

ORR/CT/18-53
Review of Opportunities from Highways England's
Innovation and Standards Management

Final Report

Hyperion Infrastructure Consultancy Ltd

June 2019



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Office of Rail and Road

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Document reference details

Client	Office of Rail and Road
	Review of Opportunities from Highways England's Innovation and Standards Management (Project Reference ORR/CT/18-53)
	Final: Issue for publication
	M Gibb
	C Spong
	June 2019
	ORRCT18-53 Final Report for publication

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Executive summary

The objectives of this commission were to:

- review Highways England's approach to identifying, encouraging and implementing innovation and standards management in its operation, maintenance, renewal and enhancement of the strategic road network; and
- review the potential to make improvements in its approach to innovation and standards management for the second Road Period (2020 – 2025, RIS2) and beyond.

The assessment entailed significant consultation to establish process and practice, and also the views and experiences of a range of stakeholders. The consultation was conducted through both interviews and online questionnaires and a good response was obtained, representing a range of viewpoints.

A number of findings have emerged; these are generally positive and reflect Highways England's progress during the first Road Period (2015-2020, RIS1) in developing its processes for promoting research and innovation to deliver change and improvement. These include:

- HE has a clear strategy and vision to inform and direct its programmes and activities in research and innovation to support its goals for the near to long term.
- Cross-sector engagement and initial engagement with a wider range of potential innovators are good, though there is scope to improve engagement with the existing supply chain, particularly in the lower tiers.
- The deployment of the Innovation Designated fund has been successful in promoting innovation and the process is maturing.
- Procurement and contract mechanisms have been developed which intend to value and promote innovation from the supply chain; further experience of their implementation and operation will be required to evaluate their effectiveness.
- The development of a digitised standards solution – the Technical Standards Enterprise System – is widely recognised as leading edge development in the field and it provides both a mechanism for the timely implementation of change and innovation, and also a foundation for further development of Highways England's Digital Roads programme.
- The RIS1 efficiency targets have proved a strong driver for innovation, particularly in operations, and while this was initially challenging, Highways England has responded by developing systems and tools to identify, evaluate and disseminate successful innovations.

Recognising that Highways England's approach to the management of innovation and standards is a continuing process of development, there is also scope for improvements to be made. Hence it has been possible to identify a number of recommendations for Highways England to consider in further developing its approach to support delivery of RIS2, and beyond, and also the long term vision that it has set out for the Strategic Road Network in "*Connecting the Country: Planning for the long term*". These recommendations include:

1. Further development of the route to implementation for successful innovation, to give clarity and confidence to innovators in working with Highways England in developing their innovations.

2. Establishment of an 'accelerator' programme to familiarise new entrants with Highways England's objectives and processes.
3. Build upon current cross-sector engagement by extending that process to the operational level and involving the supply chain in those forums.
4. Build upon the success in engaging with new entrants and a wide range of potential innovators by working with the existing supply chain, particularly the lower tiers, to raise their awareness of, and access to, Highways England's resources and mechanisms to support innovation.
5. Ensure that the support for research and innovation covers resource investment as well as capital investment as this is essential both for the development of innovation and also for the provision of appropriate skills and services to support the implementation and operation of new systems, products and processes.
6. Development of a framework for the managed evaluation and acceptance of the performance risk of novel solutions to accelerate innovation on long life assets.
7. Extension of the standards review to the standards owned and managed by Information Technology Directorate in the light of the success of Technical Standards Enterprise System.
8. Ensure consistency of approach and provision of resourcing to support development of innovation across the whole of Highways England's business.

Introduction

The Office of Rail and Road (ORR) monitors how Highways England (HE) delivers performance, including efficiency, safety and sustainability, for the benefit of road users and the public. In November 2018 ORR commissioned Hyperion Infrastructure Consultancy Ltd (Hyperion) to review HE's management of innovation and standards management and, hence, identify opportunities for development of the approach in the Road Investment Strategy for the Roads Period 2020 to 2025 (RIS2) and beyond.

The review was undertaken in close collaboration with Highways England; the review was overseen and facilitated by HE's Strategy and Planning (S&P) Directorate while the Innovation and Continuous Improvement (ICI) team of HE's Safety, Engineering and Standards (SES) Directorate provided valuable input and support throughout.

This report presents the findings from the review and recommendations for HE to consider in the further development of its approach to the management of innovation and standards.

Objectives

The objectives of the commission were to:

- review Highways England's approach to identifying, encouraging and implementing innovation and standards management in its operation, maintenance, renewal and enhancement of the strategic road network; and
- review the potential to make improvements in its approach to innovation and standards management for RIS2 and beyond.

The review has focussed on process, framework and policy; however, reference is made to specific examples and case studies where appropriate to illustrate and evidence particular themes or findings.

Background

HE recognises that it will have to identify, develop, implement and manage changes across the breadth of its business in order to deliver the programme and targets for RIS2 and beyond and also to realise its vision for the strategic road network (SRN) set out in *"Connecting the Country: Planning for the long term"* (1) while meeting its three imperatives of:

- Safety;
- Customer service; and
- Delivering the Road Investment Strategy.

HE also recognises that:

*"We are on the verge of a **roads revolution**, as new technologies emerge and impact on how people interact with the roads themselves, their vehicles and each other."* (2)

There is also an awareness, at a strategic level, within government and across the infrastructure sector, of the potential savings and efficiencies to be driven by sourcing innovations both from deeper within the supply chain, from the likes of SMEs and start-ups, and across a wider range of industry than the traditional sectors.

Review process

Management and approach

The overall approach taken throughout the review was highly collaborative, and Hyperion worked closely with ORR and HE to ensure that all parties were informed of progress and status, that the delivery of the review was able to respond and develop to findings as they emerged and that findings and recommendations were fair and constructive. This was supported by regular meetings of a Steering Group that monitored progress, identified issues and risks, and agreed appropriate actions. From HE the review was championed by HE SES ICI team who, along with HE S&P, identified and coordinated key stakeholders in Highways England, as well as useful contacts in the supply community.

Information gathering

The principal activity of the review was the gathering of information both for analysis to determine findings and consequent recommendations where appropriate, and to provide evidence to support those findings. The sources of information are summarised as follows:

- Desk study/document review
- Stakeholder consultation
 - Internal stakeholders, i.e. Highways England staff;
 - External stakeholders, e.g. suppliers, research and innovation bodies; and
 - Comparator organisations, infrastructure owners/operators in the UK and overseas with a similar remit to HE.

Lines of enquiry

The form and focus of the information gathering evolved dynamically through the review in response to the progressively accumulated information and findings. The principal lines of enquiry; were:

- Supply chain engagement
- Identification and support of potentially beneficial innovation
- Transition to 'business as usual'
- Assessment and management of risk
- Development and governance of standards to support change
- Encouragement of innovation through procurement/contracts, operations and culture

Reporting

Consistent with the collaborative way of working a 'no surprises' approach was adopted in that points for clarification and potential findings were raised throughout the process and used to update and refine the information gathering while the review was underway. This final report has been produced following review and comment by both ORR and HE.

Desk study

The original aim of the desk study was to enable an initial understanding of HE's policy, process and practice with regards to the management of innovation in standards which would, inter alia;

- Inform the selection of consultees for the stakeholder engagement; and
- Provide the basis for refining the lines of enquiry and planning stakeholder interviews.

