National Infrastructure Assessment

Arcadis submission to the Call for Evidence

FEBRUARY 2022

About Arcadis

Arcadis is the leading global Design & Consultancy firm for natural and built assets. Applying our deep market sector insights and collective design, consultancy, engineering, project, and management services we work in partnership with over 1,800 clients across the world to deliver exceptional and sustainable results throughout the lifecycle of their natural and built assets.

We are 27,000 people active in over 70 countries that generate €3.3 billion in revenues. In the UK we employ over 4,000 professionals across 27 offices. We support UN-Habitat with knowledge and expertise to improve the quality of life in rapidly growing cities around the world. Arcadis' vision is to improve the quality of everyday life for all citizens.

Section 1. System-wide questions

Question 1: Do the nine challenges identified by the Commission cover the most pressing issues that economic infrastructure will face over the next 30 years>

We mostly agree with the challenges that have been identified by NIC. We support the NIC's shift in priorities away from the large-scale strategic transport network. In our view, this acknowledges that much of the strategic thinking in connection with the upgrade to the national network has been completed and that implementation is well underway. NIC should of course continue to monitor implementation to ensure that forecast future need is met. The decision to focus transport infrastructure considerations on the levelling-up agenda and emerging technologies is appropriate.

We have identified further themes that we believe that NIC should also examine.

Health and well-being. One area where we believe that NIC could place more emphasis is on health and wellbeing. This is very important to Arcadis given our long-term commitment to Improving the Quality of Life. Inevitably the NIA is focused mostly on large-scale economic infrastructure, where the 1:1 relationship between asset and user is less material to the investment priority. Other challenges, including those associated with water resource management and air quality will have a very important but again, indirect relationship with individual well-being. We would like NIC to consider whether there are aspects of infrastructure provision including Active Travel infrastructure, parks and natural habitats that through use have a direct relationship with health and wellbeing. The objective of the challenge would be to identify infrastructure needs in connection with a wider definition of economic activity and to encourage a debate on the investment planning of assets that do not necessarily deliver a positive return when assessed on BCR.

Reconstruct vs. deconstruct. In addition to the content of challenges 3 and 7, we recommend that NIA should introduce a challenge associated with the reuse and repurposing of existing assets and the design of new assets for long-term flexibility and adaptability. We anticipate that many assets will become obsolete in their current use as a result of changing performance regulations. These assets should ideally be considered as embodied carbon repository infrastructure which should be reused where possible. We suggest that the next NIA should include an assessment of the potential for asset reuse and an identification of the enabling steps required to support wider reuse.

Systems view. We are not wholly convinced that the NIC's nine challenge structure is the most appropriate response to the challenge of infrastructure planning. We acknowledge that it is necessary to impose a structure on the call for evidence. However, our view is also that the NIA should take into account the interconnected nature of much of the UK's infrastructure. We support the Infrastructure and Project Authority's 'system of systems' concept and urge NIC to align their thinking with the IPA framework used in

the TIP2 report[1]. An example of the systems thinking required is described by the links between hydrogen, building heat decarbonisation and the circular economy of construction waste associated with the demolition and recycling of obsolete buildings.

We anticipate that NIC will receive plenty of feedback on all of these linkages and more but might not have a structure to organise these insights. The system of systems approach will facilitate this.

In addition to these general points, we make the following observations around scope associated with specific challenges. Whilst we have answered using the NIC's structure, most of these requirements are cross cutting, further emphasising the value of a systems approach.

Challenge 3. Decarbonisation of heat. The scope is described as homes and business. The scope of the challenge should of course include the public sector. Our view is that the size and complexity of the public-sector estate requires particular consideration – for example, the complex nature of campus-wide retrofit in the health and education sectors. Furthermore, our view is that the decarbonisation market will operate differently in the public sector due to the operation of varying incentive and funding models. The NIA in connection with low-carbon retrofit should also account for the application of 'polluter pays' costs on the public purse.

