the intervention is. They are used for measuring an intervention's success and understanding whether to continue with the intervention.

When planning an impact evaluation, the following should be considered

1) Use of Counterfactual (control group)

An impact evaluation must include a counterfactual to the intervention. The 'counterfactual' measures what would have happened in the absence of the intervention, and impact is estimated by comparing counterfactual outcomes to those observed under the intervention. Without a counterfactual the impact measured in an evaluation cannot be assigned to the intervention.

There are three categories of counterfactuals that are available. These are presented in below in order of robustness, from most to least.

- a. **Experimental** – where possible have a control group to compare the intervention against, one that is created through random assignment. This is the gold standard and is an essential element to a Randomised Control Trial (RCT). Often this approach is not possible, for example random assignment will not be possible in all interventions.
- b. **Quasi-experimental** - Develop a counterfactual using a comparison group which has not been created by randomization. There to many quasi-experimental counterfactual methodologies to cover in this note, we suggest reviewing the Better Evaluation guide on [quasi-experimental methods](#).

- c. **Non-experimental** - Develop a hypothetical prediction of what would have happened in the absence of the intervention. This is typically done by interviewing key stakeholders.
- The [Magenta Book](#) is government evaluation guidance, covering purpose, scoping, methods, data collection, managing an evaluation, and dissemination. However, this guidance can be applied to evaluation conducted outside central government. See [page 35](#), Table 2.3: Choosing an experimental or quasi-experimental approach to impact evaluation

2) Sample Size

For any evaluation the sample sizes must be large enough to be able make robust estimates of the impact of the scheme. There are various ways to calculate the necessary sample size prior to a scheme and these depend on its objectives. We therefore won't go into detail on these, but it is expected that a bid tries to provide evidence for the sample sizes they have selected when bidding. .

4.3 Process evaluation

Process evaluations are only required where there is a need to learn from the implementation of the scheme. Process evaluation answers the question “what can be learned from implementation?” and is in general an analysis of

- Whether an intervention is being implemented as intended
- Whether the design is working
- What is working well, or less well, and why
- Did you have to make any changes from the original proposal to meet the latest requirements.

The output from a process evaluation are **formative learnings**, lessons that can be acted upon within an intervention to course correct and optimise implementation. They are very important as they give interventions their greatest chance of success as they allow for evidence-based optimisation decisions to be made during implementation

- Section from Public Health England on implementing a [Process evaluation](#) (health focused but some is also relevant to ITS)

4.4 Value-for-Money evaluation

Value-for-money evaluation is a form of impact evaluation which concentrates just on the economic value of the scheme. Essentially, it seeks to answer the question ‘what is the economic value of the impact compared with the cost of its implementation?’.

There are various approaches for value-for-money evaluation and which should be used depends on what the output of the intervention is (social, physical etc.).

However, most result in a Benefit Cost Ratio (BCR) which is defined as:

$$\text{BCR} = \frac{\text{Present value of Benefits}}{\text{Present Value of costs}}$$

Value-for-money evaluations should be conducted for interventions where there is doubt in the cost-effectiveness and are particularly valuable when the intervention may be repeated.

- Section by Better Evaluation (website for an organisation providing information on monitoring and evaluation frameworks, methods and approaches) useful when considering a [Value-for-Money evaluation](#)

4. Evaluation design checklist

Table 5.1 Evaluation design and delivery checklist

- ☐ Embed evaluation in scheme design (5.1)
- ☐ Decide what data is required (5.2)
- ☐ Look for baseline data (5.3)
- ☐ Use official statistics (5.4)
- ☐ Use other secondary data (5.5)
- ☐ Plan monitoring and other primary data (5.6)
- ☐ Consider comparisons (5.7)
- ☐ Plan for data transfer, management and storage (5.8)
- ☐ Develop an evaluation framework (5.9)
- ☐ Involve stakeholders (5.10)

5.1 Embed evaluation in scheme design

Embedding evaluation processes into scheme delivery from an early stage will help ensure that you have the right systems and incentives in place to get the evidence about impacts that you will need. Although it is possible to conduct an evaluation entirely retrospectively, you risk missing important information including baseline data, measures of outputs and feedback from scheme users.