Key sources that were identified and reviewed include:

- Innovation, Technology and Research Strategy. Highways England. April 2016. (3)
This was published a year after the start of RIS1 and when HE came in to being. It sets out HE's overall strategy with a long-term horizon and goals. It also gives indicative allocations for the Innovation Designated Fund (IDF).
- Connecting the Country: Planning for the long term. Highways England. December 2017. (1)
This is a key document across HE's business as it sets out its vision and, hence, gives direction for business planning. It is particularly significant given HE's role in contributing to the wider development of policy for transport and mobility developing UK policy, which is a major change from the remit of Highways Agency. In the context of research and innovation, it identifies the issues and challenges that need to be addressed to support delivery of the vision.
This document has also provided a structure for the governance of the innovation and research strategy, against which business cases can be established in alignment with the aligned with the five themes from the vision, i.e.:
 - Design, construction and maintenance
 - Connected and autonomous vehicles
 - Customer mobility
 - Energy and the environment
 - Operations
- Highways England Innovation Hub (highwaysengland.co.uk/innovation-hub)
Developed and owned by HE SES ICI team to promote HE's approach and attitude to research and innovation and to encourage engagement from potential suppliers/partners. It is HE's first outward facing online portal and has been instrumental in achieving engagement with a wide range of potential innovators. The documentation and information presented on the Innovation Hub includes information about HE's challenges, how to engage with HE regarding innovation and the innovation competitions that HE runs. It also presents HE's 'Innovation Journey' which maps the principle of the development pathway for innovation and change from initial source or driver, through evaluation to implementation. This represented by the diagram reproduced below.

The innovation journey

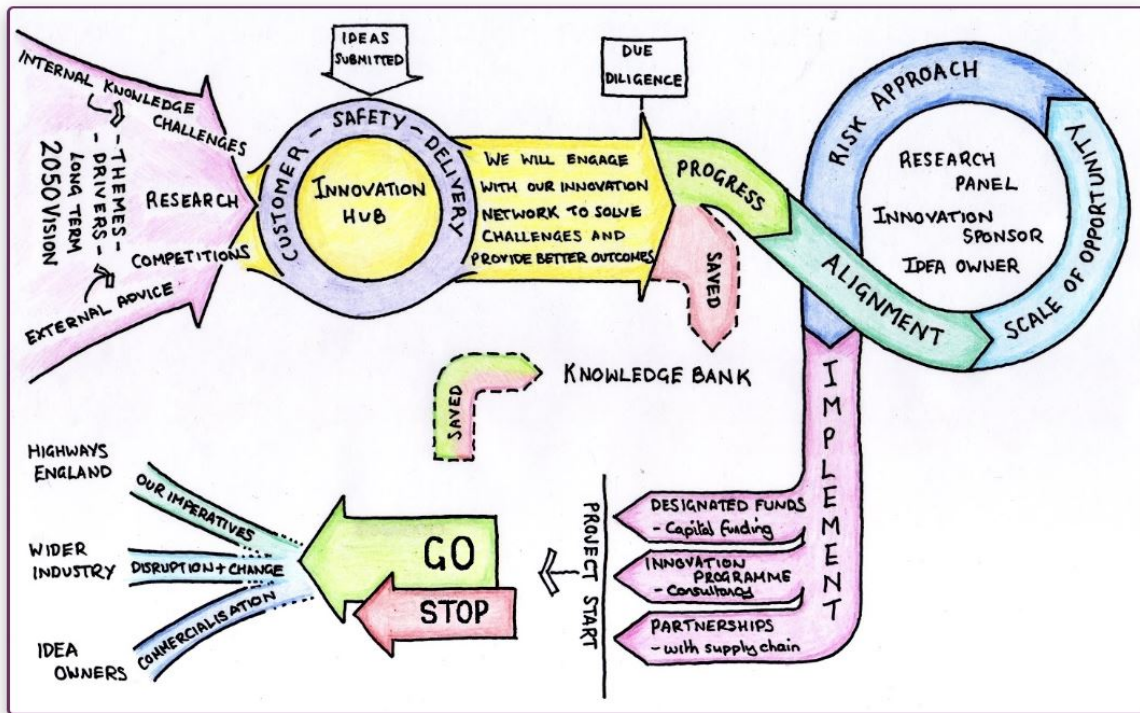


Figure 1 - Highways England's 'Innovation Journey'

Stakeholder consultation

The stakeholder consultation was the principal source of information, evidence and views on HE's management of innovation and standards from past performance through current practice to future plans.

There were two elements to the consultation:

1. Direct engagement

This took the form of either a meeting or phone call and was planned and delivered in two strands:

- Internal Stakeholders: HE staff from the various elements of the HE business, i.e. SES, Major Projects (MP), Operations and Commercial and Procurement. These interviews were arranged and coordinated through HE's S&P team supported by HE SES ICI team
- External stakeholders, e.g. suppliers, research bodies, other infrastructure owners/operators. These sessions were arranged direct with appropriate direction and support from ORR and HE

2. Online survey

Two separate online questionnaires were developed and issued; one for suppliers of products to HE and/or similar organisations and the second for 'comparator' organisations, i.e. infrastructure owners/operators in the UK and overseas with a similar remit to HE. The format and content of both questionnaires was developed in collaboration with ORR.

Potential respondents were contacted in advance to raise awareness and gauge willingness to participate.

Direct Engagement: Internal Stakeholders

Discussions were held with Highways England staff from across the business as indicated below:

Scope of consultation with Highways England	
Directorate	Roles
Safety Engineering and Standards	Senior leadership Strategy development and implementation Operational development
Major Projects	SMART motorways programme Regional investment programme Complex infrastructure programme
Operations	Regional planning and development Area delivery Programme and efficiency
Procurement and commercial	Contracts and incentivisation

Direct Engagement: External Stakeholders

Discussions were held with over twenty organisations that have direct interest in Highways England's management of research, innovation and standards. These included:

- New entrants to the supply chain, including SMEs and start-ups
- Existing suppliers of both products and services, from Tiers 1 to 3
- Research and innovation bodies, including funding organisations and academic institutions

Online Survey: Suppliers

The direct engagement with external stakeholders was augmented by an online survey. A total of 25 responses were received; 6 from Tier 1 suppliers and 19 from Tier 2/3 suppliers.

Online Survey: Comparator organisations

A number of organisations were identified as 'comparator organisations', ie with similar remit to Highways England for the management and/or operation of transport infrastructure assets, to consult on their approach to the management of research, innovation and standards. This was conducted through an online survey; three responses were received, all from organisations within Europe and with a direct interest in highways.

Observations and assessment

The information obtained from both the desk study and the stakeholder consultation has been assimilated and reviewed. Observations arising from this review are presented and assessed below under the following headings:

- Strategy and structure
- Engagement
- Innovation designated fund
- Supply chain
- Delivery
- Enablers and barriers
- Culture

Strategy and structure

As part of its role, Highways England contributes to the development of the national vision and policy for transport and mobility. This is a significant advancement from the remit of its predecessor, Highways Agency, and one which gives HE a long-term perspective for its goals and, hence, the development needed to achieve them.

HE's vision is presented in *"Connecting the County: planning for the long term"* (1). This is a key foresight document based on widespread research and consultation to identify *"the trends which will shape the SRN and influence our operations over the next 30 years and beyond"*. It presents the outcomes of long-term scenario planning for full range of HE operations and assets which help to focus and refine the objectives and approach that had previously been set out in HE's *'Innovation Technology and Research Strategy'* (3).

"Connecting the County: planning for the long term" has also provided the structure for framing and aligning the innovation strategy within the HE business and so providing a basis for the establishment of business cases for the justification of research and innovation, i.e. the 2050 vision themes of:

- Design, construction and maintenance
- Connected & autonomous vehicles
- Customer mobility
- Energy and the environment
- Operations

The research and innovation strategy is owned by the Innovation and Continuous Improvement (ICI) division within HE's Safety Engineering and Standards (SES) directorate

