INTEGRATING HIGHWAY ENGINEERING AND TRANSFORMATION PROJECT MANAGEMENT

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EPPM2015 Paper 87

Abstract
The reduction in local government funding coupled with national requirements to ensure that maintenance regimes are efficiently and sustainably managed means that there is pressure on the UK highway sector to transform the way it delivers services. This research indicates that there is guidance from government and industry regarding various aspects of change but no comprehensive model for transformation programmes. The aim of this research is therefore to identify the theoretical ingredients for managing change, analyse where these ingredients have been practically applied within this engineering sector and to synthesise a model from the results to provide a project plan for successfully implementing a holistic transformation programme, based on an extensive literature review and on structured interviews and questionnaires within the UK highway sector to test whether these components are effective in practice. The findings from this research have been used to propose a process protocol route map which can be used by both private and public highway sector organisations as a guide to the essential steps required for transforming services. Proposals for future work include further investigation into the role of specialist or smaller suppliers, and further debate on ownership and funding of the highway network.
Keywords: highways engineering, project management, transformation, process protocol route map

Introduction
Purpose
The aim of this research is to identify what theoretical components are required for transformational change in the highway engineering sector, evaluate the practical success of these components and to produce a process protocol map that encapsulates essential steps for transformation.

Context and drivers for transformational change in the highway sector
There are several issues facing the highway network at this present time and driving the need for transformational change:

1. How to achieve long-term quality and affordability in construction and maintenance of highway assets
2. How to maximise the contribution that the highway network makes to economic growth, by ensuring ease of access, a variety of transport choices and a reduction in the negative effects of road use (e.g. environmental impacts such as congestion, air pollution, carbon emissions)
3. How to reverse the decline of the local highway network and maximise the life-span of the assets
4. How to ensure safety and sustainability of the highway network for all users

These requirements are underpinned by an inescapable driver: how to achieve these aims given that in the UK, local authority funding is facing its most severe cuts in the history of modern local government.

The UK highway network

187.7 thousand miles of road network exists in England alone, with a total of 245.7 thousand miles in Great Britain (Department for Transport, 2014). In England, 2% of these roads are motorways or strategic 'A' roads managed by the Highways England. The remaining 98% come under the jurisdiction of local highway authorities (Lugg, 2014). Other major assets managed by highway authorities include pavements, cycleways, street lighting, structures, coastal or river defences, traffic systems, drainage and infrastructure such as signage, lining, safety barriers, guard-railing, bollards, benches, grit bins and verges.

The Department for Transport (DfT, 2013) predicts a rise in traffic levels in the future, up to 24% by 2040 on strategic routes. In addition, the highway network provides for other types of travel, including pedestrian, cycle and bus. It is the one transport asset that links to almost all locations in the UK, whether this is direct to people's homes or providing access to rail, ports, airports and places of leisure, business and health activities.

The Department for Transport's document giving context to the Strategic Spending Round (2013) emphasised transport's role in driving economic growth:

"Transport is an engine for growth and essential for everything we do…High-performing networks are essential for the UK to compete in the global race." The link between a high performing network and a more evolved and competitive economy is explicit.

The conclusion therefore is that the highway network must continue to exist and provide for its customers for many years to come.

It is generally agreed (RAC Foundation 2013, Asphalt Industry Alliance AIA ALARM annual survey 2014, Road Surface Treatment Association annual survey 2014, National Audit Office 2014) that the state of roads in the UK is in decline as a result of sustained under-investment, and that action is required to arrest this. The All-Party Parliamentary Group on Highway Maintenance (2013) cites the United Kingdom's roads as currently ranked 24th in the Economic Forum's Global Competitiveness report. This is much lower than similar European counterparts such as France or Germany. In a recent report by the Chartered Institute of Highways & Transportation (CIHT, 2012), countries such as the Netherlands and Switzerland reported that road surface damage was uncommon.

Methodology

A state of the art literature review was undertaken, followed by research within highway engineering organisations to draw on their experiences of change in practice.

The research involved current practitioners in the sector. A survey approach was chosen in order to obtain sufficient responses (a sample selection) from across the highway sector and from which the data could be used to inform more generalised results. A questionnaire was devised, which could be used as a prompt for telephone/face-to-face interviews or could be filled in remotely by participants. The questionnaire was designed to elicit qualitative data, with open-ended questions as the main focus. This was because it was felt important not to 'lead' participants; rather the objective was to discover what they thought about tools for change within the sector (attitudinal research) and about change processes within their own organisation (exploratory research).

