Ripe for transformation, ready for change?

Project 13 Digital Transformation Workstream:
Infrastructure industry benchmarking report

Foreword

Dale Evans
Infrastructure Client
Group chair

As chair of the ICE Infrastructure Client Group (ICG), I am delighted to support this infrastructure industry benchmarking report from the Project 13 Digital Transformation Workstream. As Project 13 has highlighted, digital transformation of our sector offers real and significant opportunities to improve infrastructure performance. Asset owners and clients must be bold and demonstrate leadership in taking these opportunities.

Progress is being made by government, through initiatives such as the Construction Sector Deal – which sets ambitious targets to cut costs and carbon emissions by focusing on digital solutions, advanced manufacturing and the through-life performance of assets – and through the Infrastructure and Projects Authority's 10-year change programme, Transforming Infrastructure Performance. What both government and industry must now do to deliver this agenda for change is lead a complete overhaul in the way we deliver assets – as set out by Project 13.

The ICG endorses the recommendations of this report, and, as the largest body of infrastructure clients in the UK, we now have a responsibility to ensure they are delivered. To that end, we have created a Digital Transformation Task Group, made up of representatives from all ICG organisations, which will lead on the implementation of this transformation agenda.

Mark Enzer
Project 13 Digital
Transformation
Workstream lead

Relative to other industries, infrastructure has been slow to benefit from digital transformation, but there are encouraging signs that it is starting to gain traction, improving both the delivery of new assets and the performance of existing ones. But there is still a long way to go. We need to recognise infrastructure as an information-based industry, in which better decisions, based on better data, lead to better outcomes for the ultimate customers – citizens.

This report represents the baseline, helping us to understand where we are as an industry and what remains to be done. Building on the work of Project 13, the ICG is in a great position to drive digital transformation and deliver meaningful change. I'm very grateful to the digital leaders from across the industry who have been brought together as part of Project 13's Digital Transformation Workstream to give us such a good start.

Miranda Sharp,
Digital Transformation
future leader,
Project 13

The digitally native people starting to enter our workplaces and use the infrastructure services we deliver will find it difficult to believe that information assets which mirror the physical assets are not complete and updated in real time. These are people who are used to being the blue dot at the centre of their map and regard individually tailored services as commonplace. Our challenge is to ready our systems and infrastructure, making them fit for a digitally enabled future with relentless customer focus – which will be an attractive industry to join. Through initiatives like Project 13 that bring together a diversity of skills and thought we can be confident in our future. Through collaboration we can expect to capitalise on the opportunities for digital transformation and see the UK lead in smart infrastructure.

Contents

Executive summary

The infrastructure industry is ripe for digital transformation, but are the key players ready for change?

Digital transformation offers vast opportunities to improve infrastructure performance, not just in the delivery of new assets, but also in their operation and integration with existing infrastructure.

The benefits could be worth £22bn a year by 2030[1].

So, what is the starting point?

This report provides a snapshot of the UK infrastructure industry's digital maturity – it's readiness for digital transformation. The purpose is to better understand the ability of asset owners and their supply chains to embrace new digital opportunities. It provides a starting point to inform the development of a national digital transformation strategy for infrastructure.

The Industry Readiness Level (IRL) has been developed as a measure of digital maturity across six broad themes – reflecting the impact of digital transformation on all parts of the business: customers; leadership; commercial; capability; asset delivery; and asset management.

Digital leaders from asset owners self-assessed their organisations' digital maturities in facilitated workshops. This benchmarking report covers the energy, transport, and water sectors, including existing asset owners and major project organisations, providing a good snapshot of where the UK infrastructure industry is today. It includes a number of members of the Infrastructure Client Group (ICG), which in total invests more than £20bn in infrastructure each year[2].

For each of the six themes we describe the impact of digital transformation, present the industry's current maturity, and share insights and case studies. Despite the wide differences between the organisations, a series of common challenges emerged:

- **Understand who your customers are – and what they want:** Create a line of sight between the enterprise and citizens as the ultimate customers, to understand how they value infrastructure and what outcomes really matter.

- **Embrace digital transformation as key to business success:** With leadership from executive level, implement a coherent digital transformation strategy that underpins the overall corporate strategy.

- **Break down data silos and better understand whole-life performance:** Start treating information as an asset; focus on making better use of information, creating the platform to unlock more whole-life value from existing assets.

- **Keep aspirations high – but get the basics right first:** Focus on embedding basic good practice as business-as-usual across the whole enterprise. Get data quality right as a key foundation.

- **Make information security everyone's responsibility, not just those in corporate IT:** Develop a culture of personal responsibility for information security similar to that for health and safety – both internally and for partners.

Collective action is also required across the industry to tackle wider challenges such as the digital skills gap and the development of new commercial models that reward the value added to information and positive outcomes for customers. This is where the power of bodies like the ICG can make a real difference. In response to Project 13, it has established the Digital Transformation Task Group (DTTG) to facilitate and accelerate the digital transformation of the UK infrastructure industry. The DTTG is initially focusing on members' strategies for digital transformation and understanding barriers to the wider sharing of data in infrastructure, in response to the National Infrastructure Commission's report Data for the Public Good.

The IRL will provide a consolidated view of digital maturity across the industry from individual owner's assessments, with future annual snapshots used to track progress in digital transformation. See the latest data available here:

https://project13.mottmac.com/

1. Transport Systems Catapult (2017): The Case for Government Involvement to Incentivise Data Sharing in the UK Intelligent Mobility Sector & National Infrastructure Commission (2017) Congestion, Capacity, Carbon: Priorities for National Infrastructure

2. Infrastructure and Projects Authority (2017): National Infrastructure and Construction Pipeline Autumn 2017

Introduction

The digital revolution is transforming industries as diverse as financial services, healthcare, media and manufacturing. The exponential reduction in cost to collect, process, transmit and store data has led to a state of digital abundance, creating opportunities to reinvent traditional business models. These developments also apply to infrastructure, enabling asset owners to deliver better services to their customers while dramatically cutting cost and carbon impacts. However, the infrastructure industry is among the least digitised[3], and there is much we can do to realise the potential benefits.

Project 13 is an industry-led response to delivery models that fail not just clients and their suppliers, but also the operators and ultimate users of economic infrastructure – the citizens. It aims to develop a new business model based on an 'enterprise' rather than traditional transactional arrangements, boosting certainty and productivity, improving whole-life outcomes and paving the way to a more sustainable, innovative and highly skilled industry. Moreover, this new model will provide better value for money for the taxpayers and customers who ultimately fund our infrastructure.

Digital transformation is recognised as a key enabler of this new business model, and as part of Project 13 we developed the Industry Readiness Level (IRL) to understand infrastructure asset owners' ability to embrace these new opportunities. In this report, we provide a snapshot of the UK infrastructure industry, focusing on the energy, transport and water sectors to inform the development of a national strategy for digital transformation. Although the focus has been on economic infrastructure, many of the challenges and recommendations will hold true for social infrastructure as well.

To produce these findings, Mott MacDonald led face-to-face workshops with digital leaders and key 'information people' in members of the ICG and other leading asset owners, guiding them through a self-assessment of their maturity against the IRL. Together they invest more than £20bn a year in their assets[4]. The spirit of the process was to undertake an open and honest appraisal, and as such the full results remain confidential to each owner. However, many owners face the same challenges and shared similar experiences. Here we present the key findings, identify key challenges and recommend initial steps that individual organisations can take to address these. We also identify areas where collective action across the whole industry is required to change the status-quo.

Full details of the IRL and a list of contributors up to June 2018 are included within this report. However, we continue to carry out workshops with ICG members and other asset owners. The latest results and more detailed benchmarking data can be found at:

https://project13.mottmac.com/

The Industry Readiness Level

We defined the IRL as a measure of digital maturity across six broad topics – reflecting the impact of digital transformation on all parts of the business. It builds on leading digital thinking across diverse industries, and tools such as the Project Initiation Routemap[5] and the ISO55001 Self-Assessment Methodology[6].

Each topic is comprised of three or four questions, against which owners self-assess based on the descriptions of increasing levels of maturity in the IRL matrix (included at the end of this report). The IRL starts at Level 0 for a traditional owner and mirrors the three levels of maturity in Project 13 up to a high performing enterprise (Level 3). It also outlines the benefits of going beyond a single owner's enterprise to develop an interconnected industry. The diagram on the next page shows a snapshot of the industry's current maturity, with scores increasing from the centre outwards, and darker shading indicating a higher percentage of owners at that level of maturity.