Challenge 4. Networks for hydrogen and carbon capture and storage. In our view, the scope of this challenge should be expanded to include all networks that have a role in meeting net zero carbon. This should include transmission and distribution of electricity and gas as well as hydrogen etc. This will pick-up issues associated with availability of power capacity for the electrification of domestic heat and road transport, illustrating the value of the system of systems approach.

Challenge 7. Recycling capacity. The question is focused on the lowest level of the waste management hierarchy. As well as focusing on the physical infrastructure associated with end-of-life recycling, the NIA should also consider the wider infrastructure requirements associated with the full waste hierarchy, including a standards infrastructure or storage capacity, both of which are necessary to enable reuse, repair and remanufacture activities as outlined in the 10R model of circularity.

Challenge 8 – Urban mobility and congestion. We agree with the identification of the issue. We anticipate that the NIC will need to consider the role of shared mobility in reducing congestion and road use as well as mass transit. We have raised the issue of active travel infrastructure in our comment on health and wellbeing.

Questions 2 to 5 - We have not responded to these questions

Question 6: In which of the Commission's sectors can digital services and technologies enabled by fixed and wireless communications networks deliver the biggest benefits and what how much would this cost?

Our response also covers issues raised in question 7.

In our view, all of the operational sectors over which NIC has oversight will benefit from the more extensive use of digital technologies. Elsewhere in our response we highlight how real time data is supporting performance-based maintenance of the rail network and is facilitating and incentive-based traffic management system in the Netherlands. Given that the benefits of network-enabled digitalisation are near universal, our view is that digitalisation efforts should focus on where the networks are going to be installed and where there is an intersection with infrastructure services that support decarbonisation and resilience.

In our view, two current programmes illustrate the potential for the harnessing of existing infrastructure to reduce digital network installation costs whilst simultaneously creating opportunities to improve infrastructure asset performance:

[1] IPA, September 2021, Transforming Infrastructure Performance

- Network Rail's Project Reach initiative to lay new fibre along the 16,000km of the rail corridor. A technology partner is expected to be appointed in 2022. The fibre network will put in place the platform needed to facilitate digital railway implementation. This will support Network Rail's Intelligent Infrastructure ambitions for a more efficient and reliable rail network with increased capacity enabled by ETCS (European Train Control System). Project Reach will also support Project Gigabit by bringing fibre broadband connectivity through many remote areas

  Project Reach illustrates the synergies that can be obtained through system of systems thinking in connection with the integration of multiple networks, together with the benefits of having a clear technology route map for Digital Railway that facilitates investment.

- Fibre in Water (FiW). Fibre in Water is an early-stage competition managed by DCMS, examining the feasibility of running fibre broadband through existing water main infrastructure. This has the benefits of enabling extensive performance monitoring of water main performance, which will result in reduced leakage and ultimately reduced bills and carbon emissions. FiW will also facilitate the lower cost deployment of digital communications by simplifying the network installation, which will benefit hard to reach communities outside of cities. DCMS investment is aimed at addressing issues associated with regulations approvals and licenses.

  FiW illustrates some very real challenges associated with the integrated use of network infrastructure that NIC should consider as part of the NIA. The response to FiW is so far fragmented, with different water companies adopting different approaches to implementation, which complicates the strategic planning of national telecoms operators. This is an area where a system of systems approach to regulation and incentive design will facilitate a more effective and more economic digital network.

There are other opportunities for working across digital networks that could potentially support other applications. For example, the 4G emergency services network could potentially be used as the platform for Network Rail's FRMCS application when the current GSM-R system is upgraded at a later point in the 2020s

Both of these examples highlight that benefits from the digital infrastructure will be secured by sectors that are within the NIC's economic remit. However, benefits are secured in sectors outside of the NIC's remit including those related to social infrastructure including housing, healthcare and social care that potentially have a much greater pay back than that associated with the efficient operation of infrastructure. This point is very much in line with the IPA vision of Transforming Infrastructure Performance.