Literature review

The state of the art literature review was undertaken to identify several components (activities or tools) that may help the highway sector in its transformation process. The literature review consists of material from academic papers, trade journal articles, guidance documents for the highway sector (in particular the Highway Maintenance Efficiency Programme), and highway sector conferences or roadshows.

Definition of transformational change

Dictionary definitions (Oxford, Merriam Webster, Business, 2014) describe transformation as a major or profound change - a radical remodelling which results in a very different method, structure and/or approach.

Table 1: Hierarchy of change process – Liassides (2015):

Level	***Description***
Transactional	Continuous improvement; simple but predictable
Transitional	Moving from current state to a predefined new one; simple but unpredictable or complex and predictable
Transformational	Radical change to an unknown end-point; complex and unpredictable

Tools or activities for change

Cultural change

The Highway Maintenance Efficiency Programme (HMEP) toolkit on Creating the Culture to Deliver (2013) states that "culture refers to the behaviours, values, beliefs and mindsets of people connected with an organisation that help us understand the world around us by providing norms, rules and a collective sense of identity."

Effectively, transforming an organisation means not just transforming processes or activities, but helping the people involved to change habits, beliefs and behaviours, which make up the culture of that organisation. How much of the culture is changed depends on the scale of need and ambition.

Case studies from the highway sector, quoted in HMEP's LEAN toolkit (2013) stress the need to invest time and resources in encouraging staff to accept change, including training (to ensure the right skills/capabilities) and communication (to encourage genuine engagement and understanding).

Operational change

The literature review indicates that the following operational components are required for transformational change within the highway sector:

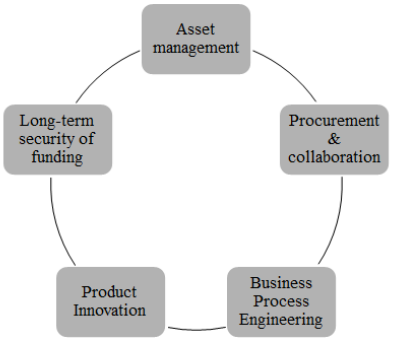

Figure 1: Components for achieving transformation within the highway sector – the author (2014)

Asset management

There is consensus across all organisations involved in providing or reviewing highway maintenance that asset management is an essential component for effective highway

services (National Audit Office, AIA, HMEP, Chartered Institute of Public Finance & Accountancy, UK Roads Liaison Board, et al).

Asset management is a long-term strategic business model which considers the whole asset (the entire network) rather than individual assets. It establishes the value of the highway network and introduces a long-term approach based on treatment interventions at optimum times in the assets' whole lifecycles rather than undertaking short-term costly repairs.

However, the Public Accounts Committee (2014) noted that 45 local highway authorities had not completed an asset management plan whilst the National Audit Office (2014) found that even the Highways Agency had gaps in its data collection, such as on drainage systems.

Procurement and collaboration

Construction industry reports by Latham (1994), Egan (1997) and Wolstenholme (2009) identified that procurement and the subsequent management of contracts had a major influence on the efficiency of projects. One route to efficiency is through collaboration in procurement, working on the principle that bulk buying and certainty of work allows suppliers to reduce their prices.

Opportunities for collaboration can also be created by shared services, across a range of functions, which may be provided by a mix of in-house or external providers.

HMEP's literature supplies evidence of cost savings arising from new models of procurement. However, Cogswell (2012) argues that it is difficult to judge whether strategic partnerships and large outsourcing organisations have resulted in overall cost savings for highway authorities, stating that there is a lack of transparency in available data. Benchmarking to ascertain cost/quality/satisfaction can be difficult since highway services are structured differently. The National Highways and Transportation Network (NHT, 2014) is working with HMEP and the University of Leeds to develop a more accurate statistical model, which is currently being rolled out as a pilot study.

There is less evidence of the extent to which behaviours have changed, particularly in regard to the ethos of public and private sector companies. HMEP's case studies from Cambridgeshire and Essex (2013) include acknowledgement by local authorities that co-location did not fully overcome poor communication, and that staff still gravitated towards more traditional 'client' and 'contractor' roles.

Collaboration between highway authorities also requires further analysis, to ascertain how successfully the issues of local sovereignty and political differences have been overcome.