Customers	How do you use information to better understand your customers and improve your services?
Leadership	Do you believe you need to transform your business around the value of information to deliver a step-change in performance?
Commercial	How do you recognise the value your partners add to information and do your commercial models provide the necessary incentive?
Capability	Do you and your partners have the skills, knowledge and mindset needed to unlock the value of information?
Asset delivery	How do you use information to deliver new assets efficiently and make it available throughout the asset lifecycle?
Asset management	How do you use information throughout the asset lifecycle to make better decisions and deliver improved outcomes for customers?

3. McKinsey & Company (2016) Imagining construction's digital future
4. Infrastructure and Projects Authority (2017): National Infrastructure and Construction Pipeline Autumn 2017
5. Infrastructure and Projects Authority (2016) Project Initiation Routemap
6. The Institute of Asset Management (2014) Self-Assessment Methodology+ (SAM+) tool

Customers

How do you use information to better understand your customers and improve your services?

Digitally-connected customers create and consume vast amounts of data. That data provides an unprecedented opportunity for owners to build an understanding of how customers value their services, to deliver improvements and influence customer behaviour. From route planning apps to smart meters, digital innovations are providing new ways to engage with customers and place them at the heart of decision making.

Best practice: Customer experience is recognised as a key metric for business performance. Owner actively seeks customer engagement, with impacts on customers connected across all systems.

Trailing edge: Limited or no engagement with the ultimate customer, although their interests may be represented through market or regulatory frameworks.

Assessment criteria

Insight	How do you use data to understand your customers?
Participation	How do you include customers in decision making?
Experience	How do your customers' experiences shape your business?

Industry snapshot
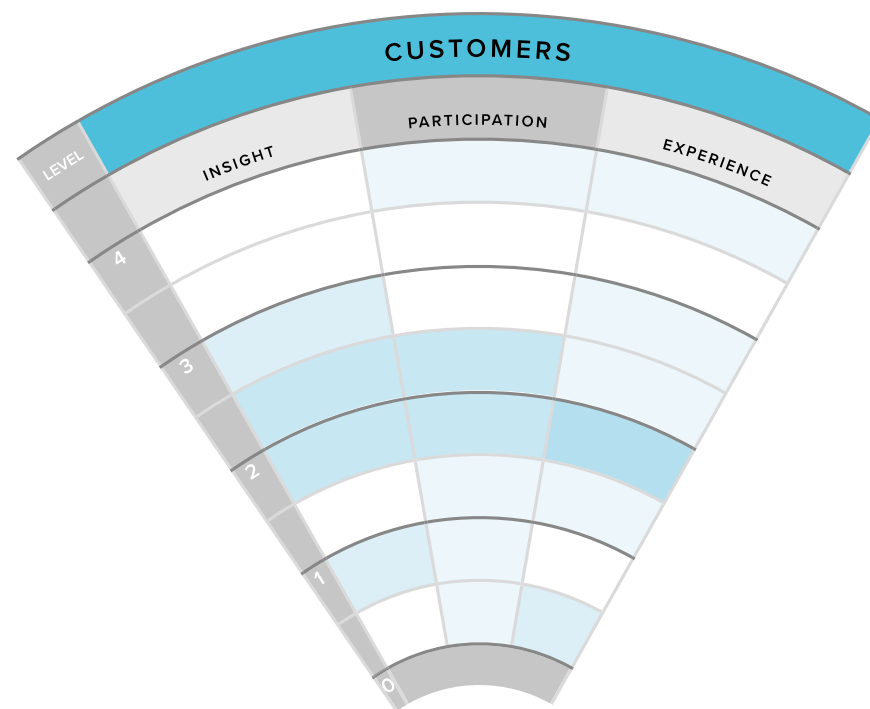
Some infrastructure owners find it a challenge to define the needs of their ultimate customers, especially those who don't have a direct relationship with them.

> *"Internally we define the customer as those organisations that pay our bills, not the end users."*

Customer insight can be delivered by both market 'pull' and regulatory 'push'. Touchpoints such as retail functions allow many owners to learn from their customers, although some don't have this luxury. Surprisingly though, some of the owners with the best understanding of their end users don't bill them directly. Instead, they build this knowledge from other data sources and interactions, striving to deliver the best possible service. Where there is no direct connection to an end user, a clear line of sight to the ultimate customers' values is still required to ensure they drive decision making.

> *"Our customer is another part of our business – they want clean, cheap and reliable energy."*

> *"Our best performing areas are regulatory-driven, in predicting impact on our [customer service] score."*

A customer-centric culture is developing among leading owners. This includes taking a more proactive approach to engaging with customers to build relationships and earn their trust. There is also growing recognition that customer experience should drive business strategy and be seen as a measure of performance, with owners being judged against service industry leaders such as online retailers and banks, not their peers in infrastructure.

Heathrow Airport uses customer maps and data to improve the traveller experience, from the point they decide to fly through to boarding the plane. The process looks at the journey from the customers' perspective at each touchpoint, including getting to the airport and progress through check-in, security, and retail functions. With so many partners operating at the airport this insight helps all 75,000 staff in the 'enterprise' to improve customer experience, supporting the vision of Heathrow as the airport of choice.

> *"Customer willingness to pay is baked into investment decisions. Everyone is informed by it mathematically, but they are not yet culturally thinking about the customer."*

Customer participation tends to be driven by owners seeking engagement through a structured process for strategic planning or capital delivery projects. Although many owners monitor social media for immediate operational customer feedback, this rarely informs longer-term decision making. Services often can't be personalised as individuals' records aren't joined-up across all of the owner's systems. But that is starting to change, with leading owners trialling new digital services that generate tangible benefits for both the customers and the owner, through sharing information.

Leadership

Do you believe you need to transform your business around the value of information to deliver a step-change in performance?

The digital transformation of infrastructure could deliver more than £22bn in value to the UK economy each year by 2030[7]. Put another way, this is more than the current capital expenditure of the entire ICG[8]. To achieve this economic benefit, organisations need to embed digital at the very centre of corporate strategy, becoming 'information businesses' with a culture of digital agility and innovation. This requires bold leadership and a belief that digital transformation is fundamental to long-term success.

Best practice: Strong digital leadership at all levels from the executive board downwards, with a comprehensive digital strategy that underpins corporate planning. A data-driven culture is developing.

Trailing edge: No overarching digital strategy exists, but it is beginning to be recognised in a fragmented manner through other strategies. Leaders talk of digital without fully understanding the benefits.

Assessment criteria

Leadership	How committed are your leaders to transformational change?
Strategy and plans	How do you align your whole business around a clear vision for digital transformation?
Culture	How ingrained are digital behaviours in the way you operate?
Innovation	How do you foster digital innovation in your business?

Industry snapshot
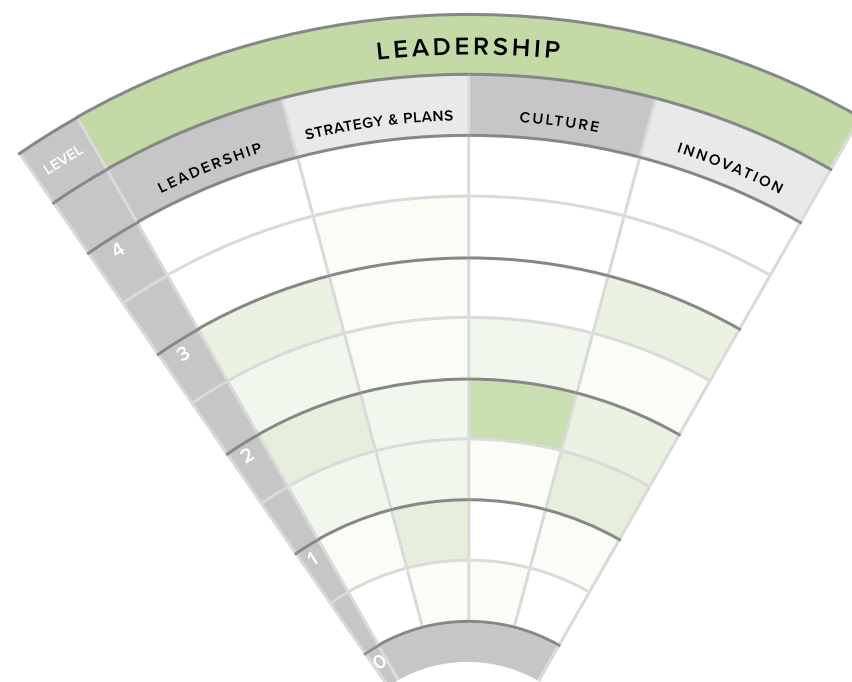
Owners increasingly recognise the need for digital transformation, and all have embarked on that journey. For those just starting out, digital is misunderstood and remains disconnected from business success. In contrast, leading owners have clear accountability and a fundamental belief in transformative digital change at executive board level.

