SAP WHITE PAPER

Digital Transformation of Public Infrastructure

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Executive Summary

Public infrastructure is essential for flourishing societies and sustaining much of our modern life. It forms the backbone of economic growth by supporting communities, growing cities, and boosting business. Over 20% of Australia's GDP is attributed to the infrastructure sector, returning a multiplier of $4 for every $1 spent on public infrastructure.

(Source: Infrastructure Market Capacity Report (Infrastructure Australia, Oct 2021)

While we have much to be thankful for with the increased investment in public infrastructure, we must also appreciate that it is by far the single largest, most complex and most expensive investment our governments can ever make. And right now, our governments are investing in public infrastructure at unprecedented levels.

Across Australia we are entering a phase of significant transformation, triggered by unparalleled levels of investment in public infrastructure and rapid digital acceleration in response to COVID-19. The 2020-21 budgets have been described as 'once-in-a-generation', delivering a record-breaking program of transport megaprojects (valued over $1 billion) throughout Australia. Close to $220 billion will be delivered by 2025, and a further $70 billion is already committed until 2030. The annual spend is forecast to peak in 2023 at over $52 billion, which represents twice the 2020 expenditure rates (Source: Infrastructure Market Capacity Report (Infrastructure Australia, Oct 2021).

Delivering this simultaneous program of megaprojects across Australia is truly extraordinary, with the infrastructure sector currently delivering projects at a remarkable rate. This monumental level of investment presents significant opportunities for both the public and private sectors and will deliver community benefits for many generations to come.

This also represents the single largest risk to Australian budgets as, despite best intentions, governments are now exposed to the possibility of substantial project time and cost overruns. This may be further exacerbated by growing pressures on sourcing materials, market capacity and skills shortages. In many ways, this record-breaking level of investment has entered unchartered territories, and now represents a collective journey into the unknown.

Delivering infrastructure is highly complex and requires controlled orchestration of many parties making technically complex decisions within the constraints of legal/contractual requirements, time, cost, site access, staging, resourcing, community concerns, and many more factors. Frequent variations are common throughout the infrastructure delivery process, which essentially alter the agreed project methodology, outcomes, and cost.

Infrastructure projects are currently delivered with relatively low data management maturity, with government agencies generally lagging private sector digital capabilities. Low data awareness, coupled with limited digital capability, is a critical issue. Poor data management is a primary cause of poor project outcomes and may negatively impact future efforts to adopt new technologies and build digital twins of public infrastructure.

We now have an urgent need and a significant opportunity to address these project risks, by transforming the management of these projects and driving a step change in productivity through the uptake of digital technologies.