Another opportunity from embedding evaluation at an early stage is to achieve an evaluation design which maximises the opportunities for learning from the scheme. This may include ensuring that there will be sufficient measures collected from the scheme and any comparisons being used to enable statistically-robust conclusions about impact to be drawn.

Some common ways of embedding evaluation in scheme delivery are:

- Building evaluation requirements into any contracts for scheme delivery and tying key evaluation deliveries to payment milestones;
- Specifying metrics for monitoring and reporting intervals;
- Recruiting and involving evaluation practitioners for statistical design, data collection and analysis; and
- Signing up users of the scheme to agree in advance to provide feedback on their experiences of using it.

5.2 Decide what data is required

You should plan what data you will need to evaluate the scheme before it is implemented.

- The [Magenta Book](#) has useful sections on this:
 - 4.2 Deciding what data is required (p54)
 - 4.3 Sources of data (p55)
- [Logic mapping Hints and Tips](#) by Tavistock Institute is also helpful:
 - 3.4 Using logic maps to identify data sources (p.18)

The following sections briefly cover types of data that you might use.

5.3 Look for baseline data

Baseline data captures the situation before a scheme is introduced and can be used to compare with data from the delivery of the scheme, to help you to understand its impact. You should consider what baseline data may be available early in the design of your scheme so that you can collect it contemporaneously – it may not be recoverable at a later date.

5.4 Use official national and local statistics

Official transport statistics can provide useful contextual evidence for programme design or can be used to provide baseline or comparison data to help you to better understand the impact of your scheme. The following links to government statistics may be useful, for example:

- [Transport statistical collections](#)
- [Road transport emissions](#)
- [Road traffic statistics split by local authority](#)

- [Road network size and condition](#)
- [Road collisions, causalities and speed](#)
- [Data.gov.uk includes a variety of statistics on areas such as Passenger Experience, Road Safety Data, Local area walking and cycling England, Street Lighting](#)
- [Eurostat website holds transport data on areas such as multimodal travel; transport safety, transport, volume and modal split, regional transport statistics, and road transport; infrastructure, equipment, registrations of vehicles, road traffic.](#)

5.5 Use other secondary data

As well as official transport statistics, you may be able to draw on other data that is 'secondary' (collected by other people for other purposes). This can save the time and resources needed for 'primary' data (fresh data collection).

Useful secondary data may be obtained from other schemes, studies, surveys and evaluations. The following are examples of secondary data:

- The Asset Management scheme: CONVERT (Westminster City Council) 'extracted and re-purposed' LIDAR survey data, which previously collected through a Smarter Parking scheme within Westminster's road network for use in its evaluation.
- [Basemap website](#) holds public transport and road based travel time analysis, access to mapping data, and detailed traffic data visualisation.
- [Ordnance Survey](#) website holds data on the road network, landscapes, route planning (much of this is freely available).

It is worth conducting a review of availability of such secondary data when planning your scheme.

5.6. Plan monitoring and other primary data collection

While official transport statistics and secondary data may provide helpful contextual information and indirect evidence of the impact of the schemes, they will rarely be sufficient to answer your research questions and identify the impacts of the scheme.

You will need to plan monitoring data to cover the important aspects of your scheme's operation; for example, information about those who are accessing a service, as well as the scheme's inputs, processes, outputs and outcomes.

- The [Magenta Book](#) has useful sections on monitoring data:
 - Table 4.2: How monitoring data can be used in an evaluation (p56)
 - Figure 4.1: Developing a monitoring system (p57)

Other primary data may include surveys and qualitative interviews with scheme users to understand the experience of using it and how they adapted their behaviour in response to it.

It may also be helpful to conduct formal interviews with scheme administrators to collect information about the operation of the scheme, and any problems with that, to aid interpretation of your monitoring data.