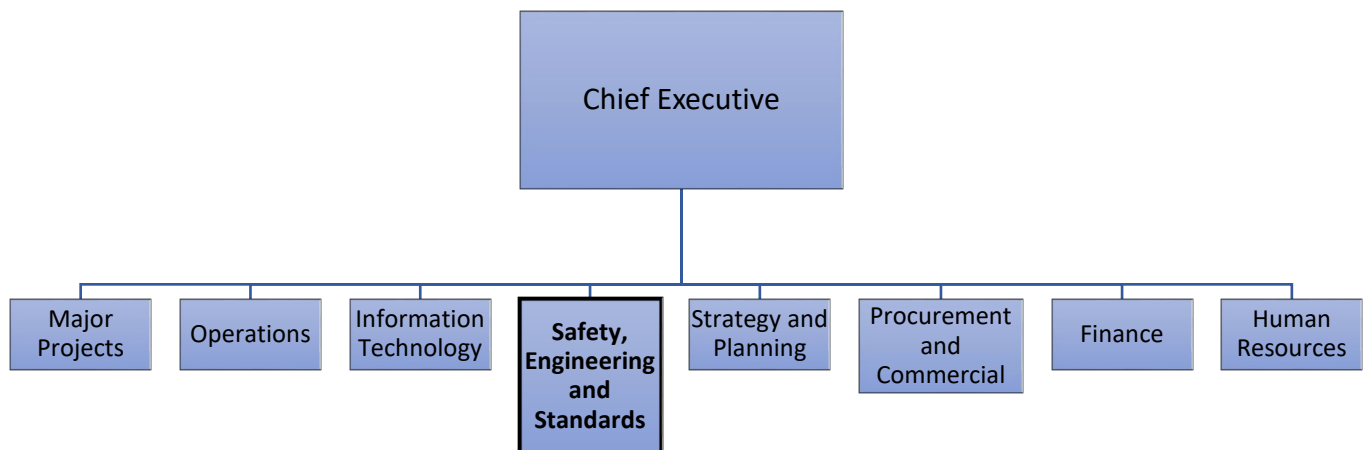


Figure 2 - Highways England Directorate Structure (April 2019)

Significant effort has been made by SES ICI in the development and promulgation of the strategy with a wide range of stakeholders from DfT as ultimate client, through strategic cross-sector partners, such as Network Rail and HS2, and the supply chain from established major suppliers to new entrants, SMEs and start-ups. The development of the Innovation Hub, HE's first outward-facing web portal, to provide information on HE's objectives, policies and activities with the aim of promoting wide-scale engagement on innovation research has been widely recognised as a positive development.

Moreover, while the new strategy and approach for research and innovation are works in progress, they are recognised at senior level in DfT as representing a step change from Highways Agency practice and this should give confidence both to HE's client and monitor with regard to HE's direction and effective use of resource in this area.

The SES ICI division is structured to reflect its '4 pillars' representation of the key elements in identifying, developing and delivering change and improvement, and this has been key in communicating and engaging on the with others, both within HE and externally, on the promotion and support of innovation.

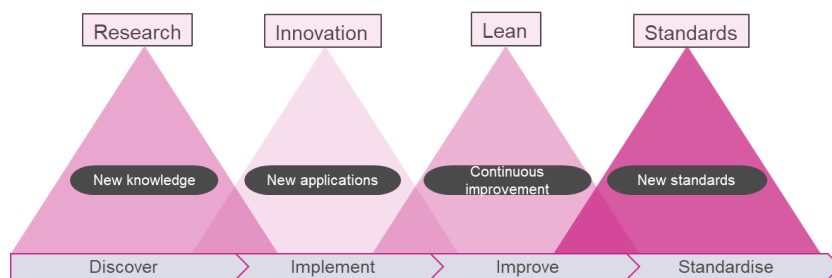


Figure 3 - The 4 Pillars of HE SES ICI Innovation Approach

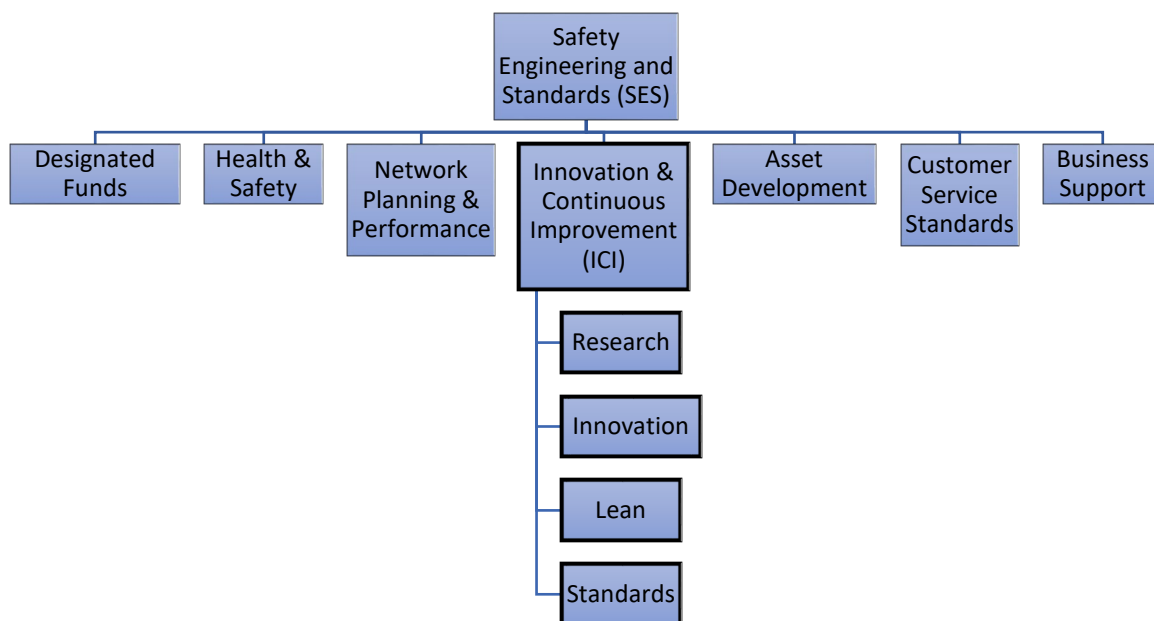


Figure 4 - SES Innovation and Continuous Improvement Division Structure (April 2019)

It has been observed that this structure and approach, with a distinction drawn between research and innovation, reflects a “maturity of thought with respect to research and innovation” on the part of HE.

However, the role, influence and, hence, approach of SES ICI does not appear to be uniformly embedded across the whole of Highways England and there are parallel initiatives to support innovation in the wider business, i.e. Operations Directorate has its Operational Excellence programme and Major Projects (MP) has its Transformation Programme. MP's Transformation Programme is designed to identify good practice and coordinate and promote it across schemes and programmes, and is structured under five themes, each with a senior management lead:

- Digital
- Productivity
- Technology
- Customer Focus
- Intelligent Client

It is noted that these themes do not directly align with those adopted by SES ICI (i.e. those from the Connecting the Country: Planning for the longer term). This is recognised by SES who are currently working proactively with both MP and Operations Directorates to ensure a consistent and complementary approach across the organisation, though the difference in themes does reflect the longer-term focus of SES ICI against the nearer term operational and delivery needs of MP and Operations.

It is recognised that SES ICI is not resourced actively to support the whole of the business and also that each directorate will have its own approach and implementation, nevertheless a consistent, collaborative approach will be required to ensure that successful innovations emerging from the 'Innovation Journey' are sponsored and supported through to implementation.

From a more strategic point of view, wider than the remit of this review, SES has also recently initiated a 'Fit for Future' programme to determine and develop its role and interaction with the wider HE business.

Engagement

Internal

The take-up of the opportunity provided by the IDF since its deployment at the start of RIS1 has varied across HE with, for example, certain of the operational areas having been enthusiastic supporters that have promoted a significant number of successful projects through the fund while others have initially been less engaged and slower to realise the opportunities. However, from the consultation it is apparent that SES are working effectively to raise the profile of the 'Innovation Journey' and the funding available through the IDF and that there is now good recognition of this across HE.

It is noted in the preceding section that there is an active focus on innovation across the HE business with programmes established in both the principal delivery directorates, i.e. MP and Operations, and that the SES ICI team is actively engaging with both of these, and across the wider business, to promote a consistent and complementary approach that addresses HE's needs and opportunities for the immediate and longer terms. It should be acknowledged in developing this approach that the strategy for innovation and research which has been promoted to key external stakeholders and has both garnered praise and gained traction - as discussed below - has been led by SES directorate.