Furthermore, as home working or digital primary healthcare services will influence future patterns of travel demand, our view is that a wider view of digital services should form part of the economic infrastructure strategy. In this case, digitally enabled journey avoidance should be part of transport strategy.

In our view, NIC should make the case for a broader remit over the use of digital networks so that the full benefits of the basic infrastructure investment are secured. The most significant forthcoming development in digital networks will be the retirement of the copper network in 2025. This changeover should have a transformative effect with respect to the provision of universal digitally enabled services including telehealth.

Whilst most of the impact of the switch to copper will be in the domestic sector, which is outside of the NIC's remit, our view is that NIC should have a role in ensuring that the full potential of this one-off transformation in national networks is fully utilised.

Question 7 to question 12. We have not responded to these questions

Question 13: In what ways will current asset management practice need to improve to support better infrastructure resilience?

Challenge 5 sets the issue of asset management and resilience in the context of the environment and the wider impacts of climate change. We agree that asset management will play a key role in supporting appropriate investment in the physical resilience of infrastructure assets. We agree with NIC's focus on data and technology and our detailed response demonstrates data-led opportunities for improved resilience and asset performance.

Our view is that infrastructure resilience is concerned with performance across all aspects of the infrastructure enterprise, including operational, corporate and financial resilience.

We think that the NIC perspective might potentially be too narrow if the focus is on physical resilience alone. A well-developed and managed operational resilience programme will have positive impacts on other parts of the resilience equation, enhancing corporate resilience by ensuring that data is in place to support strategic requirements including risk management and resource allocation. Financial resilience can be also enhanced by a combination of improved asset reliability and performance and a reduction in the cost of condition-based maintenance activity.

Our response to this question is based on specific project experiences covering the development of an asset resilience data base in the water sector as well as the long-term implementation of a condition-based asset maintenance programme on behalf of ProRail, the body that operates and maintains the Dutch rail network.

Measurement and comparison of infrastructure resilience.

This project, originally undertaken with United Utilities in 2017[2] involved the development of a common asset management resilience metric focused on operational resilience.

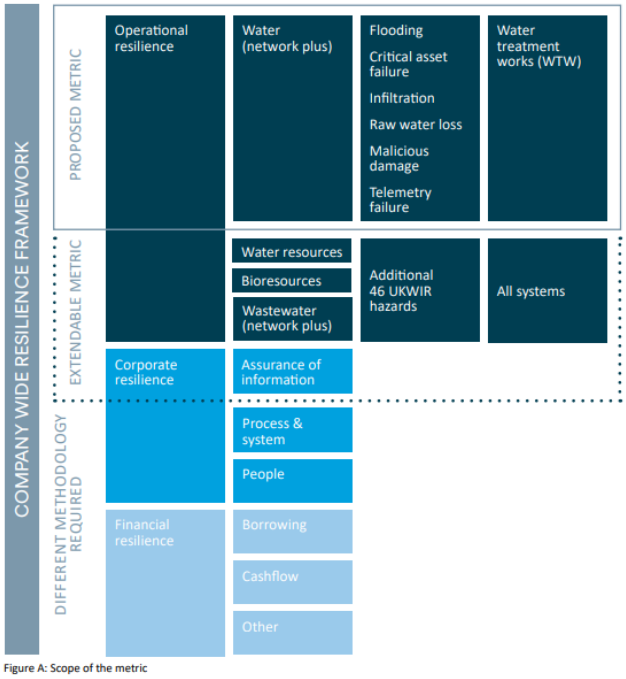
The UU initiative sets out to develop a resilience metric that is simple enough to be defined as an industry standard or benchmarking whilst being sophisticated enough to support a cross-portfolio comparison of relative resilience. The benefits of the methodology include the encouragement of performance improvement, the tracking of change over time and also the assessment infrastructure sectors' collective risk exposure.

The metric assesses asset specific resilience against six hazard categories including flood, critical asset failure and telemetry failure. Assets are considered at a relatively high level of aggregation – e.g., at the level of a Wastewater Treatment Works.