Primary data collected about individuals participating in the scheme raises special considerations under the General Data Protection Regulation (GDPR) if this constitutes 'personal data', that is any information relating to an identifiable person who can be directly or indirectly identified.

If your evaluation requires personal data you should consult your organisation's data protection officer and develop a Data Protection Impact Assessment (DPIA). This should be done prior to the scheme beginning so that data protection is built into the design of the scheme to prevent risks before they occur. A DPIA is necessary if a scheme involves (this list is not exhaustive):

- Collection of personal data without privacy notices
- New technology
- Online or offline tracking of individual's locations
- Surveillance of public spaces
- Where you are sharing safety data specific to individual drivers.

See: Information Commissioner Office. (2018). Guide to the General Data Protection Regulation. [pdf]. Available at: <https://www.gov.uk/government/publications/guide-to-the-general-data-protection-regulation>

5.7 Consider comparisons

It may help you to understand the impact of your scheme if you can compare data from it with other routes and locations which have similar characteristics but where no equivalent scheme has been implemented.

For example, if a ITS is being tested on a specific route it may be helpful to compare traffic speeds and flows with another route in the same area which has no intervention but has comparable underlying traffic flows. Comparing patterns for test and comparison locations before, during and after the scheme is implemented can highlight how different the change in the test location is from that in a comparable location (the 'difference-in-differences').

Where local area comparisons are not available you could look for data from other, comparable areas:

- Is there potential to collaborate with contacts in other local authorities to obtain comparison data for similar locations which have no intervention?
- There is a useful page from The Office for National Statistics on [area classifications and corresponding authorities](#), which links up local authorities with similar characteristics and rates their similarity (socio-economic and demographic characteristics)

5.8 Plan for data transfer, management and storage

As well as planning what types of data you will need collect, you should consider:

- How will the different data sources be stored and analysed? Will existing systems be compatible with the ITS; what changes are required?
- How will the security risks associated with data transfers and storage be managed?
- How will you ensure that the various datasets will be documented and stored and how can you ensure that they are accessible for other users in the future?

5.9 Develop an evaluation framework

It is good practice to develop a bespoke evaluation framework to help you to manage the evaluation of the scheme by documenting your plans to collect and analyse data so they can be followed by others. You may want to develop this as a living document which can be maintained and updated by scheme managers as the evaluation proceeds. This can provide a strong basis for project handovers when these are required.

[The FESTA \(Field opErational teSt support Action\) handbook](#) is an example of evaluation methodology used to support successful delivery of Field Operational Tests (FOTs). This handbook is widely used for trials and pilots across the EU, to evaluate “a function, or functions, under normal operating conditions in road traffic environments typically encountered by the participants using study design so as to identify real-world effects and benefits” (p.14).

The [C-Roads Evaluation and Assessment Plan](#) has been created using the FESTA handbook. It evaluates the impact of connected intelligent transport services in the areas of user acceptance, safety, traffic efficiency, environment, organizational, socio-economic.

5.10 Involve stakeholders

Finally, consider how you can involve stakeholders in delivery of the evaluation.

- Who should be responsible for governance of the evaluation? Might a project board be required?
- Will you require technical advice on the design and delivery of the evaluation? How might this be obtained; might an evaluation steering group be used?
- Which partner organisations have an interest in the scheme evaluation – e.g. highway management, technical suppliers - and how will you communicate with them?
- Are there other ITS tackling similar challenges where some form of sharing of evaluation learnings may be helpful?