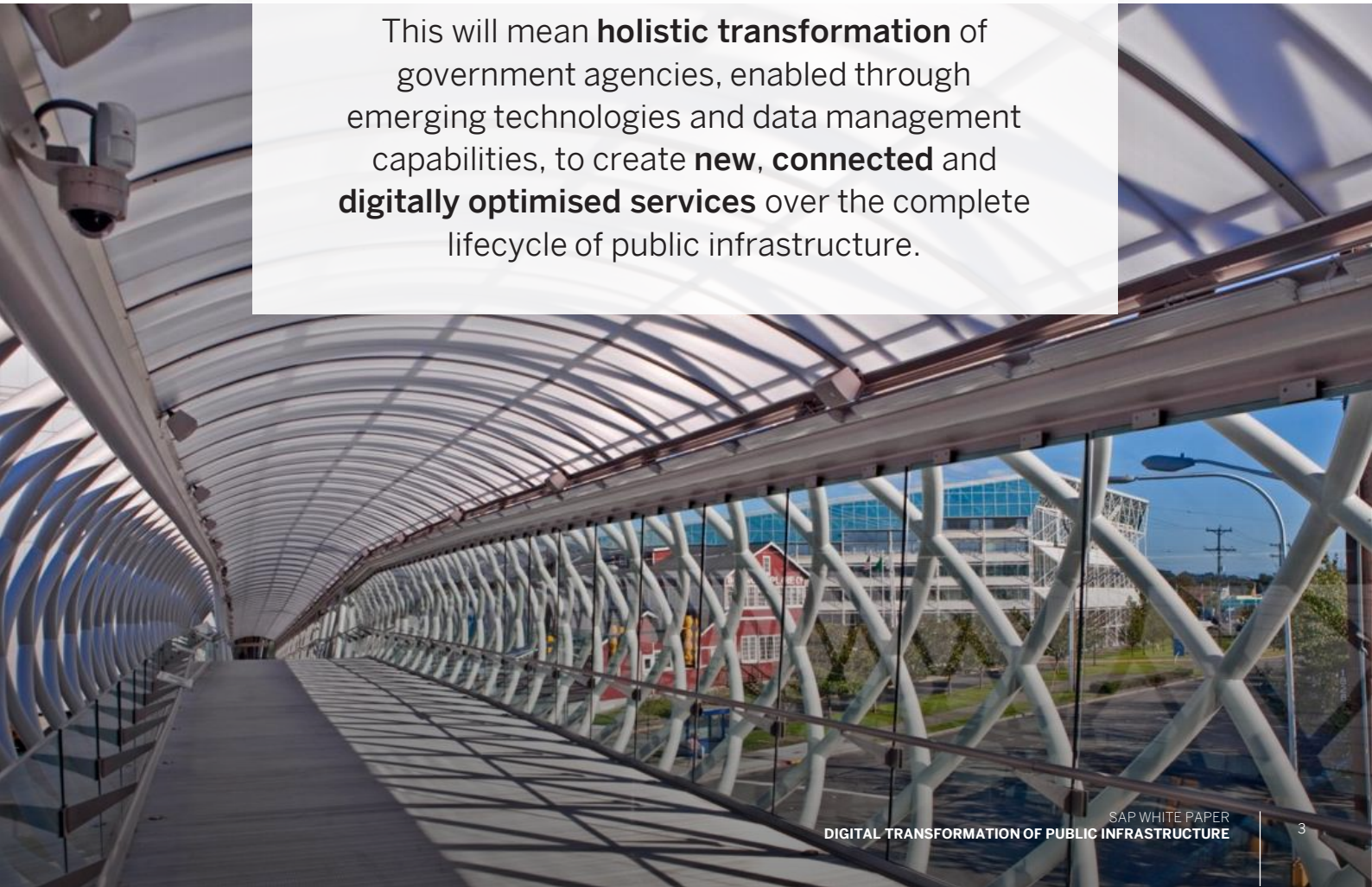
Digital transformation of public infrastructure represents a new, end-to-end vision for the systems and services throughout the built environment that support and connect the general public. This concept extends beyond customer facing technologies, personalised services or point solutions with emerging technologies.

This vision will create a complete digital ecosystem, built on trusted and reliable data, that connects infrastructure agencies with their suppliers, stakeholders, and customers. It will also promote cross-agency cooperation, by actively supporting data sharing and digital collaboration, to re-invent how government agencies partner together to plan, deliver and operate public infrastructure.

Government agencies will benefit from new business strategies, that are led by senior leadership who recognise the significant opportunities of broadscale digital transformation. These strategies will help agencies navigate the journey of resource allocation, coordination of new initiatives and building new digital business capabilities (such as improved data literacy and digital dexterity). Leading organisations are becoming more agile, powered by a core that is end-to-end digital over the complete lifecycle of infrastructure assets – otherwise known as the "digital thread".

The 'digital thread' will enable agencies to transform asset performance, boost productivity and to capitalise on new opportunities offered through digital technologies. This will also lay the foundation of structured data, that will pave the way for broader benefits and opportunities such as networked digital twins, smart infrastructure, and the holistic objectives of smart cities.

This will mean **holistic transformation** of government agencies, enabled through emerging technologies and data management capabilities, to create **new**, **connected** and **digitally optimised services** over the complete lifecycle of public infrastructure.