Cross Sector

HE's commitment to cross-sector engagement at a strategic level has been recognised. It contributes actively to a number of key innovation forums, including:

1. The DfT's **Transport Research and Innovation Board (TRIB)** which seeks to promote open innovation to *"join-up and coordinate disparate transport research and innovation activities across the UK to achieve a more strategic and coordinated programme of work which is aligned with agreed national priorities."* TRIB comprises senior level representation from:
 - DfT and other government departments
 - Transport infrastructure authorities including Highways England, HS2, ADEPT and Transport for the North
 - Academic and research institutions
 - Organisations responsible for the funding/promotion of innovation and research

HE has made a positive commitment to TRIB;

- Represented by an Executive Director
 - Expressed desire to be involved in all four of TRIB's work themes, reflecting the positive acceptance by HE of its wider role in transport and the economy beyond its remit for the strategic road network
 - Is providing resource and engaging actively, e.g. with Living Labs
2. The **Transport Infrastructure Efficiency Strategy (TIES)** presents examples of efficiency initiatives that offer scalable opportunities and supports the objectives of the Government's Industrial Strategy to increase innovation, develop skills, grow business and drive productivity across the UK. It ensures that for publicly funded infrastructure these wider interests are taken into account at the earliest stages and highest levels of decision-making. The TIES partners are:
 - Department for Transport (DfT)

- Crossrail
- Highways England
- High Speed Two Ltd (HS2 Ltd)
- Network Rail
- Transport for London (TfL)

HE has shared the work it is doing on digital technologies, i.e. Technical Standards Enterprise System (TSES) and Rapid Engineering Model (REM) which has given other partners confidence to look at adopting/adapting/developing similar solutions themselves. For example, HS2 is looking at automated design following REM. DfT and the Infrastructure and Projects Authority (IPA) see the TSES and REM models as drivers for efficiency in design.

In relation to standards, HE has worked with HS2 and other infrastructure organisations with BSI to produce guidance on temporary works to Eurocodes (European standards for structural design). In turn, HE is also interested in Network Rail's Standards Challenge and will look at this for future application to HE's development of standard

3. The **Infrastructure Industry Innovation Platform (i3P)** is effectively the successor to Crossrail's Innovate 18 project which provides both a platform for sharing innovations and a mechanism for funding innovation. i3P comprises members from major client groups and the supply chain. The aim is to drive innovation across industry in areas of common interest, e.g. low carbon concrete, using a collaborative approach to derive optimum benefit from investment. i3P has very senior, influential representation and is accepted across industry and well recognised by Government as a platform for developing and sharing innovation.

HE is a founder member of i3P and is taking a significant role in the current phase in developing workstreams. HE has shown good commitment at senior level though could make some improvements to cover the 'wider picture', i.e. there isn't so much engagement with 'on the ground' staff

Whilst HE's efforts are recognised it has been observed by key stakeholders that HE, along with other similar national transport infrastructure agencies, could:

- collaborate more and effectively at an operational level, sharing problems as well as solutions;
- improve involvement of and engagement with the supply chain, much of which is common, in these forums; and
- look to wider industry and academia for sources of innovation.

Supply Chain

Key stakeholders with a strategic, cross-sector perspective have stressed the need to HE, and similar national transport infrastructure asset owning/operating organisations, to look both deeper into and beyond their traditional supply chains to access a wider source of potential innovators, i.e. to engage directly with the lower tiers of supply chains – SMEs, start-ups – and to seek and encourage input from other industries and sectors.

HE's Innovation Designated Fund (IDF) has been well received by a range of stakeholders, from DfT to new entrants, as it provides visibility, both within HE and to potential suppliers, that there is both willingness and funding to support innovation. The process of initial engagement with potential innovators, particularly those from outside the industry, has also been positively acknowledged by the majority of those who took part in the consultation. There is good awareness of the Innovation Hub and, from that, the process of engaging with HE e.g. through the innovation competitions that HE runs. The most recent competitions – developing digital roads and improving air quality - established in conjunction with Innovate UK, have been well promoted and generated a lot of interest with the innovation element having received approximately 170 submissions. Making use of Innovate UK's experience in this area has been recognised as a sound approach which “*avoids reinventing the wheel*” and gives confidence to potential innovators.

However, response from the stakeholder consultation for this review indicated that there is perhaps both less awareness of HE's initiatives with regard to innovation and also less direct engagement with HE (at least less than would be preferred by respondents) among the lower tiers of traditional supply chains and sectors. In consequence there is scope to improve engagement with such organisations; HE has recognised as much in reviewing its procurement approach for the Asset Delivery model in its network operations and the introduction of Collaborative Works Frameworks (CWF) which seek to achieve more direct engagement across the various tiers of the supply chain with the aim of identifying and supporting innovation from those sources. Similarly, the award and operation of frameworks for the Major Projects Regional investment programme (RIP) have been designed to recognise and encourage innovation by suppliers. However, both the CWF and the RIP are recent initiatives and their effectiveness in promoting innovation is not yet proven. It is recognised by industry representative bodies that, while a more collaborative culture is evolving, some suppliers need further engagement and encouragement to develop their behaviours in this area.

Innovation designated fund

ORR published a study into HE's delivery of its designated funds programme in 2018 (4) therefore this review specifically excluded revisiting the delivery of IDF or HE's performance in this area. However, given the significance of the IDF for HE in supporting its goals for, and delivery of, research and innovation, its operation and effectiveness have featured significantly in the stakeholder consultation. Therefore, the scope of this review has included reference to some of the enablers, governance and processes associated with the IDF.

It is evident that the process for scrutinising and approving investment decisions has developed since the fund was first deployed. There is a documented governance system with oversight and initial review and sifting of proposals by the SES IDF and ICI teams and a 'Dragon's Den' forum from HE Operations to ensure that proposed projects align with the needs and aims of the business. Many innovations are expected in the technology domain and HE has a rigorous information technology concurrence process to ensure that products in this area are compatible with HE's requirements and existing systems. Final approval, or otherwise, lies with the Designated Funds Investment Decision Committee (IDC).

While the previous study for ORR showed that the IDF was initially underspending against programme, Highways England has significantly increased its cumulative expenditure in the IDF by over three times in the intervening period. This is due largely to the success in promotion of the fund, both within HE and externally, through the competitions in particular. The IDF is currently over programmed, i.e. the value of the pipeline of potential future projects exceeds the available in-year funding, which further emphasises the need for both effective review and prioritisation of applications to the fund and management of the programme.

It is noted from the information obtained that:

- The *Innovation, Technology and Research Strategy* (3) gave initial guidelines on the allocation of funding against themes but these have since evolved to align with HE's developing policies and priorities, i.e. as in *Connecting the Country: planning for the longer term* (1) and the maturing of the operation of the designated funds.
- In addition to the aspect of supporting particular themes, the IDF supports tasks and work strands that will be identified through different routes, e.g.
 - 'strategic' programmes such as 'Digital Roads' in general (and the further development of the TSES in particular) which have been identified by HE itself as crucial to delivering its longer-term objectives
 - Potentially beneficial opportunities for development for HE, and its stakeholders, that are identified from HE's proactive engagement with potential innovators, e.g. through the innovation competitions
 - More 'altruistic' innovations which, while of interest to HE are also a major concern for the local authority network and thus offer wider national benefits than may accrue directly for the operation and use of the SRN.
- Funding for approved projects is released in phases; each release is dependent upon successful completion of the preceding phase, which is judged against measures/deliverables that are established at the outset and documented for each project.
- There is a commitment to fund competitions up to their advertised value.

- There is a commitment to funding 'high profile' projects through to conclusion, which is seen as development to the point where it could be considered for adoption as 'business as usual'.

Stakeholder comment on the IDF process from the review has been mixed. Positive aspects that have been noted include:

- The process has developed and is now much clearer than it was initially
- The timescale for decisions on funding is both clear and quick

However, responses to the consultation suggests that there a number of areas where further guidance or support could be provided, especially for new entrants e.g;

- Indication of the level of market readiness required both to give innovators an "idea of where to pitch" and to assist understanding and support across HE. This could usefully be routinely expressed in terms of the established Technology Readiness Level (TRL) framework. The TRL framework has been used by HE but does not appear to have been universally or consistently adopted.
- The guidance on what constitutes a 'good' submission could be improved with the use of examples and/or clear templates

It has also been observed that feedback is not always consistent with some concern on occasion about timeliness and the lack of specific recommendations or actions required to address concerns that have been raised, which can lead to significant delay and extra effort in revising and finalising applications.