Anglian Water invited directors and senior managers from all its key engineering and works management Alliance partner organisations to join its leadership development programme; to build a shared understanding of strategy, collaboration, digital transformation and how to embed and sustain change. Participants learned from more than 30 successful organisations, including digital disruptors in industries ranging from financial services, retail and manufacturing.

Part of this process is a cultural shift, moving away from simply focusing on compliance to unlocking opportunities that increase efficiency and improve business performance. Scottish Power's parent company Iberdrola, for example, is targeting more than £500M in annual benefits from digital transformation by 2022[9]. Major project owners such as HS2 and Tideway are trying to build information-centric organisations to future-proof themselves for technological disruption over the many years before their assets even become operational.

However, challenges remain as many owners report fragmented progress, with pockets of digital innovation across different functions and teams, and some inefficiencies from duplication. The majority already have structured innovation processes, and a few are starting to harness them to drive digital transformation.

"Our innovation team is very active, but not specifically in digital. They run events with hundreds of people every year, but the digital team is never invited."

Most owners have multiple, piecemeal strategies across different parts of the business that include digital elements (such as BIM, information systems and data strategies). They recognise the need for an overarching digital strategy that joins up the constituent parts, and many are well on their way to developing it. There would be value in co-ordinating and sharing best practice among leading owners to accelerate digital transformation of the industry.

Scottish Water's digital strategy underpins all elements of its strategic planning for the next regulatory cycle, SR21, driven by an understanding of how digital transformation will enable better business outcomes. This builds on a long history of embracing digital technologies – for example, the company first started to provide customer-facing field teams with digital tools 14 years ago.

7. The sum of wider sharing of transport data unlocking £14bn/yr value by 2025 and smart demand management reducing the need for new energy generating capacity by £8bn/yr by 2030:
Transport Systems Catapult (2017): The Case for Government Involvement to Incentivise Data Sharing in the UK Intelligent Mobility Sector
National Infrastructure Commission (2017) Congestion, Capacity, Carbon: Priorities for National Infrastructure

8. Based on analysis of the National Infrastructure Pipeline 2017-21 for ICG members:
Infrastructure and Projects Authority (2017): National Infrastructure and Construction Pipeline Autumn 2017

9. Scottish Power (2018) "Digitilisation and Innovation: Iberdrola expects digitilisation-related initiatives to contribute an additional €600M to its EBITDA for 2022." Accessed 31 May 2018

Commercial

How do you recognise the value your partners add to information and do your commercial models provide the necessary incentive?

A shift in focus is needed to truly realise the full benefits of digital transformation, from minimising capital costs to maximising the whole-life value of assets. Crucial to achieving this is understanding the outcomes being delivered to the ultimate customer. New commercial models are needed that align all partners and incentivise sharing information to deliver best value for end users.

Best practice: Owner's decisions are based on whole-life cost, with an understanding of actual asset performance, although partners are not fully incentivised on the same basis. Digital investments are driven by digital strategy to maximise gains.

Trailing edge: Focus is on minimising capital cost, with reactive investment in digital systems to mitigate short-term risks.

Assessment criteria

Value definition	How do you define value to incentivise the right customer outcomes?
Value of information	How do you value information in your commercial models?
Digital investment	How well do investments in digital infrastructure meet business needs?

Industry snapshot
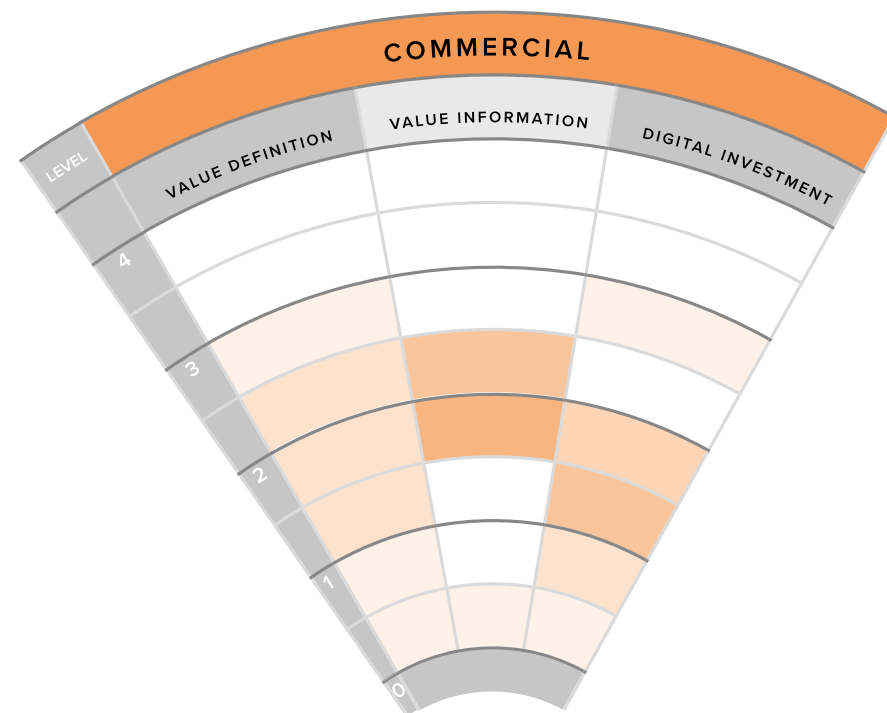
Few owners have a comprehensive view of the actual, as-operated performance of their assets. This limits the opportunity to share risk and reward on a whole-life basis, or to optimise as part of a system-of-systems. Owners may procure on minimum forecast whole-life costs, but beyond a performance test at handover, they typically carry all the risk for actual operation and maintenance costs.

> **Iberdrola** scrutinises the through-life performance of its assets, combining diverse data feeds from its global windfarms to develop in-house weather models and forecasts of future electricity prices. This information is used to update 'live' predictions of the rate of return on all investment decisions. These information assets are highly valued and commercially sensitive, but provide opportunities for further gains through fair value exchange with partners that hold similar data on the turbines they supply globally. The company is exploring value-based pricing models, with operational monitoring providing an alternative to standard fixed-period warranties.

Leading infrastructure owners are using outcome-based procurement for major capital programmes to minimise whole-life costs, for example, challenging their partners to "reduce pollution incidents by 10%". However, this approach is limited to major investments, as the appraisal tools require significant manual analysis. Minor works and maintenance are typically 'like-for-like' replacements at minimum capital cost, missing opportunities to optimise the system.

Owners recognise the value of information to drive better decisions, but this is not yet embedded in commercial models. Furthermore, the potential for cross-network benefits goes unrealised. At best, a contractual 'stick' may be used for compliance, for example, linking final payment to receipt of verified data at project completion. Equivalent rewards for providing better information that delivers operational efficiencies to the asset owner are absent. As such, current models will not incentivise the shift in focus and behavioural change needed for partners to truly maximise whole-life value.

> **HS2** has committed to delivering £500M in savings from better information management. The owner reviewed the benefits they would gain from buying and exploiting data, benchmarking itself against international best practice. This led to embedding hard requirements for data into contracts with all partners, supported by KPIs to measure that value.

Although the regulatory model has a strong influence and can even drive differences within individual businesses, the three highest-scoring organisations operate under different regulatory frameworks. This highlights the importance of the owner's business strategy in focusing on long-term value.

> *"If we considered a 40-year revenue stream on the assets, rather than CapEx and OpEx in a single regulatory cycle, that would transform our decision making."*

Investment is required for digital transformation, and most owners are still working to rationalise their legacy systems. Those with a clear digital strategy are more likely to invest proactively to unlock new efficiencies, rather than focusing purely on risk mitigation.

> *"Our investment in digital systems remains risk-driven and reactive. A fundamental change is needed, from a focus on minimising service costs to adding value and enabling better business outcomes."*

Capability

Do you and your partners have the skills, knowledge and mindset needed to unlock the value of information?

