Transport Priorities Review for UKRI Final Report

Prepared by Pragmatex and International Transport Experts Network (ITEN)

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May 2020
## Table of Contents

Executive Summary ................................................................................................................. 1

1 Introduction and Objectives ................................................................................................. 3

2 Our Approach ......................................................................................................................... 4

2.1 Challenge visualisation - Mind-Map .................................................................................... 4

2.2 Workshop ............................................................................................................................. 5

3 Findings .................................................................................................................................. 6

4 Potential Future Transport Challenge Areas – by Sector ....................................................... 7

4.1 Road Sector .......................................................................................................................... 7

4.2 Rail sector ............................................................................................................................ 11

4.3 Maritime sector .................................................................................................................... 13

4.4 Aviation ............................................................................................................................... 16

4.5 Crosscutting Themes .......................................................................................................... 18

5 SBRI as a R&D Procurement Mechanism ........................................................................... 23

5.1 Awareness of SBRI across Interviewees ........................................................................... 23

5.2 SBRI From Procurement Professionals’ Perspective ............................................................ 23

5.3 SBRI From the Delivery Professionals Perspective ............................................................... 24

5.4 SBRI Process and Competitions ......................................................................................... 26

5.5 Barriers to Innovation ......................................................................................................... 27

5.6 Summary of SBRI as a R&D Mechanism Findings .............................................................. 28

6 Draft Challenge Statements .................................................................................................. 29

6.1 CASE 1 - REDUCING NON-OPERATIONAL INJURIES ON THE RAILWAYS .................. 29

6.2 CASE 2 – DECARBONISING ROAD CONSTRUCTION AND MAINTENANCE ..................... 31

7 Recommendations ............................................................................................................... 34

7.1 Raise the level of awareness of SBRI across transport sector bodies .................................. 34

7.2 Highlight successes and support effective use of SBRI within the transport sector ............ 34

7.3 Address transport challenges ............................................................................................. 36

Annex A. Strategy documents reviewed .................................................................................. 39

Annex B. Personnel interviewed during the project ................................................................. 40

Annex C. Challenge statements completed during the workshop ........................................... 41

Annex D. Lessons learned from the project approach ............................................................. 42
Executive Summary

This short two-month project undertaken on behalf of UKRI had four key objectives:

1. Assess the level of awareness of SBRI across public sector transport bodies.
2. Understand the extent to which SBRI had been used within the transport sector and the benefits and drawbacks encountered.
3. Identify transport challenges that exist across all modes of transport.
4. Develop transport challenges from the information gathered, with at least two challenges developed in detail.

A series of interviews combined with desk-based research, and subsequent validation through workshops, identified a wide range of challenges across the transport modes. A hierarchy of challenges for all the transport modes has been visualised through a mind map that can be found at (https://mind42.com/public/655ca360-3518-45b6-9c9a-0b0b83e4c9fa).

From the research a number of key high-level themes emerged that were generic to all transport modes. These were: decarbonisation, air quality, digitalisation, and automation & autonomy.

Within each of these high-level themes the underlying specific challenges for the individual modes were often very different. However, a common challenge that came through was that data and access to data will play an increasingly important role in informing and improving the design and operation of transport systems for all passengers in the future.

From the research around the application and experiences of using SBRI within the transport sector, the findings were as follows:

- A number of procurement professionals and delivery partners that were interviewed for this study were not aware or did not fully understand SBRI as a mechanism for procuring R&D services, and its role in accessing new innovations.
- There were a number of pre-conceived misconceptions around the application of SBRI in terms of process and the steps required to procure the innovation developed through SBRI.
- Expertise and resources to develop challenge statements and conduct pre-market engagement across some organisations were limited and this area was highlighted as critical to ensure that the desired outcomes for projects are achieved.
- Conditions related to IP rights through SBRI was raised as an issue with regard to SMEs specifically - making SBRI appear less attractive to them and their investors.

Through the interviews it became apparent that many of the above issues could potentially be resolved through improved communications about the flexibility already permitted within SBRI. See section 5 for more details.
Key recommendations are discussed in section 7 and include:

1. **Raise the level of awareness of SBRI across public sector transport bodies**
   - Develop and update specific SBRI information, communications material, and case studies.
   - Create a focal point for SBRI leadership across Government - an individual or group identified within Cabinet Office or HMT with a mandate to promote the application of SBRI across central government and other public sector organisations.

2. **Highlight successes and support effective use of SBRI within the transport sector**
   - Provision of support for business case and pre-market engagement; coupled with guidance about the most appropriate delivery mechanism.
   - Develop the challenge statement approach discussed in section 6 into a guide for use during the competition development phase.
   - UKRI support at a local level (budget) to enable experts in this area to work alongside organisations and help to identify relevant research through Innovate UK data or the Innovation Nation initiative (which captures transport related projects), and embed the appropriate knowledge, skills and processes for challenge led competition development.
   - Undertake and document a review of best practice from across previous and existing challenge led competition activities within government organisations in the UK and globally.
   - Promote and raise awareness of the flexibility within the SBRI competition process to closely match the aims and objectives of client organisations. Highlight the options for commercial procurement through separate routes such as CCS SPARK innovation marketplace.
   - Address concerns over intellectual property. In the short-term, specific IP advice should be developed for UKRI SBRI run competitions with specific workshops on SBRI intellectual property issues run alongside the briefing events. In the medium-term, undertake a review of the intellectual property clauses to understand the perspective and scale of concerns of SMEs and their investors to SBRI IP clauses.

3. **Address transport challenges**
   - Conduct deep dives into specific transport areas to fully understand specific challenges and approaches that might be used to adopt these challenges. These should include:
     - Maritime – a high impact area specifically in regard to decarbonisation and air quality.
     - Freight - cuts across all modes with significant challenges around decarbonisation, digitalisation and transfer between modes and the departure from the EU.
     - Transport Hubs - Given the increasing focus around mass-transit a deep dive should be done around transport hubs.
   - Improve engagement with local authorities by undertaking a review of transport challenges at the local level and identifying generic, cross-authority challenges to support the case for a specific local authority fund. Develop an appropriate collaboration framework and forum for local authorities.
   - Identify and work with existing departments that already have significant R&D and or procurement budgets to see how SBRI can help address key challenges.
   - Undertake a review of business as usual activities (those large-scale procurements where significant budgets are spent repeatedly yielding limited innovation from the supply chain) to understand the applicability of SBRI to improve these activities.
1 Introduction and Objectives

Pragmatex Ltd and the International Transport Experts Network (ITEN) were appointed by UKRI to undertake a short two-month Transport Priorities Review. Our approach has been designed to assist UKRI in identifying transport sector challenges which could be addressed through innovation and specifically the use of the Small Business Research Initiative (SBRI).

SBRI is a process that enables public sector bodies to connect with innovative businesses, finding novel solutions to public sector challenges. It operates under the EU pre-commercial-procurement (PCP) legal framework; an approach that enables new ideas to be explored with the risks managed through a phased development programme running a portfolio of the most promising projects.

SBRI is challenge led, technology agnostic, and delivery focused. The approach provides opportunities for innovators to engage with the public sector, and the public sector to access innovative solutions to their problems. It leverages the public sector’s role as a ‘lead customer’ allowing organisations, and particularly SMEs to develop novel products and processes with confidence that a substantial market exists.

There is a clear separation between the SBRI process and the deployment of commercial volumes of end-products. SBRI helps identify the best possible solutions the market can develop. Commercial procurement of the final solution would be undertaken through established procurement routes.

The objectives of the project were to:

- Assess the level of awareness of SBRI and its potential benefits across public sector bodies including organisations such as Highways England, Network Rail, Department for Transport (DfT) and Department for Business Energy and Industrial Strategy (BEIS).
- Understand the extent to which SBRI had been used to address transport challenges within the public sector.
- Where organisations have used SBRI, understand benefits and drawbacks in using the approach.
- To undertake interviews with representatives from the road, rail, maritime and aviation sectors, as well as multi-modal stakeholders, procurement representatives and cross-cutting areas such as passenger experience and accessibility.
- Based on the responses, develop several challenge statements per mode.
2 Our Approach

The approach taken followed four key activities:

1. Desk research – review of existing literature published around overall transport strategy and policy and sector specific literature: more than ten documents were reviewed (Annex A. Strategy documents reviewed).

2. Interviews – face-to-face interviews, using a standard set of questions, with relevant representatives from appropriate government organisations and industry bodies: 39 interviews took place involving 46 people (Annex B. Personnel interviewed during the project).

3. Challenge visualisation – information from the desk research and interviews was collated into a format that enabled categorisation of challenges (See Section 2.1).

4. Workshop – findings were discussed and refined and some initial challenge statements were developed.

2.1 Challenge visualisation - Mind-Map

Given the breadth of the project and the potential for a significant number of challenges to be identified, a key issue was to develop a quick and simple way to visualise the challenges. A mind map (Figure 1) was chosen as the best way to do this as it provided a visual way to organise information and can show hierarchical relationships between information.

![Figure 1 Mind Map Level 1 and 2 Branches](image-url)
The key points and findings from the desk research, interviews coupled with the project team’s sector knowledge were collated within a mind map. This was broken down into sectors covering different transport modes: road, rail, maritime and air, as well as two further sectors: cross-cutting areas and procurement. Below, each sector high level challenges are identified (Figure 1), and these are broken down further into more refined/specific challenges to provide increasing insight into the underlying challenges (Figure 2).

The mind-map is available at https://mind42.com/public/655ca360-3518-45b6-9c9a-0b0b83e4c9fa.

2.2 Workshop

A workshop was held to validate the challenges, get stakeholder feedback and develop challenge statements. Unfortunately, due to the COVID-19 outbreak, which saw government begin to advise against all but essential travel, attendance at the workshop was significantly reduced from planned. Around 25 stakeholders participated representing all modes except aviation/aerospace.

Five facilitated tables covered each specific area of the mind map: road, rail, maritime and air, cross-cutting themes and procurement. For the purposes of the workshop, the mind map provided to delegates was capped at the Level 2 point to prevent leading the delegates into specific areas of detail. Two separate sessions were held. Session One provided delegates the opportunity to validate the findings within the mind-map, by confirming challenges, identifying challenges not present, or removing challenges that were not relevant. Delegates were given the opportunity to prioritise the challenges through voting.

Session Two focussed on the development of specific challenge statements within each sector. Due to the lower than anticipated attendance topics selected were those having the greatest interest to delegates present. As a consequence, areas selected in the second session were not always the top voting choices.
3 Findings

Challenge-led approaches that are technology agnostic could be used in a majority of these cases to develop solutions to these problems and SBRI is one of a number of mechanisms that can be used. In developing the appropriate business cases and delivery plans for each challenge, proper consideration of all the different mechanisms available should be made. Adoption of a mechanism that is suitable to the aims, objectives and desired outcomes should be chosen.

The findings have been split into two sections:

- Potential future transport challenge areas – by sector.
- SBRI as a research procurement mechanism.

The first section focuses on each individual transport sector road, rail, maritime and aviation with the cross-cutting theme looking at areas not categorised under those modes and cross-sectoral challenges. This section provides details of potential challenges that either already exist or are foreseen.