The methodology highlights the value of being able to compare resilience at a number of levels, including the customer view, taking into account the practical impact of single and multiple service interruptions. This approach reflects the local context of resilience challenges – helping to ensure the corporate ownership of the resilience plan. The detailed design of the metrics was also focused on the end customer. For example, the impact of individual asset failure events is measured through the number and type of customers affected. Similarly, the initiative also supported the development of the business plan response through support to the prioritisation of maintenance and replacement activity.

The enterprise-wide resilience model is set out in Figure 1.

[2] United Utilities and Arcadis. Measuring resilience in the Water Industry. (2017) measuring-resilience-in-the-water-industry_final.pdf (unitedutilities.com)



The diagram sets out the components of financial, corporate and operational resilience. The pilot work undertaken by Arcadis focused on wastewater assets

The assessment methodology also includes a direct link to critical resilience activities as described by the 4Rs of resilience, *resistance, reliability, redundancy and response and recovery* which are applied as control factors in the event of a hazard:

NIC's recommendations in connection with Asset Management practice should highlight the importance of the embedding of these activities within the core business functions of an infrastructure asset owner.

Figure 1. Overall structure of the infrastructure resilience model

As an illustration, the calculation of the operational resilience score is detailed in Figure 2

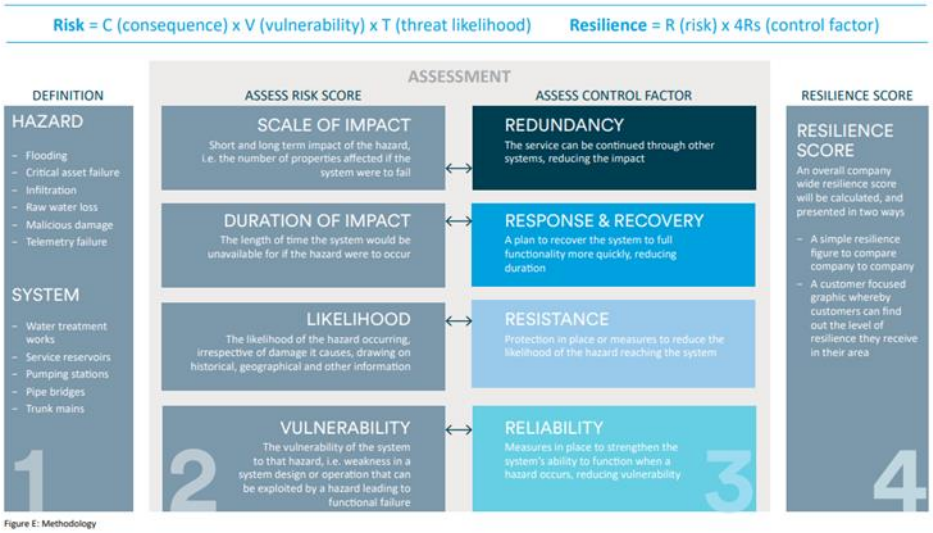


Figure 2. Outline of the assessment methodology at asset level.

Figure 2 communicates the volume of data required to support enterprise level Asset Management benchmarking. In the assessment, a weighted score for each risk event is calculated based on the severity of the hazard and the presence or absence of control factors. Collation of results for each hazard gives the single asset score.

For NIC, the relevant findings from the pilot study are:

- The critical role of resilience knowledge, including the need for minimum data standards,
- Current issues with the quality of data. Asset data is not generally trusted by owner organisations and as result, is not used widely as the basis for decision support,

- Automation. Technology propositions are available to support the transition to a more data-led approach, in particular the increasing availability of rapid data acquisition surveys. However, common benchmarking methodologies rely on the sector-wide adoption of data standards,
- Customer focus and resilience. The importance of the establishment of links between the utility and the customer in the resilience model – particularly links between events, customer experience, customer satisfaction, incentive models and revenue.

The methodology has subsequently been adopted by other UK water companies.