Digital transformation requires a whole new set of skills and behaviours, cutting across all personnel from executives to technicians. The disruption caused by rapid development of new technologies makes digital agility and upskilling vital – attributes that are highly transferable from other sectors. Suppliers must form new partnerships, spanning disciplines that have historically worked in isolation, and we all need to understand and accept our personal responsibility for information security as we have for health, safety and welfare.

Best practice: Digital skills have been identified, with plans to manage them more strategically. Owner brings different partners together and an information security culture is developing.

Trailing edge: Digital skills are only considered where they are fundamental to specialist roles. Partners continue to work in traditional siloes and security relies primarily on technical controls.

Assessment criteria

Skills	How well do you understand and manage the digital skills needed for your business?
Suppliers	How do suppliers meet your needs for digital technologies and services?
Information security	How do you assure information security and compliance?

Industry snapshot
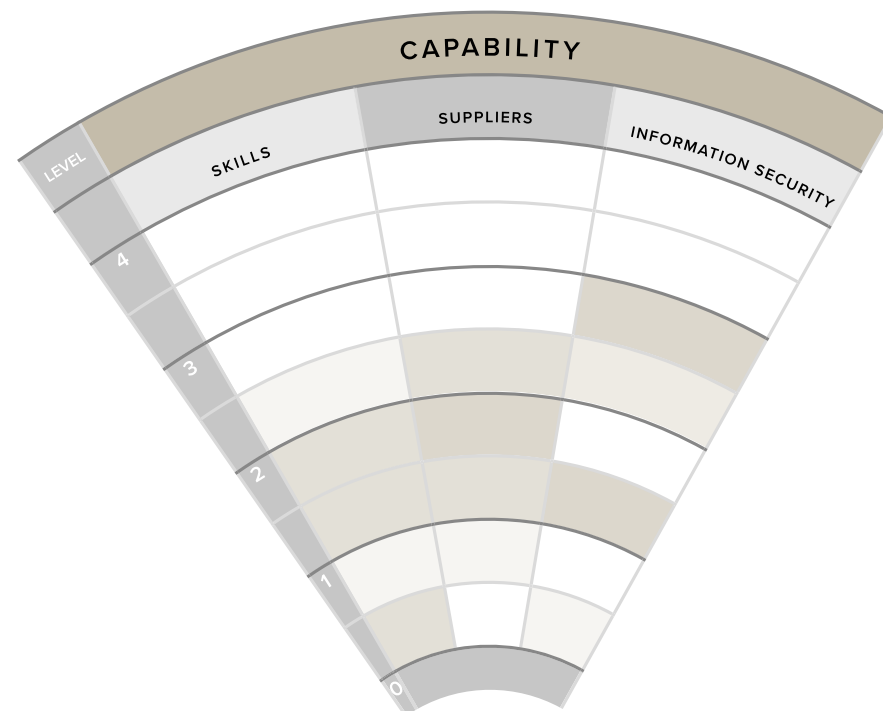
As one of the lowest scoring sections of the whole assessment, digital capability clearly presents a significant challenge. Many owners don't understand their skills gaps and fail to bring digital into training or recruitment.

> *"To become truly digital we almost need a generation to disappear. That generation is generally too senior, vocal and strident in their resistance to change… Engineers who just want a drawing to mark-up in red pen."*

Leading organisations are beginning to define their core digital capabilities, embedding them in job descriptions and developing training to increase digital agility.

> *"Recruitment considers digital skills for specialist roles, but it is not widespread across the business. We are trying to get it written into [all] job descriptions from next year."*

Looking outside the owner organisation, frameworks for digital suppliers are quite common (particularly for the public sector, through the UK government's Digital Marketplace). However, strong collaborations are yet to emerge between digital vendors and traditional engineering companies. In fact, digital specialists are generally viewed either as a threat, or as an excuse for engineering suppliers not to invest in digital upskilling. Leading owners are trying to bring these groups together, building an enterprise that draws on the strengths and domain knowledge of all partners.

> *"The threat remains very real and growing. I'm not saying that no progress has been made, but there are basic things still not being done… Encourage your organisations to get these basics right."*
> **Ciaran Martin, NCSC CEO, The Times Tech Summit, November 2017**

The last two years have seen ransomware affect critical NHS services, SCADA breached at a US water utility and loss of power to quarter of a million customers in Ukraine from cyber-attacks. Almost 600 significant incidents were reported to the National Cyber Security Centre (NCSC) in 2017, including foreign-state attacks on UK telecoms and energy companies[10]. A successful attack on UK critical national infrastructure could cost the economy tens of billions of pounds[11].

> *"The professionals managing information security are very high performing, but that culture is not yet ingrained in day-to-day business. Our partners would score significantly lower."*

Those accountable for cybersecurity in owner organisations are confident of the measures they have in place, but there is little evidence of a strong security culture extending into operational and engineering functions, or across all partners. Few owners assess their partners' cybersecurity performance or require certification to ISO 27001 as standard, despite up to two-thirds of corporate data breaches globally being caused by employee negligence or malicious acts[12].

Scottish Water is one of the Scottish government's 'cyber catalysts', spearheading information security through the Cyber Essentials scheme and an active member of the NCSC's Cybersecurity Information Sharing Partnership (CiSP). Strong governance is in place to manage incidents, with a robust investment plan and ISO 27001 accreditation for data-centres and key systems. The organisation assesses all partners on their cybersecurity performance and ethical hackers regularly conduct penetration tests.

Ensuring compliance with the General Data Protection Regulation (GDPR) and Network and Information Security (NIS) Directive was most owners' top priority, as might be expected with maximum penalties of €20M or 4% of global turnover. This should help focus efforts on embedding the principles of PAS 1192-5 for managing security risks to built assets and information across the whole enterprise. Understanding and mitigating these risks is the first step towards enabling wider sharing of data in infrastructure as part of "a shift towards minimum levels of commercial confidentiality"[13] advocated by the National Infrastructure Commission.

10. National Cyber Security Centre (2017) Annual Review: 2017
11. Parliamentary Office of Science & Technology (2017) Cyber Security of UK Infrastructure PN0554
12. Willis Towers Watson (2017) When it comes to cyber risk businesses are missing the human touch
13. National Infrastructure Commission (2017) Data for the Public Good

Asset delivery

How do you use information to deliver new assets efficiently and make it available throughout the asset lifecycle?

Constructing a new asset presents an opportunity for a step-change improvement in the quality of information for that part of the asset base, unlocking new efficiencies in operation. At the same time, embracing smart construction methods based on BIM and advanced manufacturing can deliver sizeable capital savings, as well as carbon and safety benefits.

Best practice: Owner has well-defined information requirements embedded in contracts, a common data environment for all partners and a growing library of standard products.

Trailing edge: Designs are produced in 2D with limited co-ordination or use of digital technologies to drive efficiencies. Each project is treated as unique, starting from scratch instead of repurposing information from previous projects.

Assessment criteria

Digital integration — How do you integrate engineering, operational and information technologies?

Data availability — How do you capture and provide the data necessary for delivering new assets?

Information management — How do you manage information about new assets?

Standardisation and automation — How do you use standard products and advanced manufacturing in asset delivery?

Industry snapshot
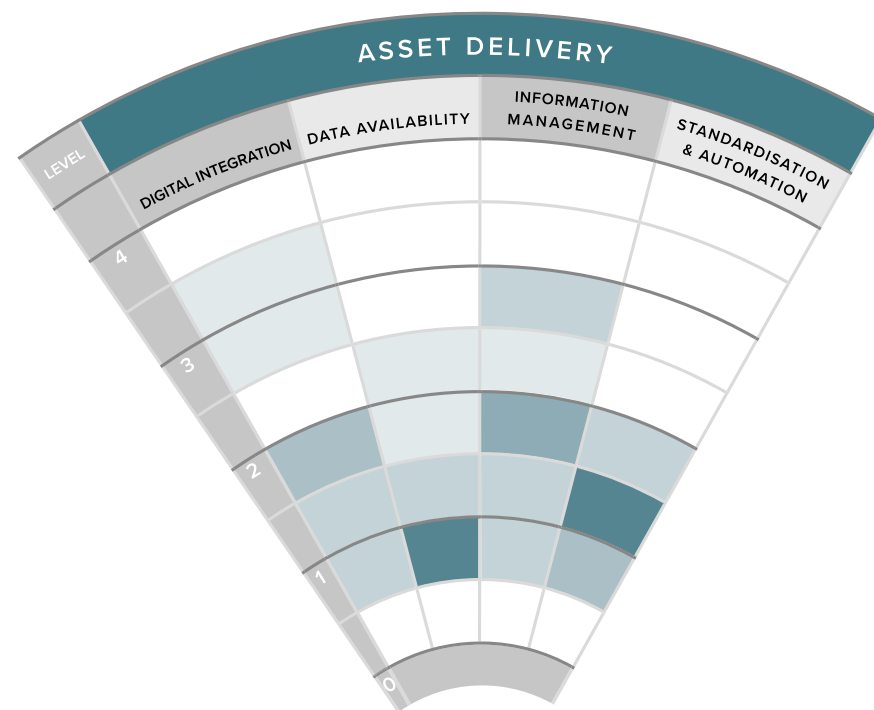
Better information management is a key enabler that improves asset delivery, but progress has largely been driven by capital delivery partners seeking cost efficiencies.