The second section focuses on SBRI as a mechanism, understanding the level of awareness across government departments and agencies, gaining insight in to how it has been used and the benefits and challenges that organisations have faced.
4 Potential Future Transport Challenge Areas – by Sector

An overview of the challenges in each sector is given below, with a number of potential challenges highlighted in tables at the end of each section. Note that further investigation is needed to assess their validity and justification for investment.

4.1 Road Sector

4.1.1 Decarbonisation and air quality

These were key themes from the interviews although, interestingly, they were not prioritised by workshop participants in their voting. Potential challenges are:

- For light electric vehicles, scale-up is needed in the provision of charging facilities. OLEV report vibrant innovation in this market and high take-up of matched funding competitions. Innovation to reach areas which are not commercially attractive to providers, such as: business models, tools for mapping demand for charging facilities, and approaches to incentivise take-up by different groups, may be appropriate.

- Different propulsion technologies are needed for different use cases, certainly for heavy vehicles where alternatives to battery energy storage are needed (also, potentially for different applications of light vehicles). Heavy vehicles are often leased. The already high lease costs and uncertain value of 5-year-old vehicles (when they are off-loaded into other, non-UK markets) are barriers to take-up. Approaches for retrofitting existing vehicles are, consequently, of interest.

- Solutions are needed for specific use-cases, including ‘blue-light’ vehicles (e.g. challenges of how to pump continuously for 4 hours using an electric fire engine and how to avoid the hazard and inconvenience of plug-in charging cables for ambulances at Hospitals), ‘yellow-light’ vehicles, public service vehicles and freight. Challenges include meeting the power requirements and finding the physical space for specialist equipment, particularly on electric vehicles where the volume occupied by batteries is an additional constraint. Re-designing the basic truck chassis was suggested, in which case it could be useful to identify areas of common need to make this more economic.

4.1.2 Safety (vision zero / safe system)

There remains a stubbornly high number of deaths and serious injuries on the road network and the downward trend has stagnated (little progress in 10 years). It was suggested that putting the basic challenge out to industry may generate new solutions.

- Tools to promote safe driving on rural roads, which typically have more challenging road geometries, patchy speed enforcement and limited funding for improvement, could be a good area of focus. Driver behaviour / compliance was a popular topic during workshop voting.

- New tools are needed for road authorities to implement a ‘safe system’ approach (the systematic identification and reduction of risk). These could make use of existing data sources and assessment methods and / or develop new approaches. A specific challenge is that economic prioritisation by the methods currently used - cost / benefit analysis or first year rate of return – does not attribute any value to the reduction of risk, only to the avoidance of injury. New approaches to value risk reduction are needed.
4.1.3 **Digitalisation**

Better approaches to modelling was a consistent theme during the interviews. Other themes were opening access to vehicle data through the CAN\(^1\) and systems integration. Also, there was considered to be a lack of specialist knowledge in highway administrations to understand the potential for data-driven innovation.

- A specific challenge is how to justify investment for future innovative transport scenarios, when evidence isn’t available to support their potential impact. Research is required to suggest what changes could be achievable/realistic (Evidence was provided of schemes being rejected as anticipated changes to transport modes could not be substantiated).
- Means of valuing a wider range of benefits needs developing (an example was how to value getting the 70+ diabetic age group out of their houses and on electric bikes).

4.1.4 **Autonomous vehicles**

CCAV were positive about opportunities for future SBRI competitions within their research programme. Within the timing constraints of this project, specific problem statements were not identified, and revisiting this through a more structured engagement with CCAV would be worthwhile. There is also a question over timeliness: identifying challenges that are suitable now rather than in 5 years. Potential areas of interest are:

- Defining an appropriate range of test conditions for vehicle sensors, e.g. considering rainfall events (wide range of intensity and duration) or fog (different to sensors compared with human perception).
- Security, including cyber security and how to ensure older autonomous vehicles remain safe to new threats.
- Providing rapid response to clear stopped (stuck) vehicles.
- Final 10m of journey for mobility impaired people if there is no human driver to provide assistance (see cross-cutting challenges in section 4.5).
- Making road infrastructure ready for autonomous vehicles (see physical infrastructure in section 4.1.5) and mitigating the likelihood of increasing congestion.

4.1.5 **Physical infrastructure**

This was a popular voting choice during the workshop. Potential challenges are:

- Appropriate infrastructure is needed to encourage innovation in, and take-up and safe use of, the expanding range of ‘personal mobility solutions’ that can support active, accessible and equitable travel. This includes pedestrians, cycles, scooters, mobility scooters, e-bikes and other small electrically-powered vehicles – both existing and new types. No specific areas were suggested for innovation, but challenges could be framed around the design of road space, for example moving beyond traditional segregation (footways, cycleways, highways) to promote safe and efficient use of shared space (including pedestrianised areas). The expected legalisation of scooters, for example, will present new difficulties for visually impaired people. Innovation could also be sought in the location, availability and functionality

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\(^1\) Controller Area Network: a protocol for data transmission by different electronic systems within vehicles. Typically, messages can be intercepted (e.g. via the standard on-board diagnostic socket) but cannot be interpreted, and hence used for new applications, without knowledge of the data protocol used by OEMs.
offered by supporting facilities (lighting, security, accessible toilets, secure parking, charging, lockers, etc.) to make use of these modes more convenient and attractive, in all weather conditions.

- Following from the above, autonomous vehicles can be considered as another type of user with specific needs. Challenges could be framed around making the roads readable to sensors in all conditions. Furthermore, considering the difficulties in introducing fully autonomous systems in a mixed environment, business models for the provision of dedicated autonomous environments could be explored. This would move on from deployment in a test environment to commercial service provision within an environment designed for automation, possibly for freight only in the first instance (easier safety case), and ultimately with human passengers. It could include new construction or repurposing of existing road space, in conjunction with new methods of road pricing.

- While not highlighted during the interviews, road construction and maintenance are traditional industries that are ripe for innovation. Challenges could be in introducing automated (i.e. robotised, not necessarily autonomous) equipment to improve safety (removing humans from hazardous activities) or improve construction quality. Economic and affordable solutions to potholes are also needed, as are low-carbon alternatives to asphalt (contributing to decarbonisation). Creating better models for prioritising maintenance on local roads was suggested as a challenge area although some work on this is already being carried out through the ADEPT Live Labs scheme. Reviewing the feedback for good quality but unsuccessful proposals for the Live Labs call may help to inform direction.

- There are opportunities to use the highway route to secure positive environmental outcomes and an interesting suggestion was to find ways of capturing the economic benefits of this (the example given was that maintaining wildflower verges reduces grass cutting costs). Reducing damage caused by de-icing salts is another potential challenge area.

- Challenges could be considered around more efficient use of the road capacity, including traffic management (how to capture and provide routing information; how to influence route choice), exploring benefits of co-location of services at rural mobility hubs (bus / rail / bike hire / drop-off points for deliveries / workplaces), and models that consider both people and freight movement in their optimisation. However, methods of preventing the released capacity being consumed by ‘more car’ are also needed.
### Title and underlying challenge

<table>
<thead>
<tr>
<th>Title and underlying challenge</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Widespread, cost effective deployment of on-street charging solutions for electric vehicles (scale up of EV charging provision may otherwise be limited to areas which are easy / commercially attractive to providers, with an inequitable societal outcome)</td>
<td>BEIS, Faraday</td>
</tr>
<tr>
<td>Retrofitting HGVs with alternative power systems to reduce CO₂ and other harmful emissions (determine under what conditions this could be feasible and commercially attractive, since the high cost and leasing arrangements are barriers to purchase of new, zero-emissions vehicles)</td>
<td>Workshop</td>
</tr>
<tr>
<td>Alternative power options for emergency service vehicles (address the power requirements for specialist equipment and high standard of reliability required)</td>
<td>Fire Brigade</td>
</tr>
<tr>
<td>Decarbonising road construction and maintenance (find low carbon / low emission alternatives in specialist areas, which can be energy-intensive, without obvious solutions at present, and where there is little tolerance to risk in the cost, timely delivery or quality of the finished product)</td>
<td>Faraday</td>
</tr>
<tr>
<td>Implementing a safe system approach – reducing risk of harm to road users (find affordable and publicly-acceptable solutions to stubbornly-high road casualty rates)</td>
<td>Road Safety Foundation</td>
</tr>
<tr>
<td>Widening take-up of active or low-energy personal travel options for journeys up to 5 miles (address fragmented ownership of the problem – health, social / behavioural, transport; central vs local government – find ways to encourage safe and efficient use of shared road space and, importantly, to reach wider demographics to promote behavioural change)</td>
<td>Independent Consultant</td>
</tr>
<tr>
<td>Business models, governance and safety case for implementation of fully autonomous roads for commercial service provision (investigate how constructing new / repurposing existing road space, exclusively for use by fully-autonomous systems with no driver present, could be achieved quickly, circumventing the challenges in full automation in a mixed environment)</td>
<td>Law Commission documents</td>
</tr>
<tr>
<td>Automating road construction and maintenance – increasing construction quality, removing humans from hazardous situations and reducing cost (address limited private sector investment in automation; the reasons for this need to be understood)</td>
<td>Project team</td>
</tr>
<tr>
<td>Trials of economically and environmentally sustainable approaches to road management methods (need to find solutions to improve biodiversity, etc., which also have a positive business case upon deployment and so will be taken up in practice. Challenge would identify new approaches, assess feasibility, demonstrate techniques and confirm the economic and environmental case)</td>
<td>Workshop</td>
</tr>
<tr>
<td>More effective management of available network capacity (needs new technology, which is flexible, interoperable and cost-effective, i.e. does not leave purchasers tied into expensive legacy systems)</td>
<td>Workshop</td>
</tr>
<tr>
<td>Effective hazard identification / warning for all-lane running smart motorways (address technical challenges in deploying systems to reduce risk associated with stranded vehicles)</td>
<td>Highways England</td>
</tr>
</tbody>
</table>
4.2 Rail sector

The rail industry is expected to publish its refreshed Rail Technical Strategy (RTS) in September 2020. A pre-publication version of the RTS was sourced and the five themes and immediate challenges within the RTS used as a reference. The RTS themes are:

- Low emissions railway – development of hydrogen and battery traction solutions as well as lower-cost electrification options.
- Data-enabled railway – improved data sharing and governance across the industry.
- Optimised train operations – development of connected driver advisory systems, traffic management systems and improved response to disruption.
- Easy to use railway – improved connectivity, better modal interchange, flexible ticketing and improved customer insights from data.
- Reliable and easy to maintain assets – remote condition monitoring of assets, use of artificial intelligence in asset management, automation of maintenance, and development of assets with improved reliability and lower whole life cost.

When discussing rail challenges with interviewees, the RTS themes were not mentioned explicitly so as not to constrain the discussion to the content of the RTS. Nevertheless, there was a good overlap between the challenges and priorities put forward during the interviews with the themes and short-term objectives of the RTS.

4.2.1 Decarbonisation

Decarbonisation was a recurring theme and there is significant activity within the rail industry to develop decarbonisation strategies and plans e.g. the Traction Decarbonisation Network Study and Decarbonisation Taskforce. Effort is principally directed to decarbonising traction power, since this accounts for approximately 80% of the energy used by the railway. The industry’s preferred solution for decarbonising the network is to electrify lines with overhead line equipment. However, the capex cost of electrification is high and currently cannot be economically justified for lines with low utilisation e.g. branch lines. Driving down the cost of electrification is a challenge and work has been carried out by the industry to explore this. In addition, some parts of the electrified network need power upgrades, due to increased power demands from newer trains fitted with air conditioning, wi-fi and at-seat power points.