Business process engineering

HMEP (2013) sees LEAN process engineering as a means of delivering what a customer wants, when they want it, to high quality and with minimum waste. As a mechanism for change, it should engage people at all levels in the re-design of services, and therefore has the potential to change behaviours through implementation.

Wolbers et al's research (2005) into the Highways Agency's framework contracts concluded that LEAN construction has been identified as bringing the biggest improvements at an operational level.

However, as both LEAN and asset management develop, there may be a tension between delivering what the customer wants versus a shift to a more preventative culture that does not focus on roads in the worst condition, and LEAN processes for reactive maintenance may need to change to reflect this shift.

There is also a need to invest substantial time, money and staff ('spend to save') and without strong leadership and ring-fenced resources, this may be the biggest barrier to embarking on re-engineering of business processes.

Product innovation

Collaborations between the highway and academic sector, and the highway and commercial sector have founded organisations such as HMEP, or developed new methodologies such as Atkins/HMEP asset management toolkit and HMEP/NHT/University of Leeds cost-quality benchmarking model.

Private sector ethos, based on understanding the market and investing up-front in order to maintain or increase profitability in the longer term, is an excellent driver for introducing new innovation, particularly at a time when traditional clients in the public sector are facing reduced funds and require 'better for less.' CIHT (2014) reports on how collaboration between highway authorities, consultants and construction companies have resulted in innovative approaches such as the introduction of sensors to detect buckling of steel plates in structures. However, Cogswell (2012) argues that the recent trend for a limited market, as a result of company take-overs, leads to a less-competitive procurement process and suppresses innovation and other contributions from small and medium sized companies that cannot meet the financial bidding requirements. The UK government's Construction 2025 strategy (2013) identifies that approximately two-thirds of construction companies are not innovating and lists the main barriers as piecemeal learning and collaboration, issues of risk and liability, the cost versus profitability and procurement complexities.

As a rapidly developing industry, IT has the potential to make the biggest impact on the maintenance and use of the highway network. At one end of the scale, new developments in vehicle performance, such as driverless or electric-powered cars, support sustainable and safer use of the network. On a more immediate level, technology results in better management of the fabric of the asset, supporting business process through the use of networked communication tools or enabling sophisticated asset management through data consolidation, condition modelling and works planning.

Long term security of funding

The National Audit Office (2014) cites Infrastructure UK as reporting that "certainty of funding is associated with cost savings of 10 to 20 per cent for routine maintenance in other sectors and countries."

Good asset management relies on long-term planning; local highway authorities felt that four to five year budgets would enable longer-term preventative maintenance programmes. The OECD in its Funding Transport report (2013) comments that asset management at lowest cost requires reliable funding flows over the long-term rather than relying on annual public funds that cannot demonstrate a strong link between the allocated funds and the expected benefits, and are more subject to political changes.

At the current time, the government has acknowledged the need for the Highways England to have longer-term funding certainty, agreeing budgets for at least 5 years. However, local highway authorities are still subject to annualised budgets and reducing revenue funds over the longer term. Meanwhile, the Department for Transport's new capital funding formula has altered the amount of capital maintenance allocation, and has introduced a greater element of uncertainty by top-slicing funds that will only be allocated through a bidding fund and through a scoring mechanism based on the authority's ability to improve in line with HMEP/DfT principles such as asset management, efficiency and collaboration. Local government as a whole is being encouraged to become self-financing, through income generation and local taxation, but still has restraints placed on it with regard to council tax and business rates uplifts.

Research results and discussion

34 responses were obtained as follows:

Table 2: Responses by organisation – Liassides (2015)

	Highway Authorities	Private sector	Total
Questionnaire	16	11	27
Interviews	6	1	7
Total	**22**	**12**	**34**

Part one:

Participants were asked: "Can you give a nominal score to each of the following (using 1 – 10, with 10 as highest) according to how much you think they help transform highway maintenance services?"

- Asset Management
- Procurement
- Collaboration
- Business Process Engineering (e.g. LEAN)
- Product innovation including information technology
- Long-term security of funding

Participants were also asked to identify additional elements that they felt were important in achieving transformational change.

The responses to this question were analysed by Microsoft Excel. Analysis included the range (or spread) the average (or mean) and the mode.