> *"Our capital delivery partners actively engage in BIM, they recognise and exploit its value. However, as an owner we are not yet on board to receive and take advantage of that information."*

Most infrastructure owners are still playing catch-up to develop the common data environments and information requirements that underpin BIM Level 2. These will provide consistency to ensure the information delivered at handover meets asset management and operational needs.

Although nearly all owners recognise the potential benefits, unlocking the investment necessary to deliver them remains a challenge.

> *"The cost of incorrect information is felt, down the line, by a different part of the business [or even a different business entirely] – not that which manages minor capital works. It is a challenge to quantify the value of accurate as-built information."*

Long-term partnerships are starting to change behaviours, not least as there is a higher probability of partners returning to work on the same asset and benefiting (or suffering) from the quality of information available. Outside major projects there remains a need to upskill the wider supply chain and drive requirements for asset information through procurement.

> *"Approximately one third of our capital expenditure is on minor works through small capital frameworks – those changes to the asset base are hardly captured."*

There is limited integration of digital and physical assets, stemming from the lack of connectivity between operational data requirements, supporting information systems and design of the physical asset. All too often the engineering technology is provided first, with operational and information technologies 'bolted on' afterwards as a digital overlay – missing the opportunity to optimise performance as digital-physical systems.

> *"By the time [our assets are] operational we need to have an actual digital twin, and the data requirements to enable that will be embedded in current contracts."*

Data quality and availability is a particular weakness, with most projects relying on manual surveys to fill the gaps in unreliable asset information. Trials of digital reality capture technologies are common, but are yet to become a standard part of the delivery process. And a lack of supporting information management systems means that most project data is lost at completion, or at best archived and not readily reusable for future work.

HS2 has invested in LiDAR data and aerial photogrammetry for the full corridor of its 230km Phase 1 route. This is combined with more than 600M spatial environmental records and an extensive network of sensors providing monitoring data. It is also using its influence as the UK's largest infrastructure client to drive a step change improvement in geotechnical site investigations, with digital data logging providing earlier access to information, reducing asset delivery risk. The data will be shared with the British Geological Survey National Geotechnical Properties Database (almost trebling its total number of records) and through Open Data UK. Efficiency savings from its reuse on HS2 Phase 2 alone are estimated at £10M[14].

14. Sophie Payne (2018) "Open UK: Unlocking Ground Investigation Data". i3P Spark, London, March 2018

Asset management

How do you use information throughout the asset lifecycle to make better decisions and deliver improved outcomes?

In the UK, we add less than 0.5% to the value of our existing asset base each year[15]. As such, the greatest efficiency gains are to be had in asset management, combining physical and digital systems to create truly smart infrastructure. This presents different challenges for owners of existing assets – who need to connect legacy systems to unlock operational efficiencies, and new owners created through major projects – who want to deliver best-in-class performance, fit for the next 50 years, in a rapidly changing technological landscape.

Best practice: An asset management system controls access for the whole enterprise to all data sources. Teams are starting to derive value from predictive analytics and machine learning.

Trailing edge: Data silos exist – multiple asset registers, with duplication and inconsistencies. Asset management processes are immature. Decisions are not data-driven, but are mostly based on prescribed procedures and individuals' experience.

Assessment criteria

Data availability	How well does data meet all your business needs?
Information management	How do you ensure that information is fit for its intended purpose and can be shared and reused?
Sense making	How do you use and combine information to inform decisions?
Decision making	How are decisions supported by data-driven insight?

Industry snapshot
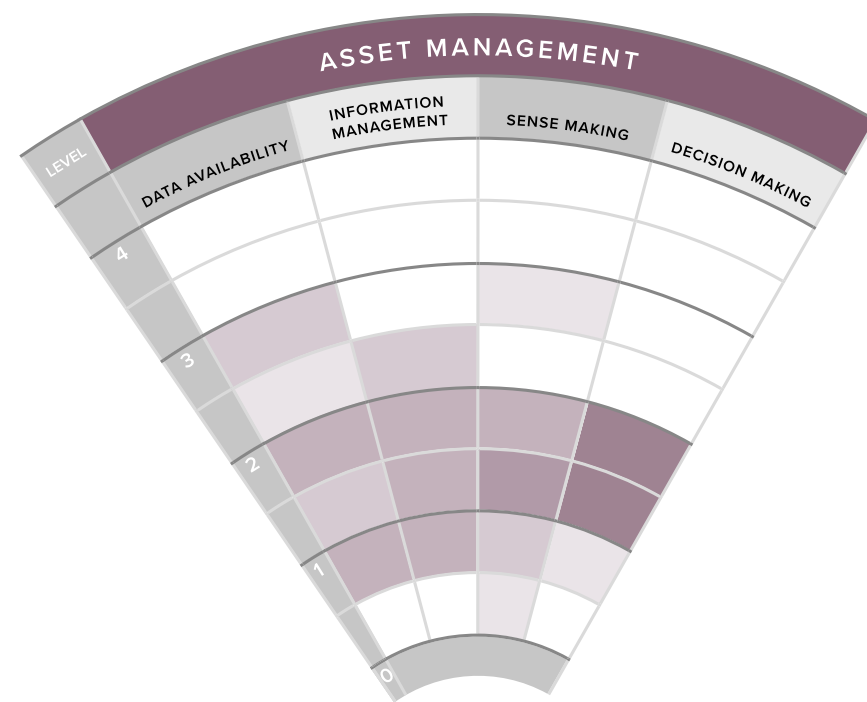
There is a clear reduction in maturity moving up the smart infrastructure pyramid[16], from data through to decision making. This reflects the fact that investment is required to improve underlying data quality and information management before more sophisticated analytics can be developed to make sense of that information and inform decision making.

There is huge variation in data availability across different parts of the same business, particularly those with an existing asset base and legacy systems where data siloes limit visibility for other functions. Restricted and disconnected systems make it prohibitively expensive to extract value from existing data, with most owners currently working to rationalise and connect their systems to drive improvements.
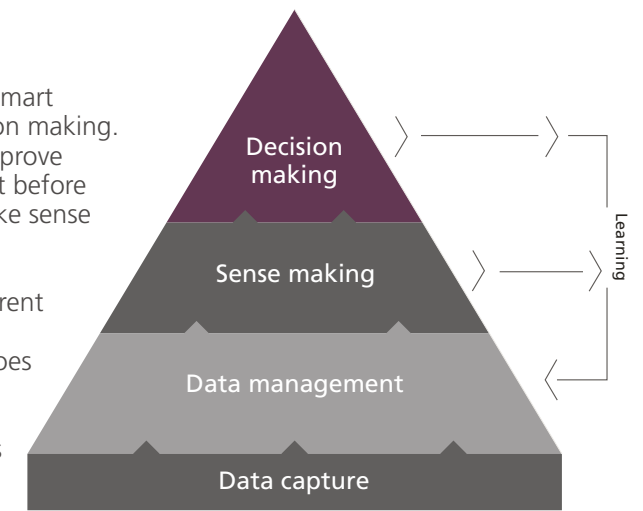
Many owners have focused on improving data quality within individual functions, defining metrics for information management, but few consistently measure and track performance against them. Accountability and ownership for data is still developing and isn't yet fully linked to business outcomes.