Rolling stock assets are typically long-life assets, with a design life of 40 years. This makes it difficult for the industry to economically refresh the train fleet with cleaner traction technologies without prematurely scrapping rolling stock. The current aim is for no diesel-only trains to be on the network by 2040 and for net zero carbon by 2050 - that is only one train refresh cycle away. Development of hydrogen and battery technologies for traction power are seen as key technologies. However, the duty demanded by rail applications, especially freight applications, presents significant challenges to the adoption of these technologies in terms of performance and packaging. Light weighting of vehicles and improved regenerative braking have the potential to reduce the traction energy demand and improve the performance of hydrogen and battery-electric self-powered vehicles.

An emerging challenge for the industry is the adoption of renewable energy and how to make best use of railway land for the generation and distribution of renewable energy. Whilst solutions for buildings, such as stations, are
mature using renewable energy for traction power does pose a challenge in converting to 750V DC for third rail applications or up to 25kV AC for overhead lines.

4.2.2 Digitalisation

Digitalisation is a broad challenge for the GB rail industry. There are still parts of the industry which rely on paper-based processes to run and many of the industry’s digital systems are legacy and don’t communicate with each other. The result is a systems architecture with significant opportunities to digitalise and improve upon what is currently available. For example, more capacity for freight trains could be made available through optimisation of the timetable and better train scheduling.

A key enabler will be making railway data more available to the supply chain and there are already industry initiatives in place to open up railway data sets to developers. Data and information has the potential to transform many areas of the industry including the design, construction and maintenance of railway infrastructure, where there are significant opportunities for the use of digital tools in the design and simulation of the railway system. The Centre of Excellence in Digital Systems at the University of Birmingham which is due to open in 2020 could provide a useful focal point for the development of new digital design and simulation solutions for rail.

4.2.3 Asset Management

Much of the maintenance on the railway is either reactive or prescriptive with assets being maintained at defined intervals. In recent years rail has made increased use of remote condition monitoring for rolling stock and infrastructure assets. The challenge now is to use these remote condition monitoring systems to better predict failures and move to a more risk-based approach to maintenance.

When carrying out maintenance on the network there is a challenge with track access. Maintenance often requires a night-time possession of the railway to be established and this can take a considerable amount of time to put in place and release at the end of the maintenance. The effect is a drastically reduced working window, which at the extreme can mean only two usable working hours over a night. Improving the process of taking possession of the railway could increase the working time available and the adoption of automation and robotics in common maintenance tasks could improve output rates, allowing more to be done in the available time and work to be carried out more safely.

4.2.4 Capacity

The capacity of the rail network is limited by a number of factors including the number of tracks, signalling system, speed restrictions, level junctions and crossings. New in cab signalling technologies will increase capacity of the existing network, but further solutions are needed to reduce headways and increase the capacity of the existing network\(^2\).

In addition, there is a need to build new rail infrastructure in a cost-effective way to reconnect communities and improve connectivity across the network. Currently there is renewed interest in reversing some of the cuts to the capacity challenge may be a lower priority given the expected reduction in patronage of the railway following the 2020 coronavirus pandemic.

\(^2\) The capacity challenge may be a lower priority given the expected reduction in patronage of the railway following the 2020 coronavirus pandemic.
network that were made in the 1960s following the publication of the Beeching reports. Alternatives to mainline heavy rail standards and construction solutions are needed to deliver these projects in a cost-effective manner.

### 4.2.5 Potential Rail Challenges

<table>
<thead>
<tr>
<th>Title and underlying challenge</th>
<th>Source</th>
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<tbody>
<tr>
<td>Dynamic response to disruption so that services can return to normal more quickly minimising delays to passengers and freight.</td>
<td>Network Rail</td>
</tr>
<tr>
<td>Automated design of railway infrastructure e.g. signalling renewal schemes.</td>
<td>Network Rail</td>
</tr>
<tr>
<td>Rail system simulation and modelling to test and validate new products and operational concepts.</td>
<td>Rail Technical Strategy</td>
</tr>
<tr>
<td>Asset condition prediction and intelligent decision support tools for maintenance to reduce the whole life costs of infrastructure and rolling stock maintenance.</td>
<td>Rail Technical Strategy</td>
</tr>
<tr>
<td>Quicker, more efficient, railway possessions and smarter maintenance so that higher effective maintenance output rates can be achieved.</td>
<td>Network Rail</td>
</tr>
<tr>
<td>Automated construction and maintenance to increase maintenance output rates and remove ‘boots from the ballast’ and thereby improving safety.</td>
<td>Network Rail</td>
</tr>
<tr>
<td>Low-cost construction and maintenance solutions for lightly used rail lines allowing communities to be (re)connected with rail transport in an economic way.</td>
<td>Network Rail</td>
</tr>
<tr>
<td>Increasing the capacity of the existing railway system by removing infrastructure constraints and reducing train headways through improved train control and traffic management.</td>
<td>Network Rail</td>
</tr>
<tr>
<td>More energy efficient rolling stock reducing the overall energy demands of the rail sector and contributing towards net zero carbon targets.</td>
<td>Rail Technical Strategy</td>
</tr>
<tr>
<td>Zero emissions self-powered rail vehicles for use on lines where electrification is not economical.</td>
<td>Rail Technical Strategy</td>
</tr>
<tr>
<td>Lower-cost electrification so that more of the network can be electrified economically to improve operational performance and reduce carbon emissions.</td>
<td>Network Rail</td>
</tr>
<tr>
<td>How to affect a reduction in the incidence of suicide on the UK rail network?</td>
<td>Workshop</td>
</tr>
<tr>
<td>Environmentally sustainable, cost effective vegetation control for UK rail lineside?</td>
<td>Workshop</td>
</tr>
<tr>
<td>How to achieve low cost, renewable, power generation using railway assets, i.e. lineside renewable power generation for traction energy.</td>
<td>Network Rail</td>
</tr>
</tbody>
</table>

### 4.3 Maritime sector

#### 4.3.1 Decarbonisation

As with other sectors, decarbonisation was a key priority area for maritime: exhibiting many shared issues with aviation - most vessels travel long distances, so electrification is not an option except for near shore applications. In addition, the maritime sector is international, so potential alternative fuels will require widescale adoption to ensure that the refuelling infrastructure is available at both ends of the journey.
The International Maritime Organisation has a target to halve maritime emission by 2050, however, as shipping is forecast to double by then, the reduction would need to be higher.

Potential challenges include:

- Low or zero emission vessels in and near ports. Unlike long-distance travel, there is some potential to decarbonise vessels in and near shore and the port operations themselves. The carbon reduction, whilst beneficial, would be fairly minor in comparison with the emissions from long-distance freight, however, the main benefit would be for local air quality, in and around the port.

- Specific challenges include electrification of the port operations and ‘cold ironing’ (connecting ships to electric power in ports) due to the large energy requirements. This could be a particular challenge for smaller ports.

- Demonstration of the efficiency of solutions. Shipping is a conservative industry with low margins, and vessels are long term assets that travel long distances. As such, there is something of a chicken and egg scenario where ports won’t invest in zero emissions facilities until there are sufficient vessels to justify the investment, and there are no zero emissions vessels until there are facilities at the ports. There could be work undertaken to help develop a business case.

- The three large UK container ports (Felixstowe, Southampton and Thames Gateway) are all in the south of the country. There could be an opportunity to use small, low carbon vessels to take goods to smaller inland ports in other parts of the country. This would take lorries off the road, and due to the relatively short distances, batteries or other lower energy density fuels could be used. This could also help in ‘levelling up’ the UK economy by creating employment and business in deprived areas. A challenge is that there is a lack of certainty around freight flows within the UK as this data is held by freight companies, whereas the data for imports and exports is held by the Government.

- There could be opportunities for ports to produce hydrogen and/or ammonia to decarbonise shipping and potentially other modes - an opportunity to create value added operations at ports.

4.3.2 Digitalisation

Another priority area for maritime was the opportunities digitalisation could bring to the maritime sector. Shipping remains largely paper based, when transferring ownership of goods between parties. This lack of connectivity extends to the connection between ports and vessels.

There have been many solutions developed, but they tend to be bespoke, rather than common or interoperable. Many port owners and operators have invested in IT previously and have not reaped the full benefits of these investments due to the bespoke nature of the solution. Therefore, they are reluctant to invest again, especially given the low margin on port activities.

Specific challenges include:

- Consider case for blockchain to overcome the existing issues with paper-based systems and increase productivity.

- Smart ships so ports know where they are, and when they will arrive at the port. There is currently a lot of waste. However, with more connectivity, ports could have more efficient operations by having the ships arrive at the port at the optimal time for loading. This could mean for example, enabling a ship to
slow down and save fuel to arrive at a specific time, rather than turn up and wait to access the port. If there was autonomy of both the ship and port, this could be done earlier, further optimising the operation. Satellites have improved and mini satellites could make a big difference in achieving this.

- There is a challenge around ‘smart ports’, where most processes are digitised. This could be facilitated by a digital twin to test options. A specific challenge mentioned at the workshop was around better storage of cargo within ports. Due to paper-based records, there is slow or inefficient recall of where the cargo is and considering the complexity of the operations in and out of the port, the storage of goods is not necessarily optimised.

- A specific challenge raised in an interview was transferring to offshore windfarms, specifically getting the technician from the boat onto the turbine. Currently, the modus-operandi is to drive the boat at full power head on to the turbine to keep steady. This flawed solution is industry standard which is bad for the environment and bad operationally. There has been exploratory research as to whether an autonomous vessel could do this better.

4.3.3 Operations

There were several issues that fall into a more general, operational category. Specific challenges are:

- The potential of free ports post Brexit, coupled with a general desire to encourage value added operations to ports to raise the levels of productivity and efficiency, which have remained stagnant. There is a consultation document out currently considering options. There are challenges of streamlining port operations, and there is a desire to turn some ports into ‘hotbeds of innovation’, where innovative companies and technology start-ups could locate to develop solutions. This could potentially be a win-win as smaller companies have ideas that need testing. There have been incubation labs established in the rail and other sectors to achieve this. There is also a feeling that digitalisation needs innovation.

- Linked to the above challenge is a more general desire to improve efficiency for consolidation, assembly and distribution activities. As identified in the decarbonisation challenges, the potential for small ‘feeder’ vessels to take goods from large ports to smaller inland ports would not only improve air quality and free up space on the UK’s roads, but could also open up opportunities at certain locations.

- A specific point raised around port air quality, was whether certain ports, e.g. the Port of London could impose strategies and limits around this and whether a low risk trial/test case could be developed for this?