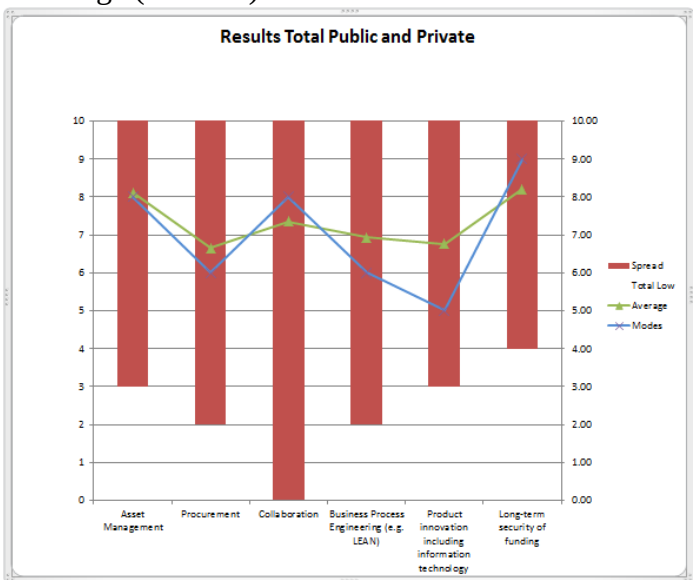

Figure 2: All responses: scoring components for effectiveness in achieving transformation – Liassides (2015)

Generally, the responses supported the data from the literature review, agreeing that the tools identified in theory were useful for transformation when applied in a practical setting, although collaboration and procurement/contract mechanisms were not necessarily producing the optimum results.

Asset management and long term security of funding were consistently identified as very important, both by the public sector and by private industry, although again issues with 'getting this right' were raised. Other tools such as product innovation or business process

engineering were considered important but varied according to type of organisation, with the private sector rating product innovation more highly than the public sector.

Where additional elements were identified, these strongly focused on customer demand and engagement, alongside cultural change (including political) and staff development for highway authorities, and on flexibility and new provision in the market place for industry providers. Capability (such as intelligent client or the right people with the right skills) and capacity were also viewed as important by both public and private sector respondents. Long-term vision (including political, strategic and operational) alongside a clarity of standards, sharing best practice, quality and risk allocation were also identified as important factors in transforming the sector.

Part two:

The second part of the questionnaire asked participants about whether their organisations had undergone change in the last 3 years, and if so, asked them to explain the reasons for this, what type of change had been introduced, what barriers had been encountered and whether they defined it as transformational.

For example, participants identified the types of change as follows:

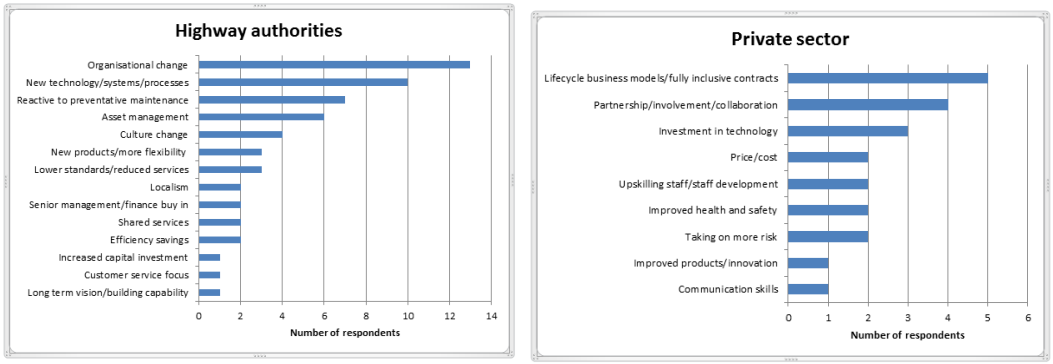

Figure 3: Types of change by organisation – Liassides (2015)

Not surprisingly, the areas or types of change strongly reflect the original reasons or drivers. Thus organisational change is high on the agenda for highway authorities, which is likely to include components identified separately, such as an asset management approach, reduced or shared services, new technology or products and a switch to capital expenditure. On the private sector side, the main areas of change appear to reflect the increased demands from the client to 'fill the gaps' that the public sector can no longer provide, such as seamless all-inclusive services via collaborative contracts with the public sector.