In the UK model of utility regulation, the link between asset data and regulatory incentives is currently indirect. The operator needs good quality data to complete their regulatory business plan processes but during the Control Period is not incentivised to develop good quality data. Arcadis experience is that regulators have not proactively promoted investment in asset data as an asset and as a result, opportunities have been missed to accelerate the development of more sophisticated asset models such as digital twins. As part of this phase of policy development, we would like to see NIC examine whether there is a case for asset data to be treated as part of the Regulated Asset Base for the purposes of promoting investment and regulatory scrutiny of what will increasingly be a high value resource.

Performance Based Maintenance

Our second evidence point is based on work undertaken by Arcadis in JV with contractor Dura Vermeer on behalf of ProRail, the Dutch National Rail Infrastructure owner operator. The JV, Asset Rail has a rail maintenance market share of 32% and is wholly responsible for the safe maintenance of over 2,000 km of railway, including track, signals and power supply.

ProRail introduced performance-based maintenance in 2008. The resulting changes in culture, process and innovation have delivered substantial performance improvements including:

- 50% reduction in the number of failures,
- 40% reduction in maintenance expenditure,
- 50% reduction in the mean repair time for urgent assets,
- 100% improvement in compliance aligned to more onerous contracts

These results are driven by a commercial framework that includes:

- Clearly stated safety thresholds,
- Powerful positive and negative performance incentives,
- Few prescribed procedures giving flexibility to the JV
- High levels of competition between four service providers working in defined zones.

The methodology is in the early stage of being piloted in the UK by Network Rail.

At the heart of performance-based maintenance is FMECA (Failure Mode, Effect and Criticality Analysis). This analysis links asset performance to the values and the priorities of the business. Whilst some priorities including safety are givens, others, such as timetable performance, might be given an enterprise-specific priority.

FMECA supports the capture of asset data and the understanding of failure modes and failure impacts using complex multi-variable analysis. Linking a dynamic model of asset condition to an understanding of criticality enables a dynamic (e.g., need-driven) rather than cyclical approach to maintenance activity which has resulted in the performance improvements measured by ProRail.

Insights that are relevant to the call for evidence include:

- The move to a data-led, condition-based asset management is a significant change that challenges management and supervisory practice,

- The approach must be adapted to the industry and business type,
- Privatisation of maintenance delivery is not necessary for the successful implementation of performance-based maintenance. However, the performance incentives are very effective in driving response times and innovation,
- Data quality and data utilisation issues are material change considerations
- National and regional organisation structures have a material impact on the pace of change adoption.

Question 14:We have not responded to this question

Question 15: What is the likely environmental impact of waste streams from construction across economic infrastructure sectors, over the next 30 years, and what are the appropriate measures for addressing it?

Our response to this question is informed in part by the work of the Green Construction Board and Construction Leadership Council in connection the development of a zero-waste construction sector.

UK construction is responsible for approximately 110 million tonnes of non-hazardous waste each year. Approximately 50 million tonnes comprise demolition waste, 10 million tonnes comprise general construction waste and 50 million tonnes is related to excavation work.

Construction waste

As energy efficiency measures take effect, it is also foreseeable that volumes of construction demolition will increase as buildings become obsolete and are taken out of use. Without regulations and other incentives to encourage the reuse of building shells, owners may choose either to demolish buildings or redevelop with a modern, net-zero equivalent. This is closely related to the reconstruct vs. deconstruct issue highlighted in our response to Q1.

The vast bulk, over 90%, of construction waste is recoverable, mostly in the form of basic materials for reuse including fill and hardcore. If new build construction volumes fall over time, then the balance between waste material production and reuse may be altered. Regulatory intervention associated with inert waste disposal may provide a mechanism to manage these flows.

One aspect of demolition waste that will have additional environmental impacts which we wish to highlight is the growing volume of hard-to-recycle composite materials. Recent building safety scandals have brought to light the large volumes of composites used in the construction sector, requiring either landfill disposal or potentially a complex incineration process. The disposal implications of complex materials are likely to grow over the next 30-years given the scale of innovation that has been driven by a combination of the energy efficiency agenda and a continuing drive for component efficiency. The NIA should take account of these developments in the waste stream.