A general feeling from maritime was that they need: innovation to develop; demonstration to prove; and innovation to integrate technologies. The lack of money and investment are barriers, as the business case is not always that strong. In this sense, SBRI could be a useful tool to address a market failure.
4.3.4 Potential Maritime Challenges

<table>
<thead>
<tr>
<th>Title and underlying challenge</th>
<th>Source</th>
</tr>
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<tbody>
<tr>
<td>How to effectively manage port traffic to maximise freight throughput and minimise ship dock</td>
<td>IUK / Workshop</td>
</tr>
<tr>
<td>time (there could be scoped to increase productivity by improving how freight is identified,</td>
<td></td>
</tr>
<tr>
<td>transported and stored in the port environment)?</td>
<td></td>
</tr>
<tr>
<td>Renewable shore supply for (cruise) ships to minimise fossil fuel use whilst in dock (powering</td>
<td>CP Catapult</td>
</tr>
<tr>
<td>of large ships in port would significantly reduce local air pollution, however the energy</td>
<td></td>
</tr>
<tr>
<td>requirements are large, so there would need to be significant generation and storage capacity).</td>
<td></td>
</tr>
<tr>
<td>How to reduce the use of fossil fuels for movement of ships, goods and freight in and around</td>
<td>IUK</td>
</tr>
<tr>
<td>ports (improvement of air quality and reduction in greenhouse gas emissions through use of</td>
<td></td>
</tr>
<tr>
<td>electric / hydrogen / other low or zero emissions fuels to power port operations such as</td>
<td></td>
</tr>
<tr>
<td>cranes, trucks, tugs and other near shore boats)?</td>
<td></td>
</tr>
<tr>
<td>Reduction in road freight by more effective use of UK port capacity, in particular the use of</td>
<td>DfT</td>
</tr>
<tr>
<td>smaller ports (most freight arrives into 3 ports in the south of the UK, then gets transported</td>
<td></td>
</tr>
<tr>
<td>to other areas of the country. Some freight could be taken on smaller and potentially low/zero</td>
<td></td>
</tr>
<tr>
<td>emission, ships to smaller inland ports).</td>
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</table>

4.4 Aviation

4.4.1 Decarbonisation

Again, decarbonisation is a priority area, but has proven difficult to address due to the large energy requirements for commercial flight. There is also the view that, as aerospace is a competitive sector with big manufacturers who invest heavily in R&D, they will come up with solutions to meet the ‘carbon-zero by 2050’ target. Some challenges were identified as:

- Zero emission light aircraft, which are expected to be flying in 2025-2030. There is good potential for cross-modal collaboration in the use of H2 fuel since land modes are further ahead in the development cycle and the infrastructure is or could be common. Here, collaboration could save cost and accelerate deployment.
- Transitioning aviation is seen as problematic due to the long development time scales for passenger and freight vehicles. However, the introduction and use of electric or H2 airside vehicles (e.g. aircraft tugs) will be a useful step in providing the infrastructure for future wider deployment.
- Upstream activities bordering academic and commercial research such as aerodynamic modelling and engine science.
- Improvements in Air Traffic Control.

4.4.2 Security

Aviation is naturally a highly security-based sector, which is under additional stress due to the rapid development of drones and new aviation concepts. Challenges include:

- Air traffic control – there are lots more flying objects (drones, taxis etc.) and their deployment and integration needs to be managed properly. The regulators (CAA, NATS) could come together and get
involved in shaping innovation. There is also a cross-sector element to this as there is common ground on how to regulate for autonomy; CCAV have done work on this and NATS would be interested, whilst the rail sector could learn from recent air traffic control developments that have allowed planes to fly closer together. There was a feeling that regulators are resource-constrained and siloed so might welcome initiatives on this.

- Interoperability of different systems for making aircraft electronically conspicuous, by transmitting their position. There are a range of issues such as how big, what part of the spectrum they operate in, what range they transmit over, whether a receiver is needed in addition to transmitter. Existing solutions exist, but the ambition is for these to be interoperable / harmonised / standardised.

- A unified approach is required for traffic management of unmanned aircraft. For aircraft such as drones, this is unlikely to be via the same voice-to-voice instructions used for manned aircraft. More likely an aircraft will provide flight path info and the system will de-conflict this with other aircraft. The Connected Places Catapult is working on the specification and there are some emerging solutions. In addition to more work being required on the technical side, it is not clear what the market will look like, who pays or whether you will have a central system or distributed model to a common standard. Work on the market is required.

- Security – aircraft security screening is necessary to protect the safety of passengers but can be a frustrating and time-consuming process. New technologies and processes are in development, but it could be an area for further investigation to speed up and make the process less intrusive whilst maintaining or improving existing safety standards.

- Airport security: this is related mainly with the detection of firearms, explosives, narcotics in bags and in cargo. Specific challenges in the short term are related to the introduction of new technology to improve detection, both in terms of better detection and also speed of detection (i.e. improve speed of throughput for passengers passing through security):
  - Needs to work with existing systems with low false positives.
  - Integrate with current technology.
  - Technology must be updateable.

4.4.3 Public Acceptance

As with connected and autonomous vehicles, there is a significant challenge around public acceptance and consent. For new aviation models such as air taxis and delivery drones, there is an issue with acceptance and trust both from an issue of noise and potential intrusion / privacy from widespread deployment of these vehicles. Work on this is being investigated by future flight.

4.4.4 General

There was limited involvement from the aviation sector, and it was the only sector not represented at the workshop.

Partly, it was felt that SBRI is not a suitable mechanism in the aerospace sector as there is no public procurement in civil aviation except where it overlaps with defence. Aircraft require huge investment, with significant amounts being invested by industry and works mainly through the Aerospace Technology Institute (ATI). Large private sector organisations are in a ‘technology war’ and highly incentivised to innovate. Also, the costs and timescales are not consistent, e.g. developing new engines will take place over many years, whereas SBRI projects tend to
take place over months. There are not many SMEs in the sector as those with innovative solutions are quick to scale up or are bought by larger companies.

There is an interest in technology that secures UK share of the growing and high value aviation market, with skilled and highly paid jobs. High value areas include Rolls Royce engines and Airbus aircraft wings.

Some areas where SBRI may be more suitable is for the innovative, new and emerging aviation technology where BEIS is trying to shape the market in areas such as drones, flying taxis, VTOL, low emission and electric aircraft. These are expected to be operating within a decade with prototypes flying now. Commercial interest is likely to focus on air taxis in large cities, whilst the DfT’s interest is urban-rural or rural where there are gaps in connectivity.

BEIS has run several collaborative R&D programmes as long-term commitment is seen as essential to keep R&D and manufacturing in the UK. This has included:

- £150M/year for mid-TRL projects.
- Innovate UK-let future flight programme. £125M backed by industry.
- Accelerator programmes to encourage smaller companies. This provides more than R&D – it includes know-how on how to grow and scale up, plus introductions to bigger companies. The first cohort has just run, and it is too early to assess its effectiveness, but there is likely to be a second cohort.
- Innovation for small business programme £20M in 2 years. (National Aerospace Technology Exploration Programme).

### 4.4.5 Potential Aviation Challenges

<table>
<thead>
<tr>
<th>Title and underlying challenge</th>
<th>Source</th>
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<tbody>
<tr>
<td>Development of traffic management systems linked to commercial aviation systems that can detect and monitor small airborne vehicles i.e. drones.</td>
<td>BEIS</td>
</tr>
<tr>
<td>Development of new propulsion systems for air vehicles (of all sizes) to reduce emission by flying – ideally these will be zero emission propulsion systems.</td>
<td>BEIS</td>
</tr>
<tr>
<td>Detection of chemical threats in baggage (both hold and carry-on).</td>
<td>DASA</td>
</tr>
</tbody>
</table>

### 4.5 Crosscutting Themes

The interviews with sector leads and cross-modal stakeholders clearly showed that challenges in the transport sector often required cross-modal and/or cross sectoral solutions (e.g. enabling social inclusion requires co-ordination across housing, health and social issues along with transport solutions). Achieving behaviour change that could enable ‘modal shift’ (e.g. move away from cars, take up of micro-mobility options) and scaling up clean energy options (e.g. infrastructure for charging, battery manufacture and energy storage etc.) that contribute to key targets for the transport sector (reducing carbon emissions and congestion) were challenges that were seen as priorities.

The cross-cutting themes identified from the desk study, interviews and workshop were Energy, Modal Shift/Choice, Transport modelling and appraisal, Freight, Social mobility, inclusion and accessibility, Sustainability
challenges, Data, Planning for the Future and Security. The multiple levels of detail associated with each of the themes that were touched upon in the study are included in the Mind Map.

4.5.1 Modal Shift/Choice

This should be considered as not just away from cars and not just technological solutions but across the sector including greater use of public transport (rail and bus) as well as micro-mobility options; cycling and walking are seen as priority areas. The main challenges in this area related to:

1. **Understanding the risks of walking and cycling** is important as there are on-going changes in the provision and use of road space. The actual risks (e.g. from mixed traffic with pedestrians, cyclists, e-bikers, scooter riders etc, sharing road space, and all with different capability levels as well) and the risks as perceived by the users (e.g. from different interpretations of rights of way, different capabilities and travel speeds) are currently not clearly understood.

2. **Improving public transport** (greater reliability, security, resilience and customer experience) is a critical aspect of successfully enabling a change from the strongly embedded current ‘personal transport’ culture to shared transport. Specific challenges that were identified included:

   - **Health issues** – Reducing the risk of communicating infection within the public transport environment. This was seen as especially important during annual ‘flu’ epidemics, for people with compromised immune systems, those travelling to/from hospitals etc. (The current Corona Virus pandemic has clearly brought this into greater focus and can be expected to have greater importance once the post-lockdown return to normal starts).
   - **Automated & driverless public transport** – while there is potential for lower costs (e.g. 40% of the cost of buses and 50% of taxis is the driver), there are challenges in ensuring appropriate care for passengers with special needs (e.g. particularly those with impaired mobility).
   - **Accessibility and Equity** - Investments to improve accessibility should ensure that solutions address the needs of all groups (including young and novice users, older population) in different areas of the country and enable access to jobs, services, leisure etc.

3. **Role of emerging micro-mobility modes /Mobility As A Choice** is a fast-growing area with potential for increasing take up of alternative choices such as e-Bikes, scooters, mopeds etc. Specific challenges relate to addressing the legal and regulatory policies governing the safe use of these types of vehicles. There may well be a need for dedicated infrastructure in terms of road space, secure parking, charging as well as soft issues in terms of social and cultural acceptability. It is also important to ensure that any policy development and planning targets all users (not just the easy to target groups).

   There is also an opportunity to enable the appropriate environment to exploit the possible role of the personal, possibly autonomous, electric vehicles in healthy aging by encouraging mobility in middle age and supporting an aging population to remain mobile.

4. **Achieving behaviour change** was raised as one of the most challenging areas while at the same time critical to enabling modal shift as it is a key enabler for the transformational change in attitudes needed.

   - **One aspect**, move to ride sharing from the current preferred ‘individual’ travel space, was selected as a specific challenge and a challenge statement was developed (see Annex C).
• For new technology and processes to work and have the desired impact, they need to be designed around people’s needs and behaviours. This means that social and behavioural aspects should be considered in all competitions and SBRI competitions could provide the route to address the challenge of building capability in behavioural aspects. Some specific examples include decarbonisation (initiatives in all the transport modes will have behavioural angles, and both organisational and individual behaviours need to be considered).

4.5.2 Energy

This theme cuts across all the sectors in terms of the need for clean technologies (lowering environmental impacts and improving efficiency), alternative fuels from renewable sources and the business models that can support their implementation. Clean technologies and alternative fuels received a high number of votes in the workshop. Significant investment into research into these areas are already underway both in the UK and globally. For example, in the UK, the Energy Innovation Programme supports technological R&D, demonstration projects and trials of business models to bring the technologies close to market. There are, however, transport sector related critical challenges that require innovative solutions. One area that featured in a number of discussions was about ‘scaling up’ to meet the huge increase in demand.