Many of the survey responses support the literature review:

- Drivers for change include limited funds, loss of resources, managing the network, managing customer service and the need for a shift in culture.
- Types of change include organisational and cultural change, attempting a long-term strategy with political and financial buy-in, introducing efficiencies through a range of measures and trying to provide the right skills and resources (often through contractual relationships) to improve customer/client service.
- Barriers to change include culture, behaviour or relationship issues (including political), the capability, resources and investment required and how to introduce new technology or products.
- Outcomes from change were generally felt to be transformational in that they had made a big difference to the strategic, operational and cultural approach within organisations. However, a large proportion of respondents felt that the sector had more to do especially in the face of continuing financial cuts.

Conclusion

There is certainly a re-shaping of the traditional local highway agenda, with a greater focus on communicating with customers and on the purpose of the asset, as well as a re-defining of authority boundaries through shared services or local partnerships across economic regions. Although part of this change is transactional (continuous improvement) or transitional (moving to a predefined new state), the overall consensus is that these processes combined with a new strategic approach is certainly leading towards transformation in the sector, with an undefined end point. However, whilst some organisations applied a coherent project plan approach to their highway engineering service, others were more reactive in their approach to change.

Where organisations had put change mechanisms in place, the following themes emerged:

Most effective

1. Asset management is rated highly as a tool for transformation by highway authorities and is likely to produce optimum results for the effort expended.
2. Long-term security of funding is seen as essential by both public and private sector organisations, in order to enable long-term strategic and business planning.
3. Shared services, sharing best practice and/or collaboration by highway authorities across economic regions are rated highly by many respondents, including those in the private sector, and would appear to yield a greater level of cohesion, quality and stability than single complex public-private procurement models.
4. Investment in business process engineering and systems thinking pays dividends in delivering efficiency and better customer/client services, in both private and public sector services.
5. Organisational buy-in is important; for highway authorities, this includes senior management and political Members whilst for the private sector, it is ensuring appropriate investment in the service. All organisations need to invest in staff development, to help them understand, accept and adopt change.

Less certainty of success

1. Product innovation is rated highly by the private sector but particularly specialist suppliers felt that this was not necessarily getting the attention it deserved. Organisations need to have a strategy for risk and innovation, and ensure that dialogue across a range of suppliers is kept open.
2. There are mixed opinions about procurement and collaboration in contractual relationships; generally both private and public sector stated that relationships, business models, innovation and risk management are not as good as they could be. Quality in procurement models – as opposed to financial efficiency savings – was hard to establish: hence there were some calls to focus on hard performance measures, less complexity in procurement, quality schemes for the sector and standardisation.

Development opportunities

1. Developing capability is a common theme for all organisations, with highway authorities striving for more intelligent (and smaller) client capability and private sector companies, including smaller suppliers, expanding to offer a greater range of skills and more complete end-to-end services.
2. Managing expectation in a climate of reduced services and winning the customers' (and overall organisation's) trust through improved communication and service delivery is an important factor for highway authorities.

Process protocol map

Drawing on these themes, this paper proposes a process protocol map that summarises the practical steps required in order to make best use of the theoretical knowledge and previous experiences of highway engineering organisations. The model can be used by any highway organisation embarking on transformational change, in both the private and public sector.