Dŵr Cymru Welsh Water is working to improve its data governance via the WISER data strategy, creating clear accountability by appointing data owners and data stewards across the whole business and providing data housekeeping tools to monitor and manage quality, accessibility and compliance with standards. Platform managers have also been appointed for key systems like GIS. These new digital roles integrate with existing service managers via a matrix structure, ensuring that data and systems are aligned to business functions and service needs.

Sense-making and analytics generally focus on monitoring compliance through static dashboards with limited functionality. Many owners reported issues with 'information overload' in parts of their business – highlighting both the importance of improving digital skills, and the need to present high-level insight rather than just low-level information.

> *"The control centre is wired, with real-time data and alarms. Although only a small part of the asset base is connected, 97% of alarms are ignored."*

Pockets of good practice are starting to emerge, with most owners citing examples of specific teams that have developed data science capabilities and are starting to unlock value for the business. However, this remains highly fragmented and work is required to embed a data-driven culture as business as usual.

Decision support tools do exist, but rely heavily on human intervention to process and review the data and make decisions offline, before feeding back into the tool. As such, they tend to support tactical or strategic decisions, rather than providing live or dynamic intelligence. Where real-time optimisation is used, it tends to run on historic trends rather than predictive forecasts and is based on relatively simple parameters that may not reflect true whole-life costs.

The growing sophistication of machine learning, catalysed by the UK's Artificial Intelligence Sector Deal, presents an opportunity to transform decision making in infrastructure and deliver a step-change improvement in performance. Enabled by improvements in data quality and information management which are already underway, it also requires a fundamental change in thinking about the role of the asset manager.

> *"A cultural shift is required around machine learning, to embrace autonomy and self-managing assets. We are too focused on attaching data to static records of assets. What is more important is whether the next asset in the chain is 'aware', not whether the centre knows."*

15. Cambridge Centre for Smart Infrastructure & Construction et al. (2016) Smart Infrastructure: Getting more from strategic assets
16. Cambridge Centre for Smart Infrastructure & Construction et al. (2016) Smart Infrastructure: Getting more from strategic assets

Recommendations and challenges

All owners can unlock real value from digital transformation, and while that process may take years to complete, acting now will start to deliver benefits while putting foundations in place for the future.

Despite the many differences between the organisations we surveyed, common challenges emerged. Here we present the top enablers to progress, with recommendations for infrastructure owners to address.

Understand who your customers are – and what they want

Links between infrastructure owners and their end users are often ill-defined. Create a line of sight between all partners in the enterprise and the ultimate customers to understand how they value your services. Then transform your business to deliver the outcomes that really matter.

Embrace digital transformation as key to business success

The need for digital transformation should be recognised at executive level, with a coherent digital strategy that underpins and helps to achieve the corporate strategy. Use this to bring together existing initiatives across the business, and provide consistency and focus around a common goal. Digital investments should be justified against the strategy – and their success linked to business and customer outcomes. Change the narrative from risk mitigation and digital functions as cost centres, to a focus on unlocking opportunities and creating value.

Break down data silos and better understand whole-life performance

Data silos are a problem for most infrastructure owners, particularly those constrained by legacy information systems. Start treating information as an asset. Focus on making better use of your information, not just on introducing new technologies, through strengthening asset management capabilities and improving data management processes. This will create the platform for new sense-making and analytics, unlocking more value from existing assets while enabling new commercial models. It will also help enable the wider sharing of information across the industry, which could deliver mutual benefits to multiple owners.

Keep aspirations high – but get the basics right first

It is good to have a bold vision for digital transformation, but achieving it relies on doing the basics well and embedding them as business-as-usual across the whole enterprise. This is particularly relevant to BIM and consolidating progress at Level 2, but applies to all areas of digital maturity within the organisation. Get data quality and information management processes right as a key foundation.

Make information security everyone's responsibility, not just those in corporate IT

Potential fines of €20M or 4% of global turnover introduced by GDPR[17] have sharpened the focus on information security and privacy for executive teams. However, the impact of poor information management practices on asset security is still not recognised by all staff and partners as a key risk. Drive change by educating everyone on their personal responsibilities and aim to develop a culture similar to that for health and safety. Assess behaviours, and work towards certification and compliance with key standards – both internally and for partners. Actively manage the risks from data aggregation to enable increased sharing in a controlled manner.

Collective action is also required across the industry to tackle some of the blockers and this is where the power of bodies like the ICG can make a real difference:

Incentivise outcomes, not hours spent on outputs

New commercial models are required that reward partners for the value they add to information and how that results in better outcomes for customers. Valuation models should be developed for information assets. Regulatory changes may be needed to enable this shift in thinking that recognises the value of digital assets as well as physical assets.

Bridge the skills gap

The challenges of attracting and developing digital skills affect all infrastructure organisations – and are too big to tackle in isolation. The UK Digital Strategy and Construction Sector Deal sets out a strategic approach to skills development. Infrastructure owners must engage to ensure the forthcoming Construction Skills Strategy meets their needs – not just for digital delivery of new assets but for the operation and management of smart infrastructure.

Next steps

This report provides a snapshot of current industry readiness for digital transformation in UK infrastructure. However, it is not intended to be a one-off project and should instead be seen as the beginning of the conversation. The results demonstrate that action is required by all owners, and their supply chain partners, to capitalise on the opportunity of digital transformation.

In response to Project 13, the ICG has established a Digital Transformation Task Group (DTTG) to facilitate and accelerate the digital transformation of the infrastructure industry. It provides a forum for sharing knowledge and best practice, initially focusing on members' strategies for digital transformation. Through identifying key components and aligning their strategies DTTG members will own and drive the development of a national digital transformation strategy for infrastructure.

Building on the National Infrastructure Commission's recommendations in Data for the Public Good, the DTTG will lead industry engagement with the Centre for Digital Built Britain in developing a digital framework for infrastructure data and making more data available for sharing by addressing barriers, including commercial confidentiality. It will also align with Government Construction Strategy to support digital transformation and delivering on the Infrastructure and Projects Authority's Transforming Infrastructure Performance objectives to support smarter infrastructure and drive faster adoption of digital technology.

The Industry Readiness Level will be used to measure progress in digital transformation as the strategy takes shape, with updated results available here: **https://project13.mottmac.com/**

What's your organisation's digital maturity?

This digital benchmarking report was written and researched by Mott MacDonald, with our Information Advisory team developing the assessment criteria used in the face-to-face workshops.
If you are interested in benchmarking your digital maturity, please contact:
informationadvisory@mottmac.com