1. Scaling up: Climate Change issues and consequent Government policy of phasing out petrol/diesel vehicles will significantly increase the move to electric vehicles and the development of battery technologies. This will require different solutions depending on the type of vehicles (e.g. cars and lorries, emergency vehicles, construction vehicles as well as micro-mobility vehicles) and locations (rural, suburban, urban, highly built-up areas with houses with on-road parking only).

Scaling up to meet huge increases in charging requirements across the transport network and the necessary infrastructure for the manufacture of batteries are specific challenges that require innovative solutions to meet the tight deadlines resulting from Government carbon reduction targets. This includes not only the technical solutions but also policy development as based on current understanding, scaling up can take between five to ten years after the policy decisions are made.

A range of solutions on the types of infrastructure (at different levels of complexity) will be needed as the choice of EVs for consumers widens and vehicles are parked for different lengths of time at home, at work, in station car parks, at the shops, hospitals etc, e.g. driveway charging, on street options, rapid charging (e.g. at ‘petrol’ stations, motorway service areas etc). There may be constraints due to power availability (e.g. on-street charging, peak power consumption periods). Different solutions may be needed for vehicle categories such as buses, taxis, delivery vans (e.g. wireless charging, overnight charging at depots).

The key challenge question with respect to batteries is “how do we secure battery manufacturing in the UK”? and ensure that the supply chain for batteries is based in the UK?

4.5.3 Data

There has been an exponential increase in the volume of data collected in the transport sector resulting from the increasing numbers of available tools and channels. There are still big gaps in the awareness of what is available, understanding the relevance of and any inherent bias in the data, accessing and sharing the data and how to get the most value from it. In terms of the current study a specific challenge that was highlighted was the collection and sharing of data both within the public sector itself and between the public and private sectors and its usage;

ensuring compatibility of data from different sources. One example given was of an opportunity to join traffic information systems between HE and TfGM that stalled as the business case was not justified to HE; this was essentially a problem of business cases being fragmented. Another key aspect of data sharing is understanding public attitude and acceptability of data sharing.

### 4.5.4 Transport Modelling and Appraisal

It is generally accepted that modelling and appraisal needs to be based on robust evidence, but it is also recognised that this can stifle innovation. At the same time, there are also situations where one has to deal with uncertainty and where evidence does not exist as yet; new approaches that support a move away from standard approaches are therefore needed to ensure that mandatory requirements do not stifle innovation and act as a barrier to the implementation of beneficial, transformative changes. Specific challenges that require innovative solutions are:

1. **Dealing with uncertainty and valuing wider impacts**: New approaches to justify investment when there is limited (or even no) evidence available about future, innovative transport scenarios (an example was given of a proposal being rejected because it was not believed that the planned changes to travel mode could be achieved). Research is needed to suggest what changes could be achievable and are realistic, as well as a means for valuing a wider range of benefits (an example was how to value getting the 70+ diabetic age group out of their houses and on electric bikes).

2. **Freight modelling, data and analysis**. Getting data around freight is not easy mainly due to commercial sensitivity. The limited information (e.g. movements and how ‘stuff moves around the country, modal split) adds to the difficulty of making long-term investment decisions in a market where the margins tend to be low.

### 4.5.5 Sustainability Challenges

Decarbonisation and Air quality improvements are being driven by Government targets and no project can go ahead unless the solution has a lower carbon footprint. This is being looked at within each of the transport sectors but there is an overarching problem for sectors/options where it is difficult to make a positive business case for a variety of reasons, such as e.g., low volumes (e.g. ambulances, fire engines), power issues (e.g. trucks), low margins (e.g. freight), current Standards etc. The fragmented nature of the industry also means that decisions that work in one area may not work in another, e.g. different Local Authorities require different solutions depending on rural /urban environments. At the same time, there is a need for solutions to be designed at a common level to avoid finding that things don’t ‘talk to each other’ once they are built. This links with the issues raised under the other themes, Data and Transport modelling and appraisal.

### 4.5.6 Social Mobility and Inclusion

This is an area where, despite efforts over a long period of time, a number of challenges remain. Effective provision of transport for all, particularly in rural areas, is continuing to be a challenge, with first mile / last mile (or even first and last ‘several miles) being ripe for innovation. This again is an area which would benefit from several of the earlier themes/challenges such as micro-mobility, innovative transport modelling and appraisal, understanding of behaviours, better data awareness and sharing.

### 4.5.7 Planning for the Future Transport System

This theme was identified in the workshop. There is a tendency to focus on making changes to the current transport system (i.e. based on ‘now’) when the real challenge is ‘How to design for the future’. It is important to
recognise that transport is only part of the solution and a systems approach considering transport, land use, housing, skills etc. is what is required. Challenges include:

1. Collective vision for the future & planning for it (evidence vs. unknown).
2. Changing perceptions (e.g. as autonomous vehicles become the norm, working practices change with greater automation etc.).
3. Climate change impacts (e.g. maintaining connectivity during increasingly more frequent flooding).
4. Resilient and secure transport infrastructure and operations.
5. Services acceptable and available to everyone, particularly in the future (with all the potential changes, known and currently not known).

4.5.8 Potential Cross-Cutting Challenges

<table>
<thead>
<tr>
<th>Title and underlying challenge</th>
<th>Source</th>
</tr>
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<tbody>
<tr>
<td>Aggregation of privately held transport, people and logistics data across modes, operators and users for infrastructure investment decision support tools (while the extent of data collected has increased significantly, data is not being used effectively and there is a need to enable better data usage, sharing between different owners and more smart management)</td>
<td>DfT</td>
</tr>
<tr>
<td>Encouraging positive modal choices through behaviour change (cultural factors (e.g. car ownership as status symbol) and influencing travel decisions; identifying the right incentives (&amp; disincentives where appropriate) to facilitate changes in travel habits to more sustainable and active options)</td>
<td>Workshop, IUK</td>
</tr>
<tr>
<td>Innovative solutions for transport modelling and appraisal to include wider socio-economic benefits (being able to evaluate options with incomplete data and dealing with levels of uncertainty in outcome, not just chipping away at risk; a systems approach where the impact on economy is measured understanding that transport is part of the solution)</td>
<td>DfT</td>
</tr>
<tr>
<td>Mitigating infection transmission in public transport / Providing safe environment (this can be important to encourage wider use of public transport by vulnerable groups (e.g. trips to and from hospital, in crowded carriages etc); in light of the current COVID-19 issues, this has increased in importance as people may move towards personal travel space with increased resistance to sharing travelling space with strangers)</td>
<td>CCAV</td>
</tr>
<tr>
<td>Options for responsive public transport services, urban, suburban, rural (Social isolation is a key issue, particularly in rural areas; loneliness is a difficult concept and it is difficult to find tangible solutions)</td>
<td>Monmouthshire</td>
</tr>
<tr>
<td>How to achieve low cost, renewable, power generation using transport infrastructure assets (Transport is the major contributor to CO₂ emissions; the infrastructure has significant potential to generate renewable energy (e.g. Solar and wind) that could be used to cover all the power needs of the sector, thereby significantly reducing environmental impacts)</td>
<td>IUK</td>
</tr>
</tbody>
</table>
5 SBRI as a R&D Procurement Mechanism

This section looks at capturing organisations’ use of SBRI (if any), and their learnings from doing so. The project identified the barriers to the use of SBRI from a general procurement perspective and tried to explore if SBRI could be utilised in more ‘business as usual’ type procurement activity.

5.1 Awareness of SBRI across Interviewees

Across the interviewee pool, the level of knowledge of SBRI could be categorised into one of following:

1. Detailed knowledge of SBRI and experience in using it.
2. An awareness of SBRI and its role to feed into the procurement mechanism.
3. No awareness of SBRI or its purpose.

Category 1, represented around 20% of the interviewees and were largely core Innovate UK people, plus agencies using SBRI to deliver innovation projects such as Highways England, Network Rail, Gov Tech Challenge and DASA.

There were a number of interviewees that fell under category 3, these tended to be highly specialised policy units within DfT, BEIS and maritime supply side organisations not directly involved in innovation delivery and DfT Commercial services. These represented approximately 20% of the interviewees.

The remaining 60% of interviewees had an awareness of SBRI as a mechanism and in many cases indicated that perhaps it was a mechanism ‘they should know more about’. These were largely Innovate UK sector leads or Government Department Policy or delivery leads. Once provided with some further information, during the interview process, many considered SBRI a mechanism they should find out more about to understand whether it could be used in their specific areas.

5.2 SBRI From Procurement Professionals’ Perspective

Within the pool of interviewees, there were a small number of procurement professionals included, these were from, DfT Commercial Services, Network Rail and Highways England. These common factors were observed based on individuals’ comments:

- Knowledge of SBRI across procurement professionals was generally limited and not a commonly recognised mechanism. However, some organisations had dedicated R&D procurement teams where knowledge and awareness of SBRI and alternate innovation procurement mechanisms was high.

- SBRI wasn’t referenced within existing procurement framework documents—this might be attributable to a failure to connect SBRI with pre-commercial procurement.

- A recognition that central procurement teams had a role to play in the promotion of alternate procurement mechanisms, but this was difficult if they were not aware of the full range of alternatives available and the contexts in which they may be applied.

- Organisations, such as Highways England and Network Rail, already using SBRI made the following observations regarding internal challenges they had faced:
  - Steep learning curve for procurement teams to understand.
  - Lack of material to explain and support the use of SBRI (including good case-studies).
Not easily identified within ‘procurement regs’ and as such wasn’t recognised as a ‘legal’ mechanism – linking to point above regarding understanding it is a pre-commercial procurement mechanism.

Organisations had used SBRI in the past but much of the learning lost as team members had moved on and knowledge was not embedded in the organisation.

Problems with central procurement often overcome by developing the specialist capability in dedicated R&D procurement teams.

Collaboration from IUK welcome in helping to optimise the procurement pathway.

5.3 SBRI From the Delivery Professionals Perspective

Interviews with people who had experience of using SBRI to help deliver innovation projects identified challenges in using SBRI as a delivery mechanism. These interviews included, Network Rail, Highways England, Monmouthshire County Council, Oxford County Council and the Emergency Services. Common positives identified were:

- It provided a way to introduce new players into a market without necessarily relying on the usual supply chain partners, and the risk of engagement was minimal.
- If there was early engagement with end-users during the development of the solution it was often the case that a solution was developed that met end-user needs.
- It could be used in a variety of scenarios to address both strategic and niche technical challenges; this was seen as a positive as it was a common mechanism that could be adapted to requirements.

Issues identified during the interviews are expanded upon in sections 5.3.1 to 5.3.5.

5.3.1 Budgets

A common issue was the availability of budget at different points in the lifecycle of the SBRI process:

- Outside of HE and NR, budgets for innovation and R&D were not always in place. This was particularly true for Local Authorities and other local government bodies/agencies where potentially quite significant challenges were being created due to regulatory or legislative changes, but no specific budget was available to either investigate or address the problems. It was often difficult to make the case for RD&I budget given already stretched resources within local authorities.