Soil management and excavation

The remainder of our response is focused on the appropriate management of soil and sub-soil waste derived from excavation. Soil is the biggest terrestrial store of carbon and is a valuable bio-diversity resource. With 30% of the world's soils in a degraded condition, soil is also a scarce resource.

Environment Agency data[3] records that in 2016, 28 million tonnes of soil, nearly 50% of the total excavated in urban areas was disposed in landfill. Losing soil in this way means we are also losing soil ecosystem services such as carbon sequestration, above and below ground biodiversity and the water holding capacity of the ground.

Our experience is that excavation operations are often not planned with soil resource management in mind and that as a result, valuable of topsoil and subsoil resources are potentially wasted. However, the reuse of

[3] Environment Agency. State of the Environment: Soil (2019)

soils requires expert input. There are over 700 different soil types in the UK. Careful matching of excavated materials with a planned requirement, whether agriculture, playing fields or a species-rich nature habitat, will give better results, making best use of the soil resource and supporting an enhanced biodiversity outcome.

What is required is a national soil management culture and planning process that matches available soil to fill requirements. Encouraging these transactions on an exchange platform rather than as an ad-hoc arrangement will facilitate better use of a scarce resource.

Question 16: What evidence is there of the effectiveness in reducing congestion of different approaches to demand management used in cities around the world, including, but not limited to, congestion charging, and what are the different approaches used to build public consensus for such measures?

Recent work that Arcadis has participated in the development of congestion zone proposals for San Francisco highlights how few exemplars there are available for the assessment of the effectiveness of in-city congestion charging. We assume that NIC has plenty of insight derived from the well-established London and Stockholm schemes and accordingly have chosen to focus on our experience of the development of an alternative demand management approach for Rijkswaterstaat, the government agency responsible for the strategic road network in the Netherlands.

Positive incentives and traffic demand management

The overall travel demand approach, *Minder Hinder* can be translated in English as 'less nuisance'. Minder Hinder is a seven-part programme designed alongside Rijkswaterstaat's 10-year road investment plan. Funding for the plan was conditional on the development of targets and plans to minimise congestion and travel time growth. The programme succeeded, meeting performance targets and delivering a positive BCR in part because some of the measures result in permanent changes to driver behaviour.

There is a specific element of the Minder Hinder approach which is very relevant to the NIC call for evidence which we describe below. Specific lessons learned from the Minder Hinder programme are:

- The importance of political engagement to force the change in approach and to provide public leverage as necessary,
- The role of up-front investment in measures – typically costing 5-20% of the overall budget of an enhancement scheme,
- The role of behavioural change in addition to more typical activities associated with smart planning and construction, traffic management and communication.

Spitsmijden, 'rush hour avoidance', is an integral part of the Minder Hinder approach, demonstrating a different approach to demand management based on positive incentives. Drivers are rewarded if they change their behaviour by avoiding periods of peak traffic volumes on designated stretches of road. We outline below how Spitsmijden works and details of impacts.

Spitsmijden has been applied in the Netherlands and Sweden. So far, the system has been implemented in the Netherlands 15 times on projects adopting the Minder Hinder methodology. Spitsmijden is a temporary intervention, but it has permanent impacts – a vital insight for the NIC.

The key components of the scheme are:

- Application of data intelligence to identify the most regular commuters using ANPR as the data source,
- Direct recruitment into the programme of volunteer qualifying regular commuters
- An incentive payment in response to a recorded changed behaviour on each qualifying journey
- Voluntary participation with the tracking of driver behaviour using ANPR. Changed behaviour such as a re-routing or delayed journey triggers an incentive payment. Mode switch or a decision not to travel also triggers a payment