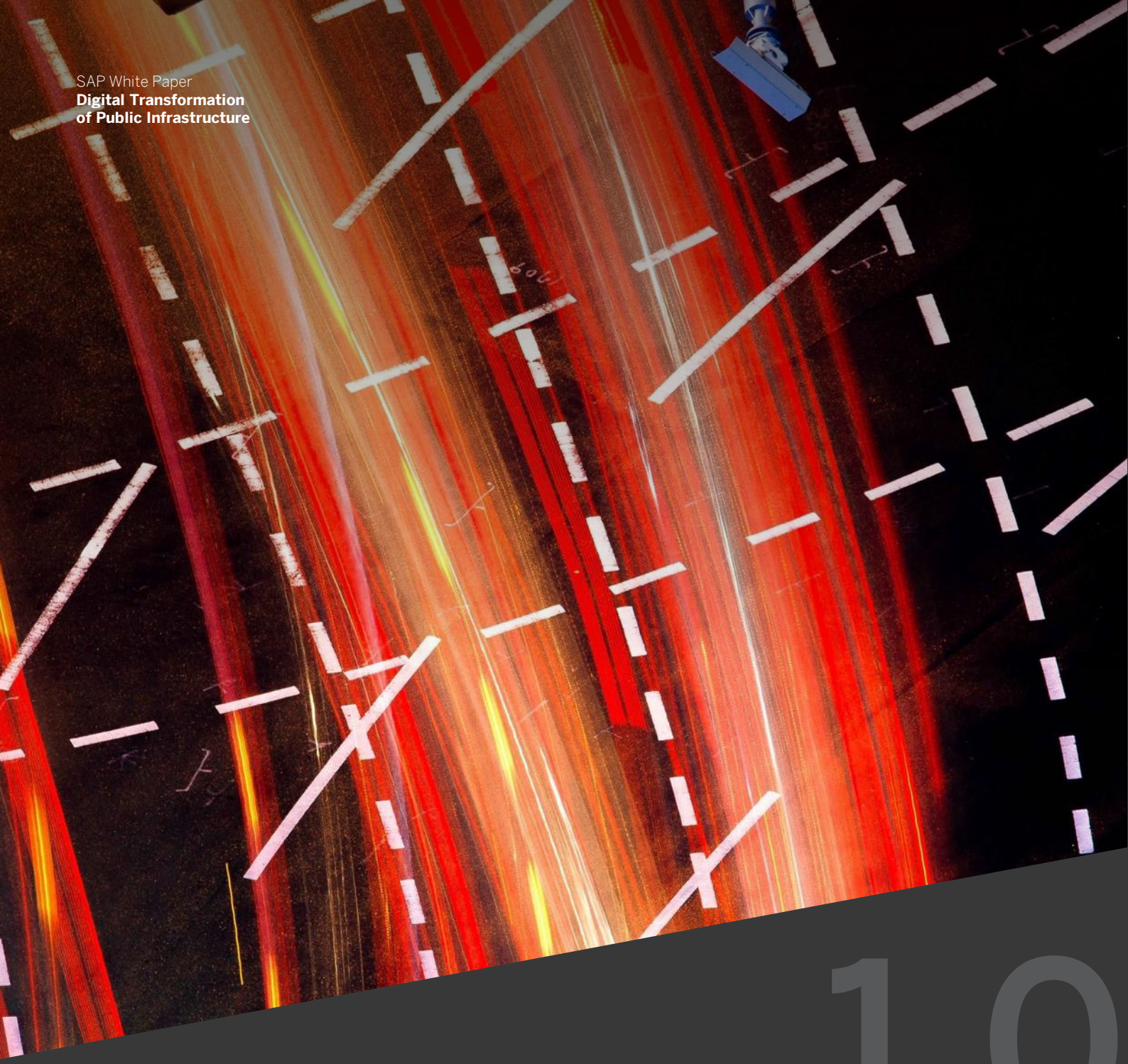


Recommendations

We recommend five immediate actions for Australian governments, that build on existing efforts and will work together to deliver the holistic improvements offered by digital transformation of public infrastructure:

No.	Theme	Current Gap	Recommended Action
01	 Digital Leadership	Infrastructure agencies are currently developing digital strategies in isolation, without formal collaboration, central governance, or national consistency.	**Establish a national body, with federal, state and territory members, responsible for leading a Australian digital strategy for public infrastructure.**
02	 Data	Data specified on public infrastructure projects is typically unstructured and does not support effective management over the digital asset lifecycle.	**Create national data standards that support the digital asset lifecycle and digital twins for public infrastructure.**
03	 People	Infrastructure projects are currently delivered with relatively low data management maturity, with government agencies generally lagging private sector digital capabilities.	**Infrastructure agencies should build in-house digital capability, through the introduction of dedicated roles, responsible for improved data management over the digital asset lifecycle.**
04	 Process	Current ad-hoc project data requires heavy administration and is not industrialised to enable the digital asset lifecycle (the digital thread).	**Infrastructure agencies should work in collaboration, defining best-practice digital processes and specifications, to 'industrialise' the digital asset lifecycle.**
05	 Technology	Current platforms unable to support effective data management over the complete digital asset lifecycle.	**Invest in a technology platform that will support the digital thread across the complete digital asset lifecycle.**

Table of Contents



SAP White Paper
Digital Transformation of Public Infrastructure

1.0

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Introduction

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1.0 Introduction

Across Australia we are entering a phase of significant transformation, triggered by unprecedented levels of investment in transport infrastructure and rapid digital acceleration in response to COVID-19. The 2020-21 Budgets delivered by Australian governments have been described as 'once-in-a-generation', delivering a record-breaking program of transport "megaprojects" (projects valued over $1 billion) throughout Australia. This presents a significant opportunity for both the public and private sectors, that will deliver benefits to their citizens for many generations to come.

These opportunities will not be without their challenges. Delivering numerous megaprojects simultaneously across Australia presents the risk of substantial time and cost overruns – that may have significant impacts to the government programs, budgets, and reputations. Commuters and the general public may also be at risk, due to the negative impacts of disruption and delays if project milestones are missed and construction times overrun.

Infrastructure projects in the urban 'brown-field' environment are highly complex and are exposed to a vast array of risks and uncertainties during delivery. It is now recognised that the traditional methods of project management in construction are no longer able to keep up with the level of scale and complexity on megaprojects. As clients demand greater certainty of project time and transparent cost outcomes, new approaches are required to transform how project data and information are managed, not only during project delivery, but over the complete lifecycle of infrastructure assets.

Digital ways of working are now emerging in the construction sector that improve project controls, enable greater cost certainty, and deliver a step change in project delivery. Bringing together the power of modern digital technologies will improve predictability of outcomes for government, delivering better value for citizens and to the economy in general.

This is transforming how project and asset information is managed, through the adoption of emerging digital technologies and new business processes, to create cost savings and improve productivity for both contractor and client stakeholders. By adopting a digital approach to project delivery, project data can be reliably re-used by all project stakeholders to make more informed, data-driven decisions throughout the project delivery.