The recognition that the identification, development and implementation of innovation are complex with uncertainty of outcome is reflected in HE's acceptance that a proportion (of the order of 30%) of the funding may be allocated to projects that do not ultimately succeed. This appetite for risk has been welcomed by stakeholders as it signals HE's intent to challenge in order to develop and gives confidence to potential innovators in engaging with HE.

The scope of the IDF is limited to funding development and does not cover implementation and the transition to "business as usual". Costs, such as those for;

- licencing
- enabling works
- changed or enhanced support services to facilitate the implementation and operation of changes resulting from innovation

are not covered and must currently be funded from existing programmes. However, it is envisaged that in RIS2 the fund will be renamed 'Innovation and Modernisation' and such costs may be considered for inclusion in scope. This reflects the fact, recognised by HE, that capital investment (capex) in innovation will often need associated resource expenditure (opex) for successful development, implementation and operation.

Supply chain

From the responses to the stakeholder consultation, from DfT through innovation and research bodies to potential innovators, HE's efforts to engage with a wider range of suppliers as sources of potential innovation, including new entrant SMEs and start-ups have been positively received. The positive promotion of HE's intent to encourage innovation and support it through the provision of funding, through a number of channels including:

- Highways England's Innovation Hub
- Innovation competitions
- Presence and profile at industry events

has proved very effective and represents a significant recent improvement in HE's accessibility; many reported earlier difficulties in finding a route in to HE.

The introduction of clearer statements of objectives and challenges to be addressed through innovation (e.g. surveys without operatives on the carriageway, no traffic cones on the network) is intended to give potential innovators a clearer idea of what HE is looking to achieve and, hence, how their innovations might support that.

However, beyond the initial engagement there is scope to provide further support and guidance, particularly to new entrants and/or SMEs and start-ups on working with HE both during the innovation phase and subsequently, if successful, in the route to implementation, i.e.:

- HE must recognise the needs and risks of innovators, particularly smaller organisations and start-ups funded by investors, e.g.
 - A clear and reasonable process and timescale for decisions
 - The need to maintain a revenue stream
 - The need to be able to demonstrate progress to provide confidence to their investors
- HE should be able to provide a clear path to implementation, recognising risks and stage gates, to inform and manage the commercial expectations, decisions and development by innovators
- HE should ensure that appropriate resourcing is provided for sponsorship to support and guide innovators through the process. This may be a challenge given the scale of investment available through the IDF which is likely to lead to a significant number of projects running through the 'Innovation Journey'

One means of addressing some of these issues would be for HE to develop an 'accelerator programme' to give new suppliers an early insight in to HE's business objectives and processes in order to inform their approach to working with HE and allow them to evaluate challenges and risks in the process. There are existing programmes, run by other organisations operating in the transportation and mobility sector, which HE could review in considering the development of such a programme including:

- Telefónica runs fast-track accelerators through its Wayra unit which aims to support start-ups and 'disruptors' looking to develop innovation and bring it to market
- Transurban, a toll road operator in the US and Australia, runs 3-month accelerators to explain their business needs to new entrants

- Kapsch, a technology company working in the fields of transportation and communication, and the National Roads Authority of Israel also run accelerator programmes

Responses from the online supplier questionnaire, in particular, highlighted that there is scope to improve the engagement with and of the lower tiers of the existing supply chain. There was somewhat reduced awareness of HE's current initiatives in seeking and supporting innovation, coupled with a degree of frustration at the difficulties for smaller/lower tier organisation experience in engaging directly with HE to discuss opportunities and challenges around potential innovation in the established contractual supply chain arrangements. It is recognised both that some of the challenge here lies with the suppliers themselves in their approach to engaging with HE and that HE does recognise this issue and has developed mechanisms such as the Collaborative Works Frameworks to address this. Nevertheless, there is scope to improve the engagement with these suppliers and, given the success of engagement with new entrants, focus in this area may well yield further benefits.

Delivery

While the initial engagement, identification and trialling of innovations has advanced and is proving effective, it is evident that there is scope for further development of the process for taking successful innovations through to implementation as “business as usual”. This entails effective handover of innovations to the delivery arms of the HE business and their subsequent adoption and ownership by those delivery arms.

The experience of similar organisations was that early involvement of all interested parts of the business who are likely to make use of and/or be affected by innovations is important to gain their buy-in and support for development and implementation. The functions and benefits of proposed innovations must be understood together with compatibility with the current practice and future direction of those delivery arms.

A number of contributors to the review have commented that neither the process nor timescale from initial trials through approval to installation and/or operation are currently clear. It is important for HE to be able to provide innovators with a clear pathway through the process from development and trialling to entering the market so that the risks and options for commercial exploitation are clear. Timely feedback from HE during the process is also important to facilitate further development by the innovator when needed and to confirm, or otherwise, HE's continued interest in order to allow commercial and development decisions to be made and, where appropriate, inform investors.

From an HE perspective it also important that the adoption of beneficial innovation can be delivered quickly and effectively. It is however recognised that there are constraints on procurement to ensure a fair market and competition for suppliers, thus the principal route to market implementation is to develop a requirements-based specification that offers no commercial advantage to the original innovator. Nevertheless, it is important that HE has effective tools to drive the uptake of beneficial innovation, whether this be working across the HE business, with the innovator and/or with the supply chain. SES ICI is aware that the further development of the Innovation Journey now needs to focus more on the latter stages of that journey, i.e. the ‘Execution Plan’.

Successful adoption and implementation also require effective dissemination across the organisation. Respondents to the review have commented that a ‘huge amount’ of innovation happens on projects. Often these innovations are developed initially for the circumstances of a particular project and will need to be reviewed and developed as a generic solution for widespread use. This requires the facility to ‘step back’ to obtain that wider perspective on potential deployment. It has been noted that HE's appointment of ‘Technical Partners’ (operating between SES and MP) should assist in facilitating this.

Appropriate procurement and contractual mechanisms are also key to the encouragement and delivery of innovation; initial evaluation and award of bids must recognise that those innovative supply organisations will have had to invest in their innovative culture and capability – staff, facilities and products - and that this adds to cost base. An evaluation that is based principally on cost will favour organisations that do not invest.

HE MP has recognised this in the award of frameworks for its regional investment programme (RIP). The RIP has also established regional and national innovation forums to bring suppliers together to share innovation. In general, though, HE reports that sharing of innovation in the fields of safety, in particular, and communications are not an issue when working with the supply chain but that more difficulty is encountered in technology where suppliers have invested in a particular area to give themselves a competitive advantage. To attempt to address this and encourage sharing HE is looking to the use of longer-term contracts and the removal of secondary competitions on the basis that suppliers will be encouraged to develop and share innovation if they are not subject to repeated competitive bidding processes. These developments are, however, relatively recent and so their effectiveness is yet to be proven.

The RIS1 efficiency targets have proved to be an effective driver both for innovation and the development of systems and procedures for evaluating and sharing that innovation. Successful, proven innovations in Operations are disseminated through the 'efficiency levers' reporting tool to promote take up across the business. HE has managed successfully to develop its systems and ways of working, including both collaboration with the supply chain and making use of the IDF to

Case example: Cold insitu recycling of asphalt pavement

Cold insitu recycling has been successfully trialled on the renewals scheme at A1 West Moor to Newton-on-the-Moor. This has resulted from significant investment in the very latest recycling equipment by the supply chain, with strong support from the Tier 1 supplier and HE's asset development team. The recycling machine first planes off the existing surfacing to the required depth and processes the milled material to produce a predetermined material grading. The material is then mixed with bitumen emulsion and a small amount of water (to aid compaction) before being laid like traditional hot mix material, but at a lower temperature. The final stage of the process is the application of a new thin surface course using conventional hot mix asphalt material and paving plant.