- Organisations often fail to account for their own time and resources in running or delivering SBRI projects or competitions. It was therefore common for RD&I to be seen as something that happens outside of the day job making it difficult to deliver.

- Whilst budget may be secured to either participate in or run an SBRI competition to find a solution, once complete there is often no immediate budget available for roll-out. This often leads to delays and the supply chain can begin to lose trust due to uncertainty around the purchase of the solution.
5.3.2 Route to Market

A common issue across all sectors was the issue of post competition procurement. It appears common place for SBRI to be perceived as a mechanism that can procure a solution rather than solely the procurement of R&D services. Whilst in some cases this was linked to budget point in section 5.3.1, it was usually more related to:

- At a late stage releasing the requirement to go through a further procurement process in order for a public body to purchase the solution. For some organisations this was interpreted as requiring a new OJEU process being required and therefore delay being built into the deployment process.

- The supply chain becoming frustrated as they thought there were direct sales at the end of the process and this additional stage had perhaps not been properly communicated or misunderstood within the original procurement documentation.

- The challenges being delivered often not meeting the end-user requirement. This was commonplace where challenges had come about from centralised bodies without specific involvement of end-user deliverers. As such the specific challenge had not been correctly understood and the solution developed didn’t necessarily address the actual problem. This issue stems from a failure to engage all stakeholders at appropriate stages within the competition development and pre-market engagement to identify existing products on the market, rather than a criticism of the SBRI mechanism.

5.3.3 Challenge Statement Development and pre-market engagement

Issues around the development of challenge statements and business case appeared to be an area that was difficult to undertake for a variety of organisations for different reasons:

- Business cases were often difficult to develop due to the early stage nature of the problem. People responsible for preparing business cases often had limited information available to them and did not usually have the necessary resources to fully explore and develop all aspects of the business case. This often led to poorly developed, incomplete business cases, where the full benefits of solving the challenge were not clearly understood.

- Experience of the process of challenge statement development was generally limited, with limited understanding and resources to develop appropriate challenge statements, the information required and the mechanisms through which this information may be found. Also, the ability to engage relevant technical expertise to assist in identifying particular technical challenges was limited.

- The benefits of solving the challenge did not accrue directly to the public sector body. With many public sector services outsourced to the supply chain it was often seen as the public sector service providers role to solve the challenge rather than the public sector itself. As such a commercial business case could not be made to support investment.

- Investment in multiple solutions – it was common for people to question why investment should be made in developing multiple solutions to a single problem. This appears to be a communications issue and is linked to the common mindset that SBRI procurement mechanism is buying a product. For SBRI this is not the case; what is being procured is the development of a solution and, as with any product development
there is a risk that the final outcome may not meet expectations. Within the private sector it is an accepted strategy to diversify risk in the early stages of product development by progressing a number of solutions through to a key decision stage. At which point a smaller number of more developed solutions are selected, based on their performance against the desired outcomes, and progressed. This private sector investment philosophy needs re-articulating into the public sector narrative to help explain the benefits of SBRI.

5.3.4 Procurement Specification

One commonly recognised issue was that procurement specifications were often solution led rather than outcome led. Some of the issues specifically around developing SBRI relevant challenge statements were:

- Lack of skills, tools and knowledge to properly identify the underlying challenge and developing the associated challenge statement.
- Lack of resources and tools to explore the existing marketplace to identify products and services already on the market.

5.3.5 Business as usual activities

Within the context of this project business as usual activities were classified as those large-scale procurements where significant budgets were spent on procuring the same product or service many times, over many years, but that perhaps did not satisfy current end-user requirements. An example might be a bolt fixing that has been purchased in bulk for many years without any change in specification but: they may be particularly heavy; and the workforce may be using more than 200 a day at remote locations. So SBRI could be used to explore whether there are more modern innovative solutions that provide an alternative fixing that might be lighter and/or cheaper and provide a better fixing.

There were no examples provided of SBRI being used in normal business as usual (BAU) activity. This has been attributed to:

- There was usually no incentive to change BAU activity, usually not included as part of R&D programmes.
- Often looked at as a straightforward volume and cost issue. Wider benefits of change are often not considered or even understood.
- In particular for high volume supplies, reliance on SME to provide necessary quantities can be difficult for large public sector bodies.

This was seen as an area where there might be significant opportunity for SBRI to make an impact and bring new suppliers and solutions to the public sector, but it would require education, a change in mindset and resourcing.

5.4 SBRI Process and Competitions

There appeared to be a general perception from those that had participated in the SBRI that the process was inflexible and had to be structured in a very specific way. Examples included the number of phases had to be 2 phases, the amount of money being awarded per project could not go above certain values and the number of
participants that could be progressed to the next stage. These misconceptions may be attributed to a lack of knowledge of the SBRI mechanism and the flexibility available within it.

Additionally, in some cases there appeared to be a disconnect between the competition evaluation and briefing, in particular around the interpretation and definition of innovation. Often feedback was received from bids into SBRI competitions in which the level of innovation within a project was criticised as being insufficient as it was a systems integration solution to the problem rather than a blue-sky research solution. This may be attributable to the use of standard documentation across all SBRI competitions and the guidance provided to both assessors and applicants not taking account of the specific objectives and outcomes desired by the programme and client. This could readily be overcome by tailoring standard documents with specific guidance bespoke to the objective of the competition. The SBRI mechanism does not prevent this and enables flexibility in choosing questions the respondent has to answer, as well as the weighting and criteria for evaluation.

Another theme within the competition process was Intellectual Property Rights (IPR). These are commonly an issue for SMEs and it has been suggested that clauses within the standard contract can be negatively viewed by investors. Better communication around the IPR clauses and the intent and principles behind them would be of value to increase overall engagement in the process. It can be common for different organisations to use their own contracts adapted for SBRI and the contractual wording of the IPR clauses may differ from the standard contract, but the intent and principles will remain the same. Therefore, a common approach to IPR and message from all government bodies utilising SBRI would avoid confusion and provide a consistent message to suppliers regarding IPR.

With respect to IPR there is a certain amount of confusion between the Innovate UK R&D Grant programmes and SBRI competitions. With many not recognising that SBRI is a contractual procurement mechanism rather than a grant scheme. Improved communication around SBRI should help to alleviate this misconception.

Finally, it was also recognised improved outcomes from the SBRI programmes may be achieved by earlier involvement:

- Of knowledgeable procurement teams during planning so that the route to final procurement of the solution can be adapted and developed as the competition progresses.
- During the competition planning process of Innovate UK, or other experts familiar with SBRI and challenge statement development, so that the competition scope is aligned with end user needs and open to novel solutions.

5.5 Barriers to Innovation

As part of interviews people raised barriers to both the development and subsequent implementation of innovation within their particular sector some of these were identified as:

- Standards – in particular where they are constructed around the way a product or service is currently delivered.
- Staff can be resistant to new ways of working that new innovations may bring with them upon implementation.
• Whole system thinking – it was difficult to identify people who have whole system overview of individual modes or the transport system as a whole. The complex structure of the transport sector meant that understanding how a new innovation may need to integrate into a particular mode or the transport sector was often difficult.

• Misaligned objectives and incentives – transport systems often cut across jurisdictional boundaries and involve many segmented public sector bodies. This often means that benefits may be realised to different organisations than those responsible for making investment decisions. This can often be a barrier as it is difficult to form the correct consortia to deliver and fund challenges and viable business cases may not be possible to secure necessary investment to solve the challenge.

The barriers identified above are a limited example of the many that exist in bringing new innovations into organisations. With particular regard to SBRI and challenge led procurement many of these barriers can often be addressed by identifying them early in the planning process and understanding what actions may be necessary to overcome them as the competition progresses.

5.6 Summary of SBRI as a R&D Mechanism Findings

In summary the findings above are varied, but there are some common themes across the sections these are summarised below:

• Awareness of SBRI outside of R&D procurement specialists appears to be limited development.

• There are preconceptions and misunderstandings of what SBRI is, how it can operate and be used and its limitations in purchasing a solution to a challenge.

• Business case and challenge statement development coupled with pre-market engagement is a critical area for good competition outcomes. However, this appears to be an area where there is insufficient resource within many organisations along with a lack of knowledge and experience to develop them.

• Misaligned incentives and benefits between organisations often meant that the value in solving a challenge did not lie with the organisation making the investment which can make it hard to secure investment.

• Budgets for RD&I were often limited within most government organisations and often these types of activities were viewed as something that must be done outside of the day job.

• Intellectual property is an area of concern and confusion, in particular for small companies and their investors. It is known that some small companies have not submitted bids to competitions due to the IP clauses.

• There appears to be a perception that SBRI is inflexible. Some of the comments appear to be directed at SBRI itself, whilst others appear to be directed towards the competition process itself.
Defining an appropriate and clear challenge statement is an iterative process, but vital, given its potential impact on the innovative solutions put forward. The following steps may help to develop a clear problem / challenge statement focused on function and performance (not on the solution).

During each iteration, increasing levels of detail are sought in each step to gain greater understanding of the specific challenges that underly the overarching problem. This iterative process is explored and applied in two selected case studies:

6.1 CASE 1 - REDUCING NON-OPERATIONAL INJURIES ON THE RAILWAYS.

6.1.1 Testing needs with end users and stakeholders:

In the UK, this problem is likely to be owned by Network Rail (the ‘lead customer’) who would assemble a team including policy, technical / delivery, and procurement experts to work with contractors. Other stakeholders might include DfT, Trade Unions, BTP, Samaritans, The Office of Rail and Road. The problem as described, excludes rail maintenance staff working on the network. It can be narrowed further to focus on certain defined challenges.

NEEDS INITIALLY DEFINED AS SOLUTIONS TO ADDRESS (I) INTENTIONAL HARM (II) ACCIDENTAL INJURIES (III) INTENTIONAL INJURIES AT LEVEL CROSSINGS.
6.1.2 Is it a strategic (policy) or operational challenge?

An operational challenge is typically narrow in scope and would be issued where there is a clear operational need. A strategic challenge may be preferable where there is interest in exploring a range of solutions and stimulating the market to provide novel solutions.

In this example the problem is operational rather than policy and the solutions generated may be procured by the funder (through a separate exercise) to make the railways safer. However, this operational example as initially set out is broad, which can make bid comparison harder. Breaking this down into a portfolio of themes in further iterations may assist.

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**THIS IS AN OPERATIONAL CHALLENGE – THEMES COULD BE APPLIED TO ENABLE BID COMPARISON.**

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6.1.3 Validation of an unmet need

A review of previous research (e.g. through Innovate UK funded projects database) can identify relevant activity and help to avoid repeat funding of similar solutions. Tools such as conducting an IPR prior art search, pre-market engagement or seeking input through a PIN can help to test the market and identify the capability and relevance of current technology.

In this example, background checks highlight related research on identified detection of unusual behaviour (precursor indicators) using video analytics, and placement of signs at key locations (e.g. Samaritans) that have been deployed. These current solutions have not had a significant impact on the underlying problem. An IPR prior art search and or pre-market engagement can also identify innovative solutions that are market ready.