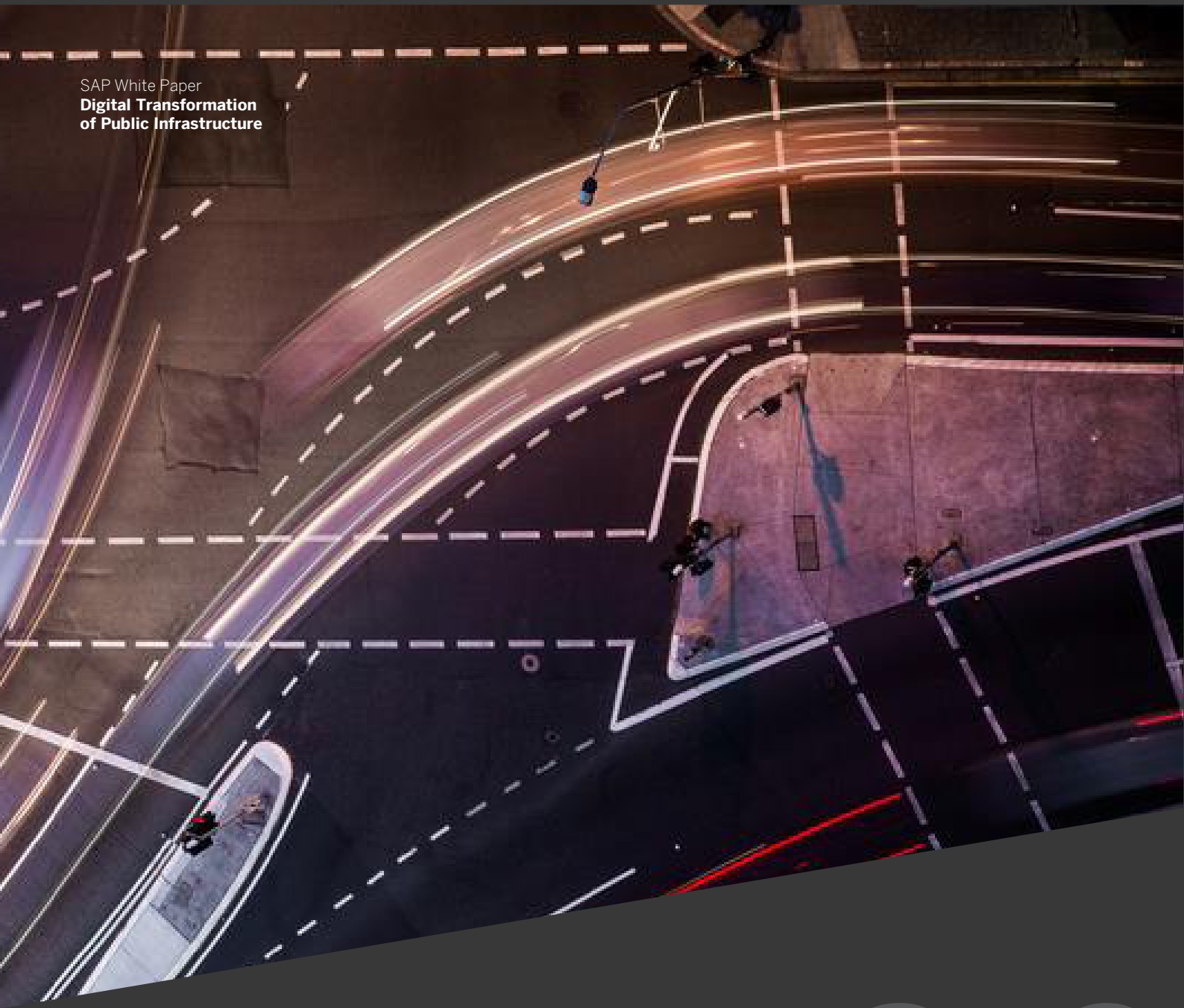
Digital project delivery is now being adopted on major infrastructure projects globally including across Australia and New Zealand. Pockets of excellence have emerged that may be adapted to help accelerate the adoption of digital engineering, enabling government agencies to truly become 'digital by default'.

> **"Embracing digital innovation and the use of data will enable the sector to deliver higher quality infrastructure for the same cost."**
> 2021 Australian Infrastructure Plan (Infrastructure Australia Sept 2021)

A significant opportunity and need has arisen for Australian government agencies to optimise the delivery of infrastructure projects, through the uptake of new technologies and digital engineering capability, so that digital excellence becomes the norm.

> **"Governments can drive digital by default outcomes by proactively working with industry to adopt tools and practices that will improve productivity."** 2021 Australian Infrastructure Plan (Infrastructure Australia Sept 2021)

There is now an urgent need for digital transformation of public infrastructure.