Infrastructure Client Group Digital Transformation Task Group

Anglian Water

Crossrail 2

Environment Agency

Heathrow Airport

Highways England

HS2

London Underground

National Grid

NDA

Network Rail

Tideway

UK Power Networks

Centre for Digital Built Britain

i3P

The Industry Readiness Level

	0 Traditional	1 Simple collaboration	2 Integrated functions and relationships	3 High performing enterprise	4 Interconnected industry
CUSTOMERS					
Insight — *How do you use data to understand your customers?*	No customer information available to most owner functions - **limited to payments, complaints and formal consultation** with a small sample of customers.	Decision making accounts for **defined customer preferences**, but with **limited personalisation**. Data provides insight on customer value across multiple groups - including those who don't contact the owner. Customer-led culture developing across owner functions, but does not yet extend to partners.	Visibility of all customers across the entire data estate provides **granular understanding of different customer groups**, and value of the services to their lifestyles. Customer-led culture developing across all partners, including understanding what customers really want through revealed as well as stated preferences.	Digital insight enables **individual customers' valuation of their services** to inform owner decisions. This deep understanding of customers extends across whole enterprise and customer value sits at the centre of all investment.	*Insight into customer value extends across **multiple sectors** and services, encompassing wider societal value and enabling offer of **cross-industry digital services.***
Participation — *How do you include customers in decision making?*	Customers viewed as **passive recipients** of a service. Owners seek customer validation of their plans. Captive customers have limited choice, with little transparency or differentiation in owner's offers of services.	Owner is transparent in their use of personal data and **informs customers of service availability**. Plans in place to give customers more control over their services. Educated customers understand how their data is used, have insight into the bigger picture and buy into benefits of owner activities.	**Digital engagement** enables owner to involve customers, making it easy for them to **propose solutions or challenge at any time**, across all owner functions. Customers able to exert meaningful control over their personal data and how it is used. Established relationship with customers creates opportunity to influence behaviours towards better outcomes.	Customers are **active participants at multiple interfaces**, with greater choice to influence and control expenditure and services. Strong digital ethics underpin customer trust. Complete digital transparency and fair value exchange means customers receive clear benefits from sharing personal data.	*Participation extends **across company and sector boundaries** to include multiple levels of impact and influence, not just direct customers, to maximise benefits for society and deliver inclusive social outcomes.*
Experience — *How do your customers' experiences shape your business?*	Minimal, one-way communication (eg: limited to bills and complaints). **Customers have no visibility of owner operations** except when something goes wrong or during formal consultation.	Digital technology delivers a reliable, easy experience. **Customers have control, accessing information** through their channel of choice. Experience tracked throughout customer journeys using multiple techniques.	Connected systems and data ensure **customer experience consistent across all functions** (owner and partners), effortless and easy. **Communication personalised to individual customers. Owners build customer** trust through enhanced digital engagement.	**Customer experience is a primary driver of business performance**, tracked in real-time for all individuals. Customer satisfaction consistent with leading firms in UK across any industry (eg: by UK Customer Satisfaction Index). Plans in place to address digital exclusion.	***Customer experience seamless across multiple sectors**, with increasing bundling of domestic products and services.*
LEADERSHIP					
Leadership — *How committed are your leaders to transformational change?*	Leaders have limited understanding of digital transformation, **do not see relevance to their business.**	Commitment to digital transformation at the highest level of key partners, **belief it is fundamental to business success**. Informal **champions exist** across multiple functions.	Strong digital leadership, with **change agents across all levels and functions** of owner and partners, empowered to drive change.	**Joined-up leadership** across the enterprise drives digital transformation in an integrated manner. **Leaders engage and create a platform** for everyone to drive change.	*Leaders recognise value of greater alignment with other owners and sectors. **Partnering with peers and competitors** becomes core business activity.*
Strategy & plans — *How do you align your whole business around a clear vision for digital transformation?*	**No overarching digital strategy** exists, work may be under way to develop it. Disconnected digital plans may be in place for specific aspects.	Owner's **digital strategy sponsored by senior leaders**. Digital plans exist for different owner functions and partners.	**Comprehensive digital strategy** addresses all aspects of transformation, at multiple levels, **closely aligned to corporate strategy**. Digital planning is coherent across different functions of the owner and partners.	Digital transformation is at the **very centre of corporate strategy** and planning. Information is fundamental to the enterprise's services and operations.	*Corporate strategy and planning account for **digital interdependence across multiple sectors** and impact of digital disruption on society and economy.*
Culture — *How ingrained are digital behaviours in the way you operate?*	**Perception that digital doesn't apply** to individual's role, function or business - it is an **IT function**. Belief that digital transformation is incidental, focused on technology.	**Digital is dealt with by specialist teams**, with limited impact on most functions. Analytics teams rely on data for decision making.	Belief that digital transformation is fundamental, focused on information. **Everyone understands how digital impacts them individually** and how their performance relates to the digital strategy. Data-driven decision making becoming commonplace across all functions and partners.	Full **digital change programme has been implemented** across the enterprise, embedded in everything people do. Digital articulated as part of organisational values.	***Digital capability of interfacing organisations** of utmost importance in assessing impacts on their own organisation and society.*
Innovation — *How do you foster digital innovation in your business?*	**Ad-hoc innovation** with highly variable investment. Limited visibility of outcomes and minimal benefit to business. Risk-averse blame culture with fear of failure.	Owner's innovation strategy considers **digital transformation, with investment in pilot projects** demonstrating financial opportunity/risk. Primarily focused on technological innovations. Innovation culture developing in pockets within certain functions/teams.	**Structured, targeted approach to digital innovation** across owner and key partners, including behaviours and processes. Risk appetite understood and partners share investment and rewards. Innovations tested in safe space to fail fast without impacting service to customers. Successful innovations scaled up across all partners.	Learning culture of continuous innovation embedded across the enterprise. **Everyone feels they can contribute ideas**. Horizon scanning supports systematic monitoring and evaluation of emerging digital technologies. Open innovation provides opportunities for digital disruptors and start-ups, incentivising digital suppliers to join ecosystem.	*Digital innovation spans **multiple owners and sectors**, co-creating for mutual value. Collaborative partnerships influence the course of technological innovation to meet industry needs at earlier readiness levels.*
COMMERCIAL					
Value definition — *How do you define value to incentivise the right customer outcomes?*	Focus on achieving **minimum capital cost** for defined outputs. No visibility of actual delivered performance.	Value defined as **minimum whole-life cost** for set levels of performance. Inconsistent application of whole-life cost across owner functions (eg: differences in lifetime, cost allocation and economic value of benefits). Visibility of performance limited to one-off pre-defined tests of 'as-delivered' performance.	Value defined in terms of **maximising societal outcomes on a whole-life cost basis**, influenced by customers. Clear definitions and assumptions provide consistency in assessing whole-life cost and value. Owner functions and partners have visibility of actual, as-operated through-life performance.	Definition of value ensures **societal outcomes fully aligned with outcomes for whole enterprise**, driving performance across the asset lifecycle. Supported by increased granularity of information, enables new business models and service offerings from owners.	*Definition of value ensures **outcomes for wider society** are aligned with those for customers and enterprise.*
Value of information — *How do you value information in your commercial models?*	**Information not valued**, information assets poorly maintained.	**Value of information** in driving better decisions **recognised**, but not fully understood and **poorly linked to business outcomes**. Information hoarded by owner functions and partners to exploit competitive advantage.	Commercial framework incentivises sharing information for mutual value. **Alternative business models share reward on basis of the value added to information**, aligning partner incentives with best value for the customer.	**Valuation models for information assets** guide commercial decisions. Information assets enhance valuation of the owner. Regulation and valuation is data driven.	*Valuation of information assets accounts for wider **commercial opportunities in the national information economy**.*
Digital investment — *How well do investments in digital infrastructure meet business needs?*	**Digital infrastructure regularly fails to meet business needs**, drives reactive investment. Proliferation of systems and owners with limited integration. Too much poor value investment (eg: in "IT solutions").	**Recognition that digital investment is needed** to enable transformation. Investment meets current needs but highly variable across owner functions and partners. Systems rationalised with clear plans to retire/replace/integrate. Focus on minimum value proposition with multiple manual workarounds.	**Key platforms are understood and have been implemented**. Investment effectively prioritised to maximise gains and linked to progress against clear digital targets. Integration of next generation digital technologies (eg: cloud, IoT platforms) across owner and partners provides connected systems and consistent performance.	**Fully-integrated, agile and scalable systems in place** across enterprise to support current and future technology needs. Ongoing investment plans driven by underlying value of information assets.	*Digital infrastructure includes shared resources, with investment that **accounts for other sectors' needs**.*