This technology provides a radical change to the pavement renewal process. Traditionally the renewal of a section of road is undertaken using separate activities of planing and asphalt. Each of these activities requires its own management, labour and support plant and equipment. Within the cold insitu recycling process, one single activity encapsulates both the planing and road laying activities. The major benefit of utilising this method is the reduction in costs required to complete the road renewal. The reduction in costs results from the following:

- 66% reduction in waste taken to landfill
 - 75% reduction in quarried aggregate
 - 49% reduction in shifts
 - 71% fewer lorry movements
 - Increase in asphalt laid per shift
 - 25% reduction in quantity of bitumen required
- In addition to the above efficiencies, additional ancillary benefits are achieved as follows:
- Reduction in road joints (as a result of fewer shifts)
 - Reduction in carbon emissions (approximately $\frac{1}{3}$)
 - Safer working conditions (fewer plant movements)
 - Environmental benefits resulting from significant recycling of materials

The total efficiency saving on this scheme has been evaluated as just over £1m.

improve significantly its performance in identifying where it has taken more efficient approaches than prior to RIS1.

Case example: Combined environmental barrier and vehicle restraint system

The requirement to provide VRS protection to environmental barriers (EBs) at the carriageway edge often causes problems due to the constraints on space to accommodate both the barrier and the vehicle restraint system (VRS) on separate foundations. A proprietary system that combines the EB and VRS in a single system has been successfully trialled in HE's Area 12.

The key benefits of this solution are:

- It enables installation of the environmental barrier and associated VRS protection without need for special prohibitively expensive measures such as piled foundations
- The single foundation can be set on the current VRS foundation alignment thus reducing or eliminating the need for works to accommodate or alter existing services, including NRTS, and roadside furniture
- It complies with all current standards for both EB and VRS, hence no requirement to submit departures
- The system can be fitted to stringcourses of underbridges, replacing the existing parapets and providing an increased restraint system as it is CE mark rated to containment level L2, far superior to the normal N2 standard for verges.

The system includes precast reinforced concrete units that are designed to form a structurally continuous foundation enabling use in weak ground conditions and allowing installation during adverse weather conditions, in a shorter time on site.

The system offers efficiency savings of 45% compared to the traditional design plus the added value of total replacement of VRS.



Enablers and barriers

Standards development

Standards and specifications are key to the delivery of innovation and change as the way in which they are presented can, if well-structured, encourage and/or drive innovation and improvement. Effective governance and management of those standards and specifications are also essential to ensure that they can respond in a timely and efficient manner and, hence support, innovation and change.

One of HE's protocol requirements from DfT was to undertake a review of the Design Manual for Roads and Bridges (DMRB). This suite of documents was known to be problematic; the number and age of the standards within it had risen steadily, and was continuing to rise, over a number of years. A consequence of this was a lack of clarity leading to cost and delay through the degree of interaction required with HE's suppliers and designers in particular.

Following an extensive consultation, HE have developed an approach based on digitising standards that has proven to be successful in that:

- HE is now well over halfway through and on schedule to complete an extensive programme of work on the DMRB
- the solution delivers the original recommendations for the DMRB review, i.e. future proofing for developments in technology and maintaining currency without the need for major rewrites
- it has improved the content and enforced discipline of drafting
- it provides a platform that that doesn't constrain future development and offers further potential benefits

The way in which HE is delivering the solution is unlocking the wider potential of the selected approach, i.e. digitised standards provide the platform for automated design – HE has developed its Rapid Engineering Model (REM) automated design solution, principally to support the SMART motorway programme but with potential for wider and powerful application – and in due course automated construction, as part of the vision for HE's Digital Roads programme.

The solution that HE is developing – the Technical Standards Enterprise System (TSES) – which has been developed as a machine-readable database has been widely and consistently praised throughout the consultation for this review as a far-sighted, strategic solution that places HE at the forefront of development and implementation of digital standards, a lead which is giving confidence to other, similar organisations to consider similar approaches themselves.

Continued development of this approach to exploit its potential is considered important, not only for the benefits to HE in supporting its digital roads programme and the development and operation of the SRN, but also for wider benefits that will accrue to other organisations, both infrastructure owners/operators and innovators who, with appropriate access to HE's machine readable databases, will be encouraged to develop further solutions that ultimately should drive further efficiency.

It is understood that a similar review of the Manual of Contract Documents for Highways Works (MCHW) is planned for RIS2 and that significant additional further funding from the IDF is being made available to support further development of the TSES.

However, the suite of standards and specifications that are owned and managed by Information Technology Directorate (ITD), i.e. the Traffic Systems and Signing Plans Registry (TSSPR), are not currently in the scope of the review and digitisation of standards that is being pursued by SES. Given the success of TSES, HE should consider reviewing the potential to address the ITD standards suite in a similar way, particularly as technology is one of the key areas of innovation and change to meet forecast usage demands where these cannot realistically be achieved through further expansion of the physical infrastructure asset.

Departures from standard

While the TSES approach has been widely praised, is proving to be successful and will deliver further benefits in the future, there continue to be frustrations raised in the supply chain about the current granting of derogations from standards - 'Departures from standards' - to accommodate proposals for change and innovation. It is recognised that the principle of being able to deviate from existing standards and specifications is a good one, but the current process can inhibit innovation. The principal concerns cited may be summarised as:

- The time taken and uncertainty of outcome are seen as a risk to proposing innovative solutions
- The need to re-submit departures for different projects/regions is cumbersome and discouraging

The TSES should provide a platform to support rapid change and approval within the standards system, however this needs to be matched by an effective governance system. The review and approval, or otherwise, of Departures is the responsibility of technical specialists within SES. HE has very recently released its updated '*Departures Manual*' (6) to provide guidance to these specialists and to support the updated Departures Approval System (DAS) which forms part of TSES. It is recognised, however, that developing sufficient confidence in a new approach for long life assets can be problematic; a long service life is required in terms of performance and value but waiting until this is proven in full would inhibit innovation (an approach to evaluating and managing the acceptance of performance risk is required - see 'Culture' below).

It is noted that the DAS enables more rapid production of information on the status of Departures Approvals including a regular (monthly) report on the most often requested departures to highlight priorities for consideration in terms of determining whether existing standards could usefully be reviewed. It also facilitates applying existing departures applications to further projects to address supply chain concerns about efficiencies in creating duplicate departures.

It is evident that HE is making good progress with significant and fundamental changes to the architecture of its standards systems that will allow these systems to support the timely implementation of change and innovation. The actual pace of implementation will, however, be largely controlled by HE governance, culture and practice in the use of the systems.

Case example: Warm-mix asphalt

Warm mix asphalt is a term which covers the use of production techniques, equipment and materials to produce asphalt at a lower temperature than the conventional processes. This has benefits in terms of improved safety and reduced energy requirements from working at lower temperatures but can also have operational benefits in that the installation time may be reduced.

Form the supplier perspective:

- One supplier alone has over 50 examples of use of WMA on the SRN dating back to 2014 but a departure is still required for each project where its use is proposed. The supplier has invested the technology, which is established overseas, and supported the proof of its performance on the SRN for what is now an extended period.
- On occasion the request for use of WMA is prompted by HE themselves, generally because of the operational benefits are recognised
- The departures process itself is a barrier to implementation, even where the technology is effectively well established and numerous identical or similar departures have previously been approved by HE, so the probability of a successful submission would be high.

From HE perspective:

- There is more than one process for producing Warm Mix Asphalt – the choice of process rests with individual suppliers. To date by far the majority of installations have been using just one of these processes.
- The outcomes from limited use of other processes has given HE some cause for caution.
- HE technical specialists would, in principle, be content to allow the use of the successfully proven process while retaining control of the use of the other processes through the departure approvals system, to the extent a draft document supporting this approach and presented in terms of Technology Readiness Levels (TRLs) has been prepared.
- However, it has been advised that, in terms of procurement, it is not possible to discriminate between processes (the final product is simply covered by a harmonised European standard which must be adhered to under the terms of the EU Construction Products Directive).
- Therefore, at present the requirement for a departure is retained, though in the majority of instances these will routinely be approved by the technical specialists as they have confidence in the principal established process.