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2.0

Digital Transformation of Public Infrastructure

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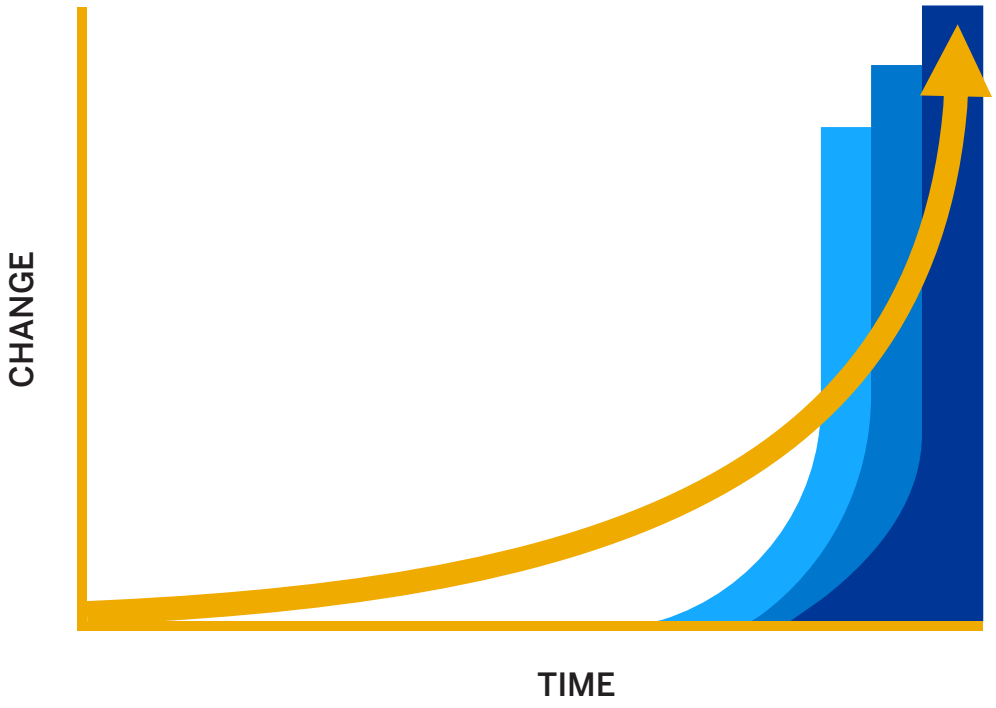
2.0 Digital Transformation of Public Infrastructure

2.1 What is digital transformation?

The world is changing. All sectors across the business landscape are shifting, with market leaders rapidly adapting to the rise of emerging technologies and pioneering new opportunities through digital transformation. Technological improvement is happening at a faster rate than ever before. Computers continue to become smaller, cheaper, more powerful, better connected, and embedded everywhere. It is now projected that today's pace of change is the slowest we will ever see, with acceleration being the new constant.



Digital transformation can unlock

$100 trillion

of value for business and society over the next decade[4]

80%

of companies plan to accelerate their digital transformations, but only 30% succeed in achieving their objectives[5]

Digital leaders achieve earnings growth that is

1.8x higher

Than digital laggards[6]

4. World Economic Forum, Digital Transformation Initiative, 2018
5. BCG, Flipping the Odds of Digital Transformation Success, 2020
6. BCG, Flipping the Odds of Digital Transformation Success, 2020

Digital transformation is a term that is commonly used but is frequently misunderstood. This level of change represents much more than simply adopting new technologies or remote working in the cloud. Digital transformation represents a fundamental shift in how an organisation manages, consumes and re-uses data – to essentially become a data-driven organisation that is built on a culture of 'digital by default'.

Digital transformation is the holistic integration of digital innovations that reaches into all areas of an organisation, and fundamentally changes how it operates and delivers value to customers. It is also a cultural change, enabled through a collective vision and cross-collaboration, that breaks down institutional siloes and continually challenges the status quo.

Digital transformation does not happen overnight. It is effectively a journey, one that requires vision and commitment from senior leadership. Leaders must demonstrate unwavering support to set the plan in motion, commit the resources, and to navigate the organisation towards a pioneering, fresh and often radically different way of doing business. As Boston Consulting Group (BCG) points out in its research, successful digital transformations are rare with the odds of success at 30%. But BCG also found companies getting six factors right can flip these odds to 80%. Interestingly, most of these factors are not technical in nature, but a foundation of change management applicable to any corporate transformation initiative. (BCG, Flipping the Odds of Digital Transformation Success, 2020)

2.2 What is public infrastructure?

Public infrastructure refers to infrastructure facilities, systems, and structures that are developed, owned, and operated by the government, including those facilities open to the general public.

Infrastructure includes all essential systems in the built environment that are fundamental for the general community's standard of living and enhance the smooth flow of an economy's day-to-day activities. All public infrastructure falls within six broad categories, namely transport, social (including health, education, justice etc.), energy, water, waste, and telecommunications.