	0 Traditional	1 Simple collaboration	2 Integrated functions and relationships	3 High performing enterprise	4 Interconnected industry
CAPABILITY					
Skills *How well do you understand and manage the digital skills needed for your business?*	**Digital skills generally not considered** in training or HR strategies. Ad-hoc recruitment on a job-by-job basis. Work may be underway to understand digital skill gaps.	Owner and partners have **clear understandings of their digital skills**, gaps in capability and priorities to address them. Recruitment considers transferable digital skills as well as sector-specific experience. Centralised digital teams may exist to create critical-mass capability.	**Core digital capabilities in place** across all owner functions and partners. Digital agility a core attribute with staff expected to learn, unlearn and relearn skills and behaviours throughout career. Training programs redesigned to develop digital skills needed by owner and partners. All role definitions updated to reflect digital requirements, some skills retired.	**Prioritise digital fluency in recruitment** - skills transferable across sectors. Digital skills are central to professional development, performance reviews and career progression.	*Digital skills strategy spans multiple owners and sectors to deliver a self-sustaining pipeline of talent that meets digital needs of infrastructure industry.*
Suppliers *How do suppliers meet your needs for digital technologies and services?*	Digital technology **suppliers limited to transactional supply** of specified hardware/ software.	**Frameworks in place for suppliers of digital** services and technologies. Digital suppliers perceived as a threat by traditional partners, creating competition.	**Collaboration between digital and traditional partners** develops understanding of respective capabilities and requirements. Owner understands its own needs, not dictated by vendor-led decisions, and matches approach to capability of partners.	**Owner supported by ecosystem of digital partners**, including agile start-ups as well as established players. Effective integration across the enterprise, drawing on strengths and domain knowledge of all partners.	*Owner **sources and shares supplier ecosystem** with other sectors.*
Information security *How do you assure information security and compliance?*	**Staff not aware** of how information security relates to their role and activities. Perception that security compliance "gets in the way" of business. Legacy IT systems may present vulnerabilities and compliance risk.	**Security culture developing** - staff aware of core principles but implementation variable across owner functions and partners. Governance focuses on controlling access to information, organisational security compliance tested. Technology risks understood and existing vulnerabilities resolved.	**Security risks managed consistently** across owner and partners through combination of physical, technical and cultural controls, **accredited to ISO27001**. Governance procedures in place to deal with any incidents, and robust technology prevents unauthorised access. Owner actively engages and informs all stakeholders with influence over security - including customers. Board-level ownership for data security and compliance.	**Robust systems manage known and emerging threats** from terrorism, malicious activity and cybercrime as part of wider corporate resilience. **Provisions of PAS 1192-5 are followed, including separation of sensitive data to prevent aggregation by others**. Strong information security culture across the enterprise: staff understand their personal responsibilities. Enterprise has knowledge and capability to maximise opportunities and manage risks.	*Contributing to National Cyber Security Strategy through collaborative action against cyber threats. Risks from interconnected system-of-systems managed through effective coordination across sectors.*
ASSET DELIVERY					
Digital integration *How do you integrate engineering, operational and information technologies?*	New assets generally specified as either **purely physical or digital. Complete lack of integration** between engineering, operational and information technologies.	Physical assets are specified, with **digital technologies 'tagged on' afterwards**. Delivered by different suppliers with limited interface and coordination.	Leading investments delivered as **integrated physical-digital systems**. Digital upgrades enhance value of existing assets.	**All investments** maximise value from integrated physical-digital systems. Delivery of new information assets considered as important as corresponding physical assets.	*Investments **maximise shared value across multiple owners** and sectors through integrated physical-digital systems.*
Data availability *How do you capture and provide the data necessary for delivering new assets?*	Existing **asset information generally missing** or unreliable. Site data provides limited samples of information (eg: trial holes). Typically collected by manual surveys with relatively high marginal cost.	Reality capture technologies provide **one-off data snapshots** (eg: scan-to-BIM of existing assets), appropriately processed to integrate with common data environment. Limited to critical and high-value assets/interfaces. Sensors may be installed for condition monitoring of high risk assets.	Reality capture and sensors **provide regular monitoring** (eg: performance, condition) throughout delivery process. Information from owner's master asset register and assured open/third party information reduces need for project-specific data capture on existing sites.	**Continuous monitoring using owner's smart infrastructure** assets and project-specific data sources provides real-time information, including condition and performance.	*Continuous monitoring draws on **data feeds from third party assets**.*
Information management *How do you manage information about new assets?*	Designs produced in **2D CAD with no coordination** between different drawings or assets. No integration of additional data.	**2D/3D content** managed with a collaboration tool that provides a **common data environment**. Engages key partners, but does not extend to all suppliers. Limited integration with production and commercial data using proprietary interfaces or bespoke middleware.	Common data environment specified by owner with **well-defined information requirements, used by all partners**. Fully open process and data enabled by industry standards. Includes production and commercial data across delivery process. Creates an as-built information model that meets operational needs for whole-life asset management.	**Open data exchange** supported by appropriate standards. **Full integration with smart infrastructure systems**, using and providing data from internet of things and telemetry systems. Enables real-time asset performance reporting and a 'digital twin' that fully reflects the physical world.	*Enables **value to be measured through wider societal outcomes** as part of a 'national digital twin' for infrastructure, with direct impact on national productivity.*
Standardisation & automation *How do you use standard products and advanced manufacturing in asset delivery?*	Delivery is non-standardised, **every project is treated as a one-off**. Traditional labour-intensive construction sites with high number of specialist trades. Limited use of off-site manufactured components.	**Standardisation/design for manufacture & assembly (DfMA)** using proprietary components and standard products for simple assets. Products do not yet integrate engineering, operational and information technologies. Product information focused on delivery phase, with some additional data (eg: BIM, cost models, carbon footprint, data sheets) but availability varies and is product-specific.	**Extensive catalogue of standard products** used by owner and partners, developing compliance with emerging industry standards. Products fully integrate engineering, operational and information technologies and meet asset information requirements. Increasing automation, particularly in design and advanced manufacturing.	**Complete 'productionisation' of delivery process**, delivering bespoke solutions from interchangeable quality-assured components. Enables circular economy approach and increasingly agile infrastructure. Extensive automation across all stages of delivery, capitalising on emerging technologies (eg: additive manufacturing, advanced materials).	*Standardisation across infrastructure industry enables further efficiencies in **integrating systems across sectors**.*
ASSET MANAGEMENT					
Data availability *How well does data meet all your business needs?*	**Limited data available for most assets** from historic records. Low quality of most data types with many omissions and inconsistencies. No visibility of data controlled by other functions, or partners.	**Asset registers are largely complete**, although multiple may exist with some duplication and inconsistencies. Asset performance defined, with some through-life performance and condition data available for high value/risk assets. Limited visibility across different owner functions and partners of non-personal data (ie system, organisational and asset data), with some limited use of third party/open data.	**Data visibility spans owner and partners to meet functional needs** (including customer, network, organisational, asset and environmental data). Master asset register exists, with performance and condition data available for all assets, but generally of limited granularity. Recognition that data variety more important than quantity reflected in decisions over what unstructured data to collect for future use. Extensive use of third party/open data, with plans in place to share more owner data.	**Data available by default to meet enterprise needs**, with required granularity, timeliness and completeness for all functions. Non-personal data (including network, asset and organisational data) shared wherever possible, accounting for security, privacy and legal considerations, to help stimulate innovation. Digital twin adequately reflects the physical world - including operational activities.	*Information **compliant with National Framework for Data on Infrastructure** and integrated into a national digital twin that covers multiple owners and infrastructure sectors.*
Information management *How do you ensure that information is fit for its intended purpose and can be shared and reused?*	Poor information **not recognised as a business risk**. Few requirements exist and most information is non-compliant. Information exists in silos, often duplicated on different systems.	**Owner knows what types of information it holds** and which processes generate it. Risks of existing uncontrolled information assets are understood. Metrics developed for information quality, quantity and usability. Data housekeeping includes processes for reporting errors/discrepancies and improving compliance.	**Information** created in different applications for different uses **can be shared and reused** across owner functions and partners. Robust governance of quality, including provenance, provides assurance. Information requirements with identified owners provide clear direction with well-structured, prioritised use cases for new information.	**Requirements are shaped and influenced by all partners** in enterprise and deliver effective through-life information management. A culture of personal responsibility for information, comparable to construction's health and safety culture, exists throughout the enterprise.	*Full interoperability between information management systems, both internal and external.*
Sense making *How do you use and combine information to inform decisions?*	Focus on reporting for compliance. **Static dashboards with limited functionality** developed by individual owner functions. Complaints of information overload, struggle to extract real value, much data never analysed nor stored.	**Integration of data streams in analysis of historic trends** reveals insights from previously unused data sets and new combinations spanning owner functions. New analytics developed and tested in exploration environment, before release to 'business as usual' systems.	**Predictive analytics forecast future states** from available data (eg: impact of operations on customer outcomes; predictive maintenance scheduling). Real-time analytics available where required. Widespread use of machine learning unlocks value of existing and legacy data.	**Analytic capability fully meets enterprise needs**, informing decisions across all functions to help optimise value. Algorithms are valued for their ability to help improve outcomes.	*Analytics incorporate diverse impacts of other sectors and **interdependency of system-of-systems.***
Decision making *How are decisions supported by data-driven insight?*	**Decisions made according to prescribed standards/procedures**; or on basis of experience, instinct and judgement - often not informed by evidence. High proportion of reactive decisions.	**Decision support tools available** to inform some high value/risk decisions, generally require **manual analysis/assessment** and input. Decisions based upon historic predictive models for performance, not actual operational performance.	**Decision support systems inform all critical decisions with timely, dynamic output**. Interdependence mapping starting to be considered. Insight available on demand, irrespective of physical location. Decisions based upon actual performance and foresight. Significant automation to optimise routine processes across all functions.	**Decision support systems integrated across all owner functions and timeframes** from real-time operation to long-term investment planning. All routine processes automated to optimise value, anticipating where human judgement is required, particularly for strategic decisions.	*Decision making and optimisation accounts for **interdependency of system-of-systems** across multiple owners and sectors.*

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