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**THIS IS AN UNMET NEED.**

**R&D ON PREVENTING SUICIDE AND ACCIDENTAL DEATH ON THE RAILWAY HAS NOT YET YIELDED SIGNIFICANT REDUCTIONS IN KSI (KILLED OR SERIOUSLY INJURED).**

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6.1.4 Assess impact and priority

There are various tools available to estimate the potential value. These may assume a best and worst-case outcome or provide an indication of the total life-cycle costs, highlighting the advantages of quality innovations that may have higher up-front costs. This activity can feed into the business case (supporting investment decisions, project management, and post project impact assessments).

In this case, the delay and disruption from an injury or death due to trespass on the railway has a significant economic and social impact. There is also a human cost for the individual, their relatives, and all staff directly involved. Death by suicide represents more than 85% of all deaths on the rail network; as such, a focus on this specific challenge would have a greater overall impact.
6.1.5 Develop challenge statement

The Challenge Statement should focus on the problem to be solved (not the solution) and provide clear technology agnostic outcomes (function, performance and or efficiency). Barriers and incentives to deploy innovation may also be relevant in identifying the underlying problem and a challenge statement.

In this example the problem can be broken down into 5 main areas (1) Access to track (trespass – intentional or otherwise) is currently relatively easy at multiple locations along the rail corridor, (2) Approaching trains are comparatively ‘quiet’ making their approach difficult to detect by people, (3) ‘trap and drag’, (4) PTI (Platform Train Interface), and (5) ‘impaired judgement’. Barriers in this case include the fact that the full societal cost of injury and death is not usually borne by the railway, so limits incentives to improve; Deploying physical barriers across the network is currently too costly to roll out.

INITIAL CHALLENGE STATEMENT: REQUIREMENT FOR COST EFFECTIVE, NOVEL APPROACH TO REDUCING DEATH (INCLUDING SUICIDE) ON THE RAIL NETWORK. BIDS SHOULD FOCUS ON ONE OR MORE OF THE FIVE THEMES AND AIM TO DELIVER A MINIMUM 20% REDUCTION IN INDIVIDUALS KILLED OR SERIOUSLY INJURED ON THE RAILWAY IN RELEVANT SCENARIOS.

6.2 CASE 2 – DECARBONISING ROAD CONSTRUCTION AND MAINTENANCE.

6.2.1 Testing needs with end users and stakeholders:

This problem is likely to be owned by Highways England although other road authorities have aligned interests: Transport Scotland, Transport for Wales, Transport Northern Ireland, other regional and local authorities. Experts on construction processes and clean energy will be needed to shape the challenge. Other stakeholders include the supply chain involved, including: construction industry, aggregate producers, hauliers (of materials) and producers of specialist plant and vehicles.

NEEDS INITIALLY DEFINED AS SOLUTIONS TO REDUCE AND DECARBONISE THE ENERGY NEEDED FOR (I) PRODUCTION OF RAW MATERIALS (II) PROCESSING (III) TRANSPORT (IV) CONSTRUCTION ACTIVITIES.
6.2.2 Is it a strategic (policy) or operational challenge?

An operational challenge is typically narrow in scope and would be issued where there is a clear operational need. A strategic challenge may be preferable where there is interest in exploring a range of solutions and stimulating the market to provide novel solutions.

This is a strategic challenge where the current practices are well-established in the supply chain and there are significant barriers to innovation, which include the lack of obvious solutions and the scale of investment needed. Furthermore, the procurement of developed solutions is potentially hindered by market conditions, which are cost-competitive and with a low tolerance to risk in the quality or delivery of the supplied product. Consequently, a holistic vision needs to be developed together with a roadmap for delivery.

**THIS IS A STRATEGIC CHALLENGE WHERE ASSESSMENT OF THE FEASIBILITY OF OPTIONS COULD BE FOLLOWED BY CREATING A ROAD MAP FOR DEVELOPMENT.**

6.2.3 Validation of an unmet need

A review of previous research (e.g. through the Innovate UK funded projects database) can identify relevant activity and help to avoid repeat funding of similar solutions. Tools such as conducting an IPR prior art search, pre-market engagement or seeking input through a PIN can help to test the market and identify the capability and relevance of current technology.

Developments have occurred in some areas, e.g. the introduction of ‘warm mix’ (low-energy) asphalt and research into non-bitumen binders and alternative fuels. This has generated incremental progress in energy reduction but has little impact on decarbonisation. Consequently, whilst Highways England requires its supply chain to report on their carbon footprint, the industry has limited options to deliver reductions without substantial changes to its operations.

**THIS IS AN UNMET NEED.**

**ROAD CONSTRUCTION AND MAINTENANCE ACTIVITIES REMAIN BOTH ENERGY AND CARBON INTENSIVE.**

6.2.4 Assess impact and priority

There are various tools available to estimate the potential value. These may assume a best and worst-case outcome or provide an indication of the total life-cycle costs, highlighting the advantages of quality innovations that may have higher up-front costs. This activity can feed into the business case (supporting investment decisions, project management, and post project impact assessments).

Various energy-intensive activities contribute to the overall energy use, each of which is a potential area for innovation. Reviewing the whole-lifecycle outputs from carbon foot-printing tools combined with pre-market
engagement would help to establish the areas in which the greatest impacts are likely. Another aspect that should be considered is the potential risk around the future availability of bitumen for asphalt production.

6.2.5 Develop challenge statement

The Challenge Statement should focus on the problem to be solved (not the solution) and provide clear technology agnostic outcomes (function, performance and efficiency). Barriers and incentives to deploy innovation may also be relevant in identifying the underlying problem and a challenge statement.

The challenge is to reduce and decarbonise the energy requirements for any aspect of road construction and maintenance, excluding routine maintenance (such as road sweeping, grass cutting, etc.). This may be refined during subsequent iterations. Barriers to ultimate implementation should be identified so that realistic road maps can be developed following successful projects.

INITIAL CHALLENGE STATEMENT: REQUIREMENT TO ASSESS OPTIONS TO REDUCE AND DECARBONISE THE ENERGY NEEDED FOR ROAD CONSTRUCTION AND MAINTENANCE. PROJECTS SHOULD ADDRESS THE TECHNICAL CHALLENGES AND IDENTIFY THE REQUIREMENTS FOR FURTHER DEVELOPMENT AND IMPLEMENTATION.
7 Recommendations

7.1 Raise the level of awareness of SBRI across transport sector bodies

7.1.1 Develop and update specific SBRI information, communications material and case studies

Awareness of SBRI amongst some procurement professionals is limited and this is coupled with misconceptions and pre-conceived ideas about SBRI amongst delivery agents and partners engaging with SBRI. It is therefore recommended that a range of communications material and approaches is developed that should include:

a) Material specifically developed for procurement specialists that enables them to quickly understand how SBRI fits with existing procurement regulations and frameworks.

b) Engagement events for procurement professionals across the public sector to help them understand SBRI, gain insight into the barriers they face in using SBRI, understand how a dynamic procurement system such as CCS SPARK may be used to overcome hurdles in post SBRI procurement. Such a session could be used as the launch for the material identified in (a).

c) Material specifically developed for delivery agents and partners and end-users that clearly articulates the benefits of using challenge led approaches, highlights the different ways SBRI may be used and helps them to understand the procurement regulations that it operates under to facilitate discussions with procurement specialists.

d) A range of specific case studies developed from multiple sectors that focus on process and outcomes and highlight the benefits to end-users and suppliers.

7.1.2 Create a focal point for SBRI leadership across government

Ensuring that SBRI has the right level of support within central government could provide confidence across government departments to explore and use SBRI, and other innovative procurement mechanisms, more frequently. It is therefore recommended that:

a) an individual or group is identified within Cabinet Office, or HMT with a mandate to promote SBRI across central government and other public sector organisations.

7.2 Highlight successes and support effective use of SBRI within the transport sector

7.2.1 Provision of support for business case and pre-market engagement; coupled with guidance about the most appropriate delivery mechanism

Crucial areas in the development of challenge led competitions are the development of the business case and the pre-market engagement activity. Identification of the correct challenge question, understanding the benefits for all stakeholders and planning for the route to market are all necessary to ensure the desired outcomes from the programme are achieved. Developing robust challenges requires a skillset that may not exist currently within many public sector bodies. It is recommended that:

a) UKRI support at a local level (budget) to enable experts in this area to work alongside organisations and help to identify relevant research through Innovate UK data or the Innovation Nation initiative (which captures transport related projects), and embed the appropriate knowledge, skills and processes for challenge led competition development.
b) Input from a variety of sources is sought to shape the challenge: technical specialists should be consulted, in many cases including cross-cutting competencies such as data science, modelling, or social and behavioural research. End users at different levels should be consulted regarding ultimate implementation and reviews of existing research, previous trials and market conditions should be carried out to inform this process.

c) **Develop the challenge statement approach discussed in Section 6 into a guide for use during the competition development phase.**

d) **Undertaken and document a review of best practice from across previous and existing challenge led competition activities within government organisations in the UK and globally** and include:

i. Development of a best practice process for challenge led competition coupled with standard templates that can utilised by end-users.

ii. Identification of key information that should be sought during this development phase and appropriate tools and techniques for capturing this information.

7.2.2 **Promote and raise awareness of the flexibility in the delivery of SBRI competitions**

There is a perception amongst some that SBRI is inflexible, whether this be SBRI itself or the implementation of SBRI through Innovate UK competitions. The first of these can be addressed through improved communications as proposed in 7.1.1. The second can be addressed by making it clear that competition processes can be adapted and shaped to more closely match the aims and objectives of client organisations. To address the second point, it is recommended that:

a) **Promote and raise awareness of the flexibility within the SBRI competition process to closely match the aims and objectives of client organisations.** This might include:

i. The ability to adapt and change competition questions and bespoke them to achieve the desired outcomes.

ii. The ability to adapt and change the assessment process and criteria such that the project can achieve the desired outcomes.

b) Regarding the interpretation and guidance of what classifies as innovation for competitions, it is suggested that specific guidance to both assessors and participants be given around what constitutes innovation for specific competitions and be refined to ensure the objectives of the programme are met.

c) **Highlight the options for commercial procurement through separate routes such as CCS SPARK innovation marketplace.** SBRI is a pre-commercial tool to get new products to market but not to procure the end product. Where a public sector body wants to procure the end result it should ensure procurement teams are aware of the SBRI activity and that they can feed into it.

7.2.3 **Address concerns over intellectual property**

There is evidence to suggest that a key area of concern, especially for SMEs and their investors, are the intellectual property clauses within the contracts. However, the underlying reasons for these concerns are not fully understood. It is recommended that:

a) **In the short-term, specific intellectual property advice should be developed for UKRI SBRI run competitions** that sets out the position clearly and is published alongside or within briefing materials. In addition, **specific workshops on SBRI intellectual property issues could be run alongside the briefing events** to advise participants during the actual competition process.
b) **In the medium-term, undertake a review of the intellectual property clauses to understand the perspective and scale of concerns of SMEs and their investors to SBRI IP clauses.** Equally, to understand the perspective of the funding organisations for SBRI. This should also include reviewing whether the branding of Innovate UK is associated largely with grant funding and as such the perception amongst the supply chain is that SBRI is another grant funding mechanism.

c) Promote a common approach across government departments that use SBRI to ensure that all contracts have identical IP clause wording.