> *"Infrastructure is the backbone of economic growth. It improves access to basic services such as clean water and electricity, creates jobs and boosts business."*
>
> **Alok Sharma,** President of COP26 & Minister of State at the Cabinet Office, Nov 2019

Infrastructure Australia reports that over **20%** of our GDP is attributed to the infrastructure sector, with every $1 spent on public infrastructure returning a multiplier of $4. There are however significant opportunities for improvement, particularly regarding productivity. Over the past 30 years, the infrastructure sector has become **25%** less productive compared to other Australian sectors such as mining, manufacturing, retail, and transport.

Source: Infrastructure Market Capacity Report (Infrastructure Australia, Oct 2021)

2.3 What is the digital transformation of public infrastructure?

Digital transformation of public infrastructure represents a new, end-to-end vision for the systems and services throughout the built environment that support and connect the public. This concept is not about customer facing technologies, personalised services or point solutions with emerging technologies. It is about helping government plan, manage and run its infrastructure better.

This vision will create a complete digital ecosystem, built on trusted and reliable data, that connects infrastructure agencies with their suppliers, stakeholders, and customers. It will also promote cross-agency cooperation, by actively supporting data sharing and digital collaboration, to re-invent how government agencies partner together to plan, deliver and operate public infrastructure.

This will mean holistic transformation of government agencies, enabled through emerging technologies and data management capabilities, to create new, connected and digitally optimised services over the complete lifecycle of public infrastructure.

Government agencies will benefit from new business strategies, that are led by senior leadership who recognise the significant opportunities of broadscale digital transformation. These strategies will help agencies navigate the journey of resource allocation, coordination of new initiatives and building new digital business capabilities (such as improved data literacy and digital dexterity). Leading organisations are becoming more agile, powered by a core that is end-to-end digital over the complete lifecycle of infrastructure assets – otherwise known as the "digital asset lifecycle".

The 'digital asset lifecycle' will enable agencies to transform asset performance, boost productivity and to capitalise on new opportunities offered through digital technologies. This will also lay the foundations of structured data, that will pave the way for broader benefits and opportunities such as networked digital twins, smart infrastructure, and the holistic objectives of smart cities.

How is this different from public digital infrastructure?

"Public digital infrastructure" is a broad term commonly used to describe telecommunication technologies, equipment and systems that connect people and communities with data, products and services. It is the physical infrastructure that enables the digital economy.

It includes physical assets, such as fibre optics, satellites, IoT devices, high-powered computing facilities and data centres, to support telecommunication services such as the mobile network, fixed phone and broadband services and location-based services (e.g. GPS). It also includes less-tangible elements such as data, digital services, and reusable components.

This infrastructure is critical and is the foundation on which digital transformation of public infrastructure is built. However, this is not the primary focus of this paper. Digital infrastructure is just one out of many asset classes that fall under the more general banner of public infrastructure. Digital transformation of public infrastructure seeks to address all infrastructure categories, namely transport, social (including health, education, justice etc), energy, water, waste, and telecommunications.

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3.0

Challenges Facing Public Infrastructure

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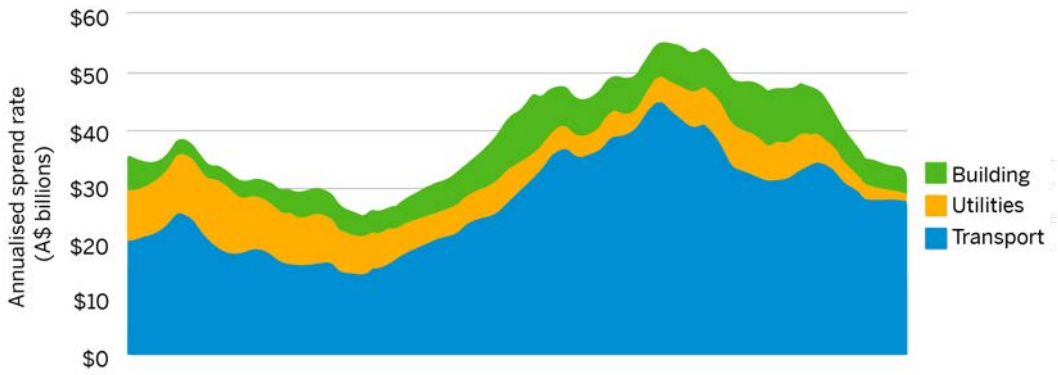
3.0 Challenges Facing Public Infrastructure