Intellectual Property Rights (IPR)

From the stakeholder consultation there was no consistent view as to whether HE's approach to Intellectual Property Rights (IPR) presents an issue, however the fact that some respondents – all suppliers to HE of either products or services – expressed concern over this indicates that it may, in some instances, be a barrier to innovation. From the responses this appears to be most likely when working with organisations, such as Universities, where intellectual property is key to their services to a wider range of clients, and where suppliers have already invested in a development to give them a commercial advantage. It has been noted that there is generally a great willingness to share openly in the areas of safety and communications.

HE has recognised the potential issues arising from IPR but is constrained by its agreement with DfT and wider Government policy. The following reflects HE's current position and its actions to reach a solution with regard to IPR:

Intellectual Property Rights

HE's default position in the majority of its contracts is to own the IP. This is mandated by HE's Framework Agreement (Clause 9.12) with DfT where ownership of any intellectual property in contracts with third parties is assigned to HE.

- As HE seeks to engage and collaborate with a wider innovation community (universities, tech start-ups, suppliers, innovation agencies such as Innovate UK, individual innovators) this "one size fits all" approach is no longer fit for purpose.
- It can discourage potential innovators from engaging with HE and has led to long delays in agreeing research contracts with, for example, universities.
- HE has no written policy on the identification, protection and commercial exploitation of IP and a lack of expertise and resources in house to manage it.
- To address these challenges, HE has formed a cross Directorate IPR working group led by SES Innovation to develop HE's approach to IP, including mapping out a number of common IP scenarios.
- At the same time, HE is fully engaged with the current HM Treasury initiative on improving the management exploitation of knowledge assets, including IP, across the public sector. HE is starting to learn from OGDs e.g. MoD and NHS who have more fully developed systems in place to protect and exploit IP.

Culture

Consistency of approach

The work by SES ICI is delivering improvement but it is recognised that Highways England are on a “journey” and there is scope for further improvement and development. There is also recognition of the need to deliver change and address innovation in the wider business, i.e.

- Major Projects ‘Transformation Programme’ to coordinate the management and exploration of innovation; and
- Operations Directorate ‘Operational Excellence’ programme.

HE SES recognise that there is a need for communication to raise awareness and promote consistency of approach and is currently actively engaging with the other Directorates to achieve alignment and consistency of approach.

More strategically, HE SES recognises the need to define its role within HE and the terms and nature of its interaction with the other arms of the business. To this end it has recently embarked upon a ‘Fit for Future’ programme to identify, understand and address these issues.

Management of change

The changes in organisational culture and behaviours to support this integration need to be owned and led at Executive level within HE.

This will also apply in terms of leading change management to exploit innovations and changes in operations and delivery. It is likely that innovation will not only result in changes to the products, processes and systems employed by HE but also the skills needed by HE to deploy and operate these innovations together with the potentially different types of services purchased from the supply chain to support implementation and operations.

Risk

Risk may be considered under a number of categories including safety, commercial and performance. In terms of safety risk, HE has clearly stated that ‘Safety’ is its principal organisational imperative and it has robust clear procedures for managing this, i.e. GG 104 (5). HE Procurement are of the view that commercial risk can be managed with the supply chain provided appropriate contractual mechanisms and drivers are in place.

The issue of performance risk for innovations to long life assets is, however, less clear. For the purposes of innovation sponsored through the Innovation Designated Fund, HE has recognised the likelihood that not all innovations trialled will ultimately be successful and that up to 30-40% of the funding could be used on such projects while the overall programme may still be considered successful. This clear statement of ‘appetite for risk’ has been widely recognised and welcomed.

However, it is less clear what appetite for risk exists, if any, in the acceptance of innovation, from the full range of potential sources, into delivery and operational use. The key points where risk is likely to be perceived by HE are:

- Acceptance in delivery of a process or product by the relevant project manager in Major Project or Operations Directorates

- Acceptance in principle, to support proposed or planned implementation, the Departures to standards and/or incorporation within standards.

It is recognised that the latter point will be increasingly addressed by HE's move to presenting standards based on outcome rather than prescriptive requirements, though an element of prescription is often desired or necessary, particularly in relation to specifications.

Suppliers of innovative solutions will typically not be able to provide a medium to long term performance guarantee simply because the innovation has not been in existence for long enough. Currently there is little consistent guidance on how this performance risk could be evaluated and managed or shared; both supply chain and HE would benefit from a such a framework which would need to be flexible and cover not only a risk sharing mechanism but also how it is monitored, managed and mitigated.

The framework should include guidance and assurance for the relevant responsible staff to make clear HE's corporate appetite for this risk and empower managed acceptance of performance risk in a consistent way in order to drive the pace of implementation of beneficial innovation so that potential efficiencies can be realised and also to support the creation of an environment where innovation can flourish.

Principal findings

The principal findings arising from this review of HE's management of innovation and standards are:

- HE's role in shaping future policy for transportation and mobility, which is a significant change from the remit of Highways Agency, has given it the basis for longer term planning. This in turn allows it to identify changes needed and challenges to be addressed through research and innovation and, hence, provides the basis for HE's longer term strategy which is reflected in its '*Innovation Technology and Research Strategy*'.
- HE's vision for the development and operation of the SRN over the longer term, as expressed in '*Connecting the Country: Planning for the longer term*', provides further focus for the refinement of innovation and research goals. The five 2050 Vision themes presented in this document, i.e.:
 - Design, construction and maintenance
 - Connected & autonomous vehicles
 - Customer mobility
 - Energy and the environment
 - Operations

are valuable in aligning the innovation and research strategy with the overall business aims and the context for developing business cases for innovation and research. They also provide a framework to guide the deployment of the IDF.

- HE has shown strong commitment and made a positive contribution in high level cross-sector collaboration. In common with other similar organisations - i.e. DfT's Arm's Length Bodies (ALBs) such as Network Rail - there is scope for HE to develop this collaboration at an operational level and involve the, often common, supply chain in these forums.
- The improvement in engagement with a wider range of potential innovators, SMEs and start-ups in particular, arising from HE's development and implementation of its 'Innovation Journey' has been widely recognised and praised by client and innovation bodies as well as the innovators themselves.
- There is scope to improve the engagement of the existing supply chain, especially the lower tiers, and raise their awareness of, and access to, Highways England's resources and mechanisms to support innovation.
- It is recognised that the process for deploying the IDF has developed, but there remains scope for further improvement, for example in providing clarity of requirements for submissions and timely feedback
- The route to implementation for preferred innovations needs to be developed to give greater clarity and confidence to innovators, and hence further encourage the development of an innovative environment and culture with the supply chain, and also to assist HE in realising benefits quickly and efficiently. SES ICI recognises this and is planning to focus further development of its 'Innovation Journey' on this crucial phase with the development

of an 'Execution Plan'. SES ICI is also working closely with the principal delivery arms of the business, i.e. Major Projects and Operations, to ensure a consistent and compatible approach to the identification and development of innovation across the organisation to support its near and long term goals.

- HE recognises the importance of procurement and contractual mechanisms in valuing and promoting innovation from the supply chain and has reflected this in, for example, the procurement and operation of frameworks for the regional investment programme. It is, however, too early to judge the effectiveness of these developments.
- HE has responded to its protocol requirement to review the DMRB by developing a digital standards platform – the Technical Standards Enterprise System (TSES) – that has potential far beyond the immediate requirement and has enabled delivery, in process, of an improved, updated DMRB. The solution has been recognised and acclaimed as 'far sighted' and 'leading edge' and provides the foundation for the further development of HE's 'Digital Landscape'.
- The remit and scope of the TSES is limited to the standards owned and managed by SES. There is a significant tranche of standards that, as directed by the HE Executive, are owned and maintained by HE Information Technology Directorate and could be considered for a similar to review to ensure optimum support for innovation and change.
- Departures from standards are perceived as an issue within the supply chain; the process, time taken for a decision and uncertainty of outcome have been identified as inhibiting proposal of innovative solutions. The developments in TSES should provide a significantly improved mechanism for handling changes to standards, including the management of departures. However, the governance process can still be an issue, though updated guidance for HE staff (*'Departures Manual'* [6]) has been issued very recently.
- A key issue in the management of departures, and innovation and change more generally, is that there is no consistent framework for evaluating and managing risk of inadequate performance of innovative solutions for long life assets. Innovation and change inherently incurs a degree of risk and the time taken for complete confidence to be established through observation of performance on long life assets presents a barrier to rapid uptake of beneficial innovation. A managed acceptance of a degree of performance risk could, therefore, accelerate this process and consequently speed the realisation of potential benefits. The development of a framework to evaluate and manage the acceptance of performance risk and the empowerment of key individuals, e.g. delivery project managers and SES technical specialists, would support this approach.
- The RIS1 efficiency targets have proved a strong driver for innovation, particularly in operations, and while this was initially challenging, HE has responded by developing systems and tools to identify, evaluate and disseminate successful innovations.
- There is a strong recognition across HE of the need for a successful framework and approach to facilitate beneficial change and improvement for HE to deliver both its commitments for

RIS2 and beyond and also its vision for the future development and operation of the SRN.