The results of applications are impressive. In a recent application associated with upgrades to the Rotterdam Orbital Highway, the scheme attracted 23,000 participants from a population of 100,000 invitees. Typically, 4,700 scheme members took action to avoid peak period travel each day and were paid €3-4 per avoidance. This equates to 0.47 avoidances per member per day. As a result, 2,300 lost hours were avoided over 10 months. The effect of Spitsmijden on peak travel levels was to reduce them to levels typically more associated with holiday periods. The behaviour changes recorded are as follows:

Retiming journey	40%
Reroute journey	20%
Change journey mode	28%
Cancel journey	12%

Table 1. Results from Rotterdam traffic management programme

The net BCR of the scheme in year 1 was 0.6 to 0.7. After 10 years, the BCR is forecast to be 1.7 to 1.9 due to permanently changed behaviours following the withdrawal of the cash incentive.

Valuable insights from the implementation of Spitsmijden include:

- A cash incentive is much more effective than an in-kind offer such as travel discounts.
- The more freedom the driver is given to select options, the more successful the incentive is.
- Recorded benefits include time savings, travel distance reductions, improved journey reliability, better air quality and noise levels, improved safety and incentivised modal shift
- The net effect of the scheme was reduced by 50% as a result of induced demand following reduced congestion

Question 17: What are the barriers to a decision-making framework on interurban transport that reflects a balanced approach across different transport modes?

Arcadis has been involved in the development of a Mobility as a Service (MaaS) pilot for the Highlands and Islands. These insights are informed by our work on HITRANS and other multi-mode transport systems.

In our response, we assume that the decision-making framework is primarily for the benefit of the user, albeit we acknowledge that platform-based approaches to mobility management give providers significant benefits associated with demand data and so on. Key barriers that we have identified include:

Access to data. This is well known as an issue associated with deregulated bus markets but also is a significant challenge in locations such as the Highlands and Islands where shared vehicle use is a more relevant mode than mass transit systems. Data sharing is also a well-known issue associated with shared mobility providers. Decision-support systems need to collate large volumes of data in advance of operation, so in addition to access issues, forward funding of development is a further consideration

Duplication of platforms. We are familiar with the development of competing MaaS platforms developed by automotive OEMs including Toyota and BMW/Daimler. These are global platforms that will encourage the development of common interoperable data standards. However, these platforms are also likely to result in a disaggregation of MaaS services in the same way that global entertainment subscription services have fragmented the media user base. Toyota is an active participant in some MaaS schemes in the UK such as Kinto Derby, which favours a range of mostly car-based options. Successful decision support systems will need to support all modes of transport.

Bundled services. Effective MaaS systems also require access to a range of ancillary services including parking, access to vehicle charging, congestion payments etc. These services are managed by a range of competing service providers, typically using dedicated apps. The future development of MaaS offerings will

need to be able to access these providers in order to be able to decision-support across the full range of criteria including total cost.

Integration of private travel solutions in the MaaS assessment. To be fully effective in modifying traveller behaviour, the system needs to be able to support decisions involving privately owned cars and other vehicles as well as public and commercial systems.

As an illustration of a response to some of these challenges, Arcadis has been working in partnership with the Zuidas district of Amsterdam to develop MaaS solutions to manage traffic in response to the rapid forecast growth in local population, tourism and traffic. The Zuidas Mobility experience is a phased experiment in interventions at different scales:

- The first phase involved a small number of participants to test willingness to give up the car. Participants were given a budget of €1,000 to use any form of transportation during a month provided they did not use their lease car. After the experiment, 50% of participants preferred to stay on the mobility pass rather than pay for a lease car. It should be noted that the problem with the unlimited travel mobility pass is that it incentivises greater use of transport modes including taxis.
- Later phases of testing involved an experimental semi-MaaS solution.
- The final implementation is an App, Amaze which was launched during the Covid pandemic. The App provides travel information, facilitates payment and rewards mode-shift behaviour including re-timed as well as avoided journeys. The rewards are travel credits rather than cash payments, up to a total value of €100. The App also eliminates the need for duplicate travel accounts and passes. The app is promoted by Zuidas district managers and a consortium of local employers as part of a joint effort to mitigate transport delays.

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