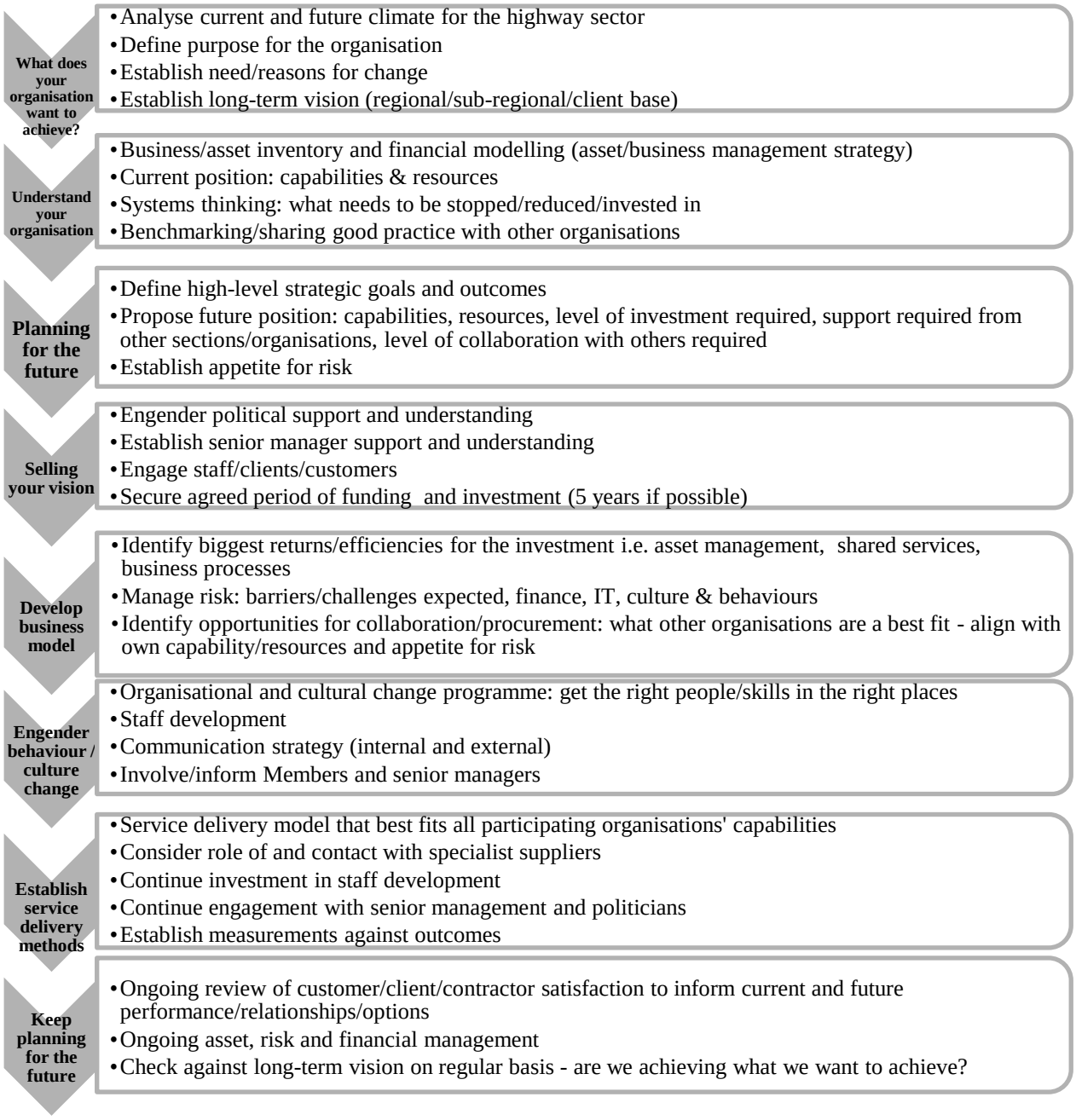

Figure 3: Process protocol map – Liassides (2015)

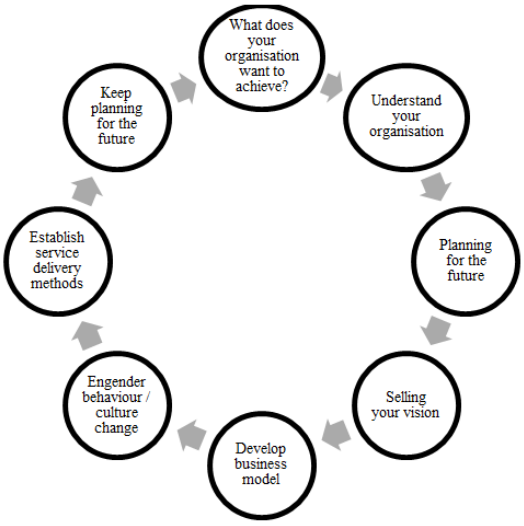

Figure 4: Protocol mapping as an iterative process – Liassides (2015)

Recommendations for future work include:

1. Explore types of efficiency and collaborative working in greater depth in order to provide a national highway sector definition. Define standards based on strategic outcomes that allow for a range of approaches that best fit the type, size and needs of each authority.
2. More in-depth research into the role of specialist or smaller suppliers in the highway sector could be undertaken. Although this is under consideration (for example, in the government's Construction Strategy), there is currently a trend towards larger managing agent contracts in the highway sector and this may be precluding client organisations from fully exploring the offers that smaller suppliers can bring to the sector.
3. Additionally, this research raised as many questions as it provided answers for the future of highway maintenance provision and its transformational journey, with some respondents commenting on the need for a national strategic view of the entire highway network. A recommendation for future research is to continue the debate about ownership and financing of the highway network, and what form that needs to take.

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