This has resulted in separate initiatives across the Directorates, e.g.:

- Safety Engineering and Standards: Innovation Journey
- Major Projects: Transformation Programme
- Operations: Operational Excellence

It is recognised that the SES perspective is on longer term change while MP and Operations are more focussed on delivery and near-term development, and also that SES is actively engaging with the other Directorates to attempt to ensure consistency and compatibility of approach. It is however essential that the need for effective collaboration on innovation across HE is supported by senior leadership as, for example, close coordination will be required to ensure that adequate resource is provided by the business to sponsor potential innovations through development and trialling to implementation.

Recommendations

Based on the assessment of the information and evidence assimilated from the review, and the consequent findings, a number of recommendations have been identified.

1. Development of a route to implementation for successful innovation

While the 'Innovation Journey' has proven successful in the initial engagement with a wide range of potential innovators, there is a need to further develop and improve the latter stages of that journey, i.e. the pathway through development and trialling to implementation and adoption as 'business as usual' ; this is recognised by ICI SES and initial steps are being taken. A lack of guidance and, hence, some difficulty in navigating through HE's structure, process and supply chain arrangements have been reported by new entrants and SMEs. Further, HE needs to acknowledge and accommodate the particular challenges faced by SMEs and start-ups in supporting the development of their innovations e.g. the need to maintain a revenue stream and/or the need to be able to demonstrate progress to provide confidence to their investors.

HE should provide a clear path to implementation, recognising the various stage gates in the process and associated risks, to inform and manage the commercial expectations, decisions and development by innovators. The timescales for this process must be clear and well managed, with input and feedback aligned with the innovators need for pace of development and modification, though it is essential that the process is not configured or applied in such a way that it constrains innovation itself.

2. Establishment of an accelerator programme

To assist new entrants and start-ups in developing their offering for a new market or client a number of organisations in the transportation and mobility sector have established 'accelerator' programmes. These programmes are designed to give new suppliers an early insight in to and organisation's business objectives and processes, such as procurement and supply chain arrangements, in order to inform their approach to working with them and allow them to evaluate challenges and risks in the process. Establishing such a programme would support the development of the route to market in giving potential innovators greater clarity and confidence and would, alongside the IDF and innovation competitions, send a strong message both that HE is interested in supporting start-ups and, therefore, that such start-ups merit investment from private funders. HE could also benefit in learning more about how to work with start-ups and their requirements.

3. Further extend engagement activity

HE should look to build upon the success of its engagement around the 'Innovation Journey' by working with the existing supply chain, particularly the lower tiers, to raise their awareness of, and access to, Highways England's resources and mechanisms to support innovation. In addition HE should also consider extending its cross-sector engagement to the operational levels within the ALBs and by involving the supply chain in those forums.

4. Development of a performance risk framework to accelerate innovation on long life assets

There is currently no consistent framework for evaluating and managing risk of inadequate performance of innovative solutions for long life assets. A managed acceptance of a degree of performance risk could accelerate the uptake of beneficial innovation and, hence, realisation of

potential benefits. The development of a framework to evaluate and manage the acceptance of performance risk and the empowerment of key individuals, e.g. delivery project managers and SES technical specialists, would support this approach.

5. Extension of the standards review

In view of the widely recognised success of the SES TSES it is recommended that consideration be given to the need for review of the TSSPR to support rapid implementation of change and innovation, particularly as the information technology field is likely to be a key area for change and innovation to meet the longer term vision for the development and operation of the SRN.

6. Ensure consistency of approach and provision of resourcing to support development of innovation across HE.

HE is committed to supporting innovation and it is important that current efforts to ensure consistency and compatibility of approach across business are supported and championed by senior leadership. It is highly likely that the scale of projects being identified and developed as a result of the drives for innovation will demand effective coordination and collaboration across the whole of HE, particularly in the provision of adequate resource to sponsor these innovations through to implementation.

7. Ensure provision of support for resource investment

The development stages of research and innovation require significant resource input, as does the successful implementation and operation through the deployment of appropriate skills and services to support new or changed systems, products and processes. It is, therefore, important that HE's support mechanisms for research and innovation cover both resource investment (opex) and well as capital investment (capex).

More generally, it is recommended that HE should continue to build on the progress it has made since the start of RIS1 through the continuation of its current activities and programmes to support research and innovation.

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6. Departures Manual Rev.0. Highways England. February 2019.

Abbreviations

ALB	Arm's length body
ADEPT	Association of Directors of Environment, Economy, Planning and Transport
CECA	Civil Engineering Contractors Association
CSIC	Cambridge Centre for Smart Infrastructure and Construction
CWF	Collaborative works frameworks
DAS	Departures approval system
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
EB	Environmental barrier
HE	Highways England
HS2	High Speed 2
HTMA	Highways Term Maintenance Association
i3P	Infrastructure industry innovation platform
ICI	Innovation and continuous improvement
IDC	Investment decision committee
IDF	Innovation designated fund
IPA	Infrastructure and Projects Authority
IPR	Intellectual property rights
ITD	Information technology directorate
MCHW	Manual of Contract Documents for Highways Works
MoD	Ministry of Defence
MP	Major Projects
NHS	National Health Service
NR	Network Rail
NRTS	National roads telecommunications services
NTEC	Nottingham Transportation Engineering Centre (University of Nottingham)
OGD	Other Government departments
ORR	Office of Rail and Road
REM	Rapid engineering model
RIP	Regional investment programme
RIS	Road investment strategy
S&P	Strategy and planning
SES	Safety engineering and standards
SME	Small and medium-sized enterprises
SRN	Strategic road network
TfL	Transport for London
TIES	Transport Infrastructure Efficiency Strategy
TRIB	Transport Research and Innovation Board
TSES	Technical Standards Enterprise System
TSSPR	Traffic Systems and Signing Plans Registry
VfM	Value for money
VRS	Vehicle restraint system
WMA	Warm-mix asphalt

Glossary

For terms as used in this report

Arm's length body	Term covering a wide range of public bodies, including non-ministerial departments, non-departmental public bodies, executive agencies and other bodies, such as public corporations. For DfT this includes Highways England, Network Rail and HS2
capex	Capital expenditure, typically for acquisition, enhancement or renewal
Comparator organisations	Infrastructure owners/operators with similar remit to HE
Designated funds	Funds established under the RIS for HE "to improve the surroundings of the Strategic Road Network in a way that supports and protects people and the things we value for quality of life, both now and in the future". The 5 funds in the programme are: Air quality; Cycling, Safety & Integration; Innovation; Environment; Growth & Housing
External stakeholders	e.g. suppliers, research and innovation bodies that interact with Highways England
Information technology directorate	Highways England directorate
Internal stakeholders	Relevant functions/individuals within Highways England
Major Projects	Highways England directorate
opex	Operational expenditure, typically for resource or routine maintenance
RIS1	Road investment strategy for the first roads period (2015-2020)

RIS 2	Road investment strategy for the second roads period (2020-2025)
SMART motorways	Smart motorways relieve congestion by making the hard shoulder available for use by traffic through the use of technology to monitor and control traffic flow
Strategy and planning	Highways England directorate
Safety, Engineering and standards	Highways England directorate