### 7.3 Address transport challenges

This project has only scraped the surface of identifying all the transport challenges and the potential benefits that might be accrued by solving these via SBRI. However, as reported in the Connell report, an NHS England study has shown that ‘growing deployment of SBRI funded technologies has a cumulative present value of benefits to the NHS between £349m and £482m by 2022 rising to between £1.2bn and £1.9bn by 2027’. These benefits have been achieved on an investment of £73m of NHS England SBRI funding since April 2014, giving a return on investment of between 4.8 and 26 times.

Specifically, within the transport sector to give an idea of the potential benefits that might be realised within the sector, in 2019 a report by the Asphalt Industry Alliance estimated that the total costs of repairing all Britain’s potholes was £9.79bn. This includes costs road repairs, car repairs and subsequent insurance claims. As such, if investment via SBRI into finding novel, cost-effective ways to identify and repair potholes could make a 20% reduction in overall costs over time this would equate to more than £1.9bn of savings. This is just one example from the transport sector.

To fully understand the potential benefits and scale of the challenges within the transport sector and to promote the use of SBRI to potentially solve some of these challenges the following activity is recommended:

a) **Conduct deep dives into specific transport areas to fully understand specific challenges and approaches that might be used to adopt these challenges.** These should include:

i. **Maritime** – this is potentially a high impact area specifically in regard to decarbonisation and air quality. The sector also has an important role to play in freight traffic but to date has had limited investment from government compared to investments in road and rail.

ii. **Freight** – whilst not a specific transport mode, the freight sector cuts across all modes and faces significant challenges around decarbonisation, digitalisation and transfer between modes and also the modal shift agenda. Alongside this there are also potential challenges to overcome with the impending departure from the EU.

In both cases the activity could act as a potential stimulus to promote and engage innovation activity in sectors where companies are often operating with low margins and investment in innovation can therefore be limited.

b) Areas that crosscut transport modes are particularly challenging due to the wide variety of stakeholders involved. **Given the increasing focus around mass-transit, a deep dive should be done around transport hubs.** This would help to understand:

i. generic challenges that exist for all transport hubs i.e. security, passenger volumes.

ii. specific challenges faced by specific transport-hubs.
iii. the specific stakeholder requirements and challenge owners.

Understanding and addressing such issues is likely to provide significant benefit to passengers and improve their customer experience and have application in new transport hub designs.

7.3.1 Expanding the application of SBRI in the transport sector

Given the 2-month duration of this project and the significant breadth it was asked to cover, there was limited to time to get into the specific detail of many of the underlying issues around the high-level challenges. The following recommendations are made in order to develop a larger number of challenges in more depth:

a) Undertake deep dives into the Marine and Freight sectors to better understand specific challenges in these sectors.

b) Better understand the challenges faced around transport hubs to help improve existing and future customer experience and improve operations.

c) Improve the engagement with local authorities by:
   i. Undertaking a review of transport challenges at the local level and identifying generic, cross-authority challenges to support the case for a specific local authority fund.
   ii. Develop an appropriate collaboration framework and forum for local authorities.

d) Identify and work with existing departments that already have significant R&D and or procurement budgets to see how SBRI can help address key challenges.

e) Undertake a review of business as usual activities (those large-scale procurements where significant budgets are spent repeatedly but yield limited innovation from the supply chain) within several transport related departments to understand the applicability of SBRI to improve these activities.

f) A specific piece of work should be commissioned to identify and develop emerging transport challenges related to the coronavirus pandemic and post pandemic recovery e.g. biosecurity on public transport, and increasing transport capacity under social distancing measures.

7.3.2 Opportunities for New Engagement

Local authorities face significant challenges with respect to innovation activity due to their limited budgets and the fact that challenges may be similar but there is no easy mechanism for them to collaborate in solving them. It is therefore recommended that:

a) A deep dive specifically around local authority transport issues is undertaken to identify generic transport challenges across local authorities and evaluate the potential benefits of solving such challenges.

b) A review of successful collaboration models is undertaken, and work is done with local authorities to develop a collaborative framework and forum to discuss, share and solve transport challenges. A successful model could be applied to other areas such as health.

c) Develop the case for a specific innovation fund for local authorities to address transport challenges.

Developing such a model could yield significant benefits through building stronger business cases and demonstrating a larger potential market to the supply chain.

Many existing departments either already have and/or are in the process of securing funding for future years’ activity. Specifically, CCAV indicated that they had potentially significant budget available to do R&D and would
be interested in support to understand how SBRI could be utilised to address some of their R&D challenges and support to help overcome CCAV internal procurement issues around delivery of money.

Business as usual activities funded through central procurement budgets represent a significant portion of government departmental spend. However, the scale of applicability and the challenges faced in applying SBRI to this activity is poorly understood. It is recommended that a review of this activity is undertaken across a number of transport-based departments within government to fully understand how and to what extent SBRI, or other procurement methodologies, might be applied to business as usual activities.
Annex A. Strategy documents reviewed

- Rail Technical Strategy
- Network Rail challenges
- Waterborne strategic research agenda
- TfL delivering goods by water
- Road Investment Strategy 2 Government Objectives
- Aerospace sector deal
- Energy Innovation Needs Assessment
- https://www.lawcom.gov.uk/project/automated-vehicles/
- FORx4 Cross-modal research roadmap
  - https://innovateuk.blog.gov.uk/2017/07/10/cross-sector-collaboration-is-essential-to-solving-innovation-problems/
- Local Council Roads Innovation Group https://lcrig.org.uk/
- Transport for West Midlands Strategy https://www.tfwm.org.uk/strategy/
# Annex B. Personnel interviewed during the project

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Specialism</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEIS</td>
<td>Aerospace, Automotive, CCAV, Energy, Rail</td>
</tr>
<tr>
<td>DfT</td>
<td>Accessibility, Aviation, Commercial, Freight, Highways, Maritime, OLEV, Research, Social / Behavioural, Transport Modelling</td>
</tr>
<tr>
<td>IUK</td>
<td>Aviation, CAV, Challenge Director, Connected Transport, Faraday Challenge, Land Transport, LEV-CAV, Maritime, Mobility &amp; Cities, NCP (H2020) &amp; Global Innovation Lead</td>
</tr>
<tr>
<td>Highways England</td>
<td>Highways England Innovation Project Management</td>
</tr>
<tr>
<td>Local authorities</td>
<td>Monmouthshire CC (Gov Tech Challenge), Oxfordshire CC (Future Mobility, Innovation Hub), Oxfordshire CC (Innovation Hub, Head of Innovation)</td>
</tr>
<tr>
<td>Maritime Industries</td>
<td>Chief Executive</td>
</tr>
<tr>
<td>MOD</td>
<td>DSTL</td>
</tr>
<tr>
<td>Network Rail</td>
<td>Commercial Director, Procurement Director, Programme Manager</td>
</tr>
<tr>
<td>Rail Freight Group</td>
<td>Director General, RFG</td>
</tr>
<tr>
<td>Other</td>
<td>Fire Brigade, Incremental Solutions (SBRI Fundee), Road Safety Foundation, Independent consultant, Transport Policy - Campaign for Better Transport</td>
</tr>
</tbody>
</table>
Annex C. Challenge statements completed during the workshop

Due to time constraints not all of the challenge statements identified during the workshop were fully developed. Table 1 provides a list of the challenge statements developed at the workshop for each of the five themes and their stage of development.

Table 1. Workshop challenge statements and extent of development

<table>
<thead>
<tr>
<th>Theme/Table</th>
<th>Challenge Area</th>
<th>Developed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail</td>
<td>Anti-suicide railway</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Innovative vegetation management</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Increasing ridership of the railway</td>
<td>No – included to capture the theme</td>
</tr>
<tr>
<td>Procurement</td>
<td>Route to Market</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rail - supply of components</td>
<td></td>
</tr>
<tr>
<td>Roads</td>
<td>Justifying investment in improving infrastructure for specific users</td>
<td>Yes – although emphasis has been changed to make it problem-orientated</td>
</tr>
<tr>
<td></td>
<td>Strategies for shifting car users away from roads</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>More effective management of available network capacity</td>
<td>Yes</td>
</tr>
<tr>
<td>Maritime</td>
<td>Better storage of cargo at ports.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>TradeTech</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Port decarbonisation</td>
<td>Yes</td>
</tr>
<tr>
<td>Cross-cutting</td>
<td>Behaviour Change - Ride Sharing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Planning for the Future</td>
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Annex D. Lessons learned from the project approach

- Significant effort was focussed on the interviews. A wide range of people were consulted, and the resulting input ranged from high-level challenges (such as decarbonisation) to very specific ones (such as pumping requirements for electric fire engines). Both are potentially valid for SBRI and this range of input enabled the mind map to be populated with multiple levels of detail.

- Many interviews identified other parties for consultation, in a snowballing effect. This was worthwhile and could usefully have been continued further, although there could be more efficient ways to gather this extended input, perhaps through sector or challenge specific workshops. Despite the number of people consulted, and their individual specialisms, it is arguable that we have not yet reached the detailed discussion that is needed to identify productive new SBRI challenges.

- Interviews were scheduled for between 30 minutes and 1-hour duration. Whilst in some cases this was sufficient time to discuss the challenges, for those with specific sector/challenge knowledge often this time was insufficient and further discussion would have been of value.

- Most interviews were conducted by video/tele conference whilst generally these worked it was felt that those interviews done face-to-face yielded better outcomes. This was largely attributed to the conversation being more natural especially were larger groups were involved.

- Depending on time availability an alternative way to enable constructive dialogue and capture innovation needs and challenges, might be to hold longer meetings with small groups of people from target organisations. These could be scheduled over a few concentrated days, e.g. IUK in Swindon and BEIS and various DfT departments and trade bodies in London. The remainder could be undertaken by videoconferencing.

- For those with little familiarity with SBRI (>50%), a lot of interview time was spent providing a description. This was positive in raising awareness of SBRI and several interviewees commented that the information was useful. However, the time ate into the interview slots and sending information regarding SBRI, e.g. a slide pack, in advance may have enabled this explanation to be shorter.

- The mind map was a useful way to capture an overview of the possible challenge areas across transport.

- The workshop structure and format were felt to be good, however the input received from the event was not as useful as hoped. This was partly influenced by the availability of people due to the COVID-19 outbreak. However, given the depth and breadth of each sector, an event for each branch of the mind map may have been more beneficial. Although this would require more time and resources, bringing in more specialists with a spread of relevant knowledge, may have generated more informed and more detailed discussion of the specific challenge areas, and a better quality of output.

- From the individual interviews, we found people with cross-cutting competencies such as social and behavioural research, and modelling and economic appraisal, who would welcome an opportunity to contribute to these discussions and whose input would be valuable. (An unexpected benefit from the interview process was the ability to put interested parties in touch with each other.) Such events would also be an opportunity to get specialist input on areas such as data or energy, where detailed knowledge is often outside the scope of transport professionals.

- IUK and to some extent UKRI is aligned to sectors and supply chain in which the UK Government is looking to grow and expand capability. As such, whilst they offer good reach in the majority of areas, in certain areas contacts and views were limited. Most notably this was true in the aerospace/aviation sector where the civil aviation sector i.e. airports, air traffic control etc. was difficult to penetrate as the focus of activity was on supply side aerospace manufacturers.
• Transport security did not appear to be major topic for discussion within individual modes. This may be due to the fact that responsibility for border security sits with the Home Office and therefore airport security is dealt with through them. However, for other modes such as rail and road there is no single entity that has responsibility for security of the rail or road networks.