5. Typology of schemes

This section provides a typology of ITS, detailing their characteristics, their stakeholders and some evaluation issues. Four types of schemes are covered:

1. Road user information service
2. Transport data management service
3. Transport payment systems service
4. On-demand transport information service

1. Road user information service	
Scheme characteristics	
Description	Service to support road users with road travel information that is relevant, timely, reliable and easy to understand whilst supporting local transport policy. Road users access real time information on road conditions and their journey
Context	High congestion, road emissions, fuel consumption, long journey times
Stakeholders	
Users of evaluation results	Local authorities (scheme stakeholders) and ministers to inform policy in areas such as road safety, air pollution management, congestion management, disability services (adaptation of traffic lights for visually and hearing-impaired users), cycling and walking
Wider stakeholders	Road users who will use the technology
Other stakeholders in society affected by evaluation results	Public transport companies, transport authorities (road space management authorities, navigation service providers e.g. journey planner companies, car manufactures)
Evaluation	
Evaluation focus	Comparing the experience between road users (e.g. stress levels, journey time, modal shift, reliability of journey planning) who use the service and those who do not.
Data needed	Historic, current, and future (predicted) traffic status of the network, accident data, diversion data, pollution data, weather prediction, user vehicle characteristics, route restrictions, real time traffic data, end time and location.
Technical learning	Was journey time reduced? Was road safety increased?
Behavioural learning	Road space user experience, stress of road users from planning and during the journey, improved productivity from saving journey time, improved ease of planning journeys

2. Transport data management service	
Scheme characteristics	
Description	Services to support Local Authorities in collecting, harvesting, analysing, fusing, managing and making data open for all relevant users and service providers. Support authorities in using transport data in the most efficient way.
Context	A need for further transport data services for disabled and vulnerable road users, need for higher rates of active travel, road defects are costly for local authorities, high numbers of road traffic accidents, and congestion
Stakeholders	
Users of evaluation results	Local authorities, regional transport authority representatives responsible for transport management and ministers to inform policy in areas such as road safety, land use planning, improving air quality and reducing noise, modal shift
Wider stakeholders	Local authorities
Other stakeholders in society affected by evaluation results	Public transport providers, taxi operators, emergency services, vulnerable road users, cycling, freight/goods, mobility on-demand providers
Evaluation	
Evaluation focus	Traffic accident prevention (early identification of hot spots and near misses) Decongestion could be evidenced through a more specific and measurable outcome such as public transport use.
Data needed	Historic, current, and future (predicted) traffic status of the network, accident data, diversion data pollution data, special events information, signal timing information
Technical learning	Cost of asset management and the longevity of assets, numbers of traffic accidents, modal shift from private cars, air quality, noise levels, costs for local authorities through improved data on road condition, coordination of road accidents across authorities and regions
Behavioural learning	Can road users access quality information? Productivity levels due to change in commuting times

3. Transport payment systems service	
Scheme characteristics	
Description	Services to support Local Authorities in implementation and running of the integrated ticketing and other transport services payment systems in the city, region, cross region or nationally.
Context	Time wasted through booking separate tickets for separate journey legs and locating the best fare
Stakeholders	
Users of evaluation results	Local authorities, transport providers, local authority politicians influencing local public transport policies, regional transport authority representatives responsible for transport strategies
Wider stakeholders	Public transport users
Other stakeholders in society affected by evaluation results	Private car users willing to carpool and share their private car
Evaluation	
Evaluation focus	Long term impacts: Modal shift to public transport à improved air quality due to modal shift Commuting time à productivity
Data needed	User transaction data, service provider transaction data, revenue sharing data
Technical learning	Air quality changes due to modal shift, changes to LA revenue stream from more effective pricing strategies.
Behavioural learning	Waiting time of passengers for public transport, productivity levels due to changes in commuting times, amount of staff needed to handle complaints due to automatic cancellation.

4. On-demand transport information service	
Scheme characteristics	
Description	Information service to enable customers to discover, pay and use a DRT (demand responsive transport) service, and provide the local authority with key digital performance metrics
Context	Good public transport is important to community wellbeing however it can be expensive and inflexible, a public service which reduces social isolation is needed.
Stakeholders	
Users of evaluation results	Local authorities and ministers to inform policies in areas such as social inclusion, access to jobs, economic growth, air quality management, reduced parking costs for business through modal shift to buses, active travel
Wider stakeholders	Passengers who use and pay for the service, drivers, LA DRT service managers who ensure data which ensures the service operates correctly is up to date.
Other stakeholders in society affected by evaluation results	Businesses who benefit from reducing parking costs (higher bus use), society who benefit from cleaner air.
Evaluation	
Evaluation focus	Long term impacts: cost savings for local authorities, environmental benefits through reduced number of car trips, and improved LA understanding of customer needs and experience
Data needed	Vehicle location, arrival time at pickup point, traffic conditions, user status (e.g. in case the user is not at the pickup point at the agreed time)
Technical learning	Environmental benefits due to use of LEZ (low-emission zone)/ZEV (zero-emission vehicle) fleet, cost savings for local authorities
Behavioural learning	Improved local authority understanding of customer needs and experiences, and of running a digital service

6. Example evaluation framework

Questions to consider	Smarter Parking
Background	<u>Objectives</u> • Increase learning around how parking can be made simpler and less stressful. Potentially leading to wider use in the UK <u>Who will use the evaluation results</u> • Evaluation results useful for local authorities (traffic/parking department)
Theory of change	<u>Context (the problem)</u> • Lack of technology adoption which could improve driver stress caused by difficulty parking <u>Input (what needs to be invested)</u> • Funding for the app, encouragement of technology adoption, data from vehicles, co-operation between vehicles and apps, sensors which detect free spaces <u>Outcomes (short and medium-term results)</u> • Reduced driver stress, shorter stopping times at car parks • Parking logistics, travel behaviour <u>Impacts (long term outcomes)</u> • Economic: business users and transport providers • Environment: greenhouse gases • Social: more enjoyable driving experience for road users

Evaluation questions: What kind of learning is necessary?	<u>Technical learning</u> • Does the app work at the right time? (e.g. when the vehicle needs a parking space) • Does the app reduce stopping time of vehicles? <u>Behavioural responses</u> • What was the stress of drivers whilst trying to find a parking space?
Approach	<u>Impact evaluation</u> • Compare stress and stopping times between the scheme (vehicles/drivers using the smarter parking app) to a counterfactual (vehicles/drivers not using the smarter parking app) • Or compares parking in one town centre which uses the smarter parking app, to another town centre in the same county which was comparable in terms of congestion, parking, but uses traditional parking without the app • Need to consider how other variables could affect the impacts, and how these can be controlled for (e.g. type of vehicle, individual differences among drivers: their stress prior to entering the parking bay, level of driving experience, level of technology experience) • Specific short-term outcome of 'stopping time' has been chosen as a precursor to reduced emissions. As it is not possible to isolate other factors apart from the scheme which may contribute to reduced emissions (e.g. more people working from home). <u>Process evaluation</u> • What can be learned from the implementation of the trial?
Intervention context and generalisability	• Will the app be simple to use for those outside of the evaluation? • Is the aim of the evaluation for the app be usable nationwide? If so, how can its efficacy be tested across multiple areas?
Access to data and resources	<u>Data from phones/vehicles on time waiting for a parking bay</u> • Likely to be less resource intensive, is consent needed from drivers to access this data? Can quantitative data (e.g. one specific drivers journey time) be linked with their survey results? <u>Surveys/interviews with drivers</u> • Can provide a richer, broader understanding than only accessing quantitative data from vehicles

Stakeholders	<u>Scheme stakeholders</u> • If local authorities are needed to co-ordinate the evaluation and collect data, how can the potential usefulness of the app be communicated to them? • Do they currently have the resources (staff, money, training facilities) to develop the evaluation? <u>Wider stakeholders</u> • How quickly can driver's responses be gained after using the app? (e.g. if it is too long they may not remember accurately) • How will drivers be selected to use the app? • Will these people be more proficient with technology and not represent the general user? • Will they have higher stress levels already? • Can their reduced stress reliably be attributed to using the parking app? • Have those who respond been using the app longer than others? • Can demographic data be collected to determine age/gender differences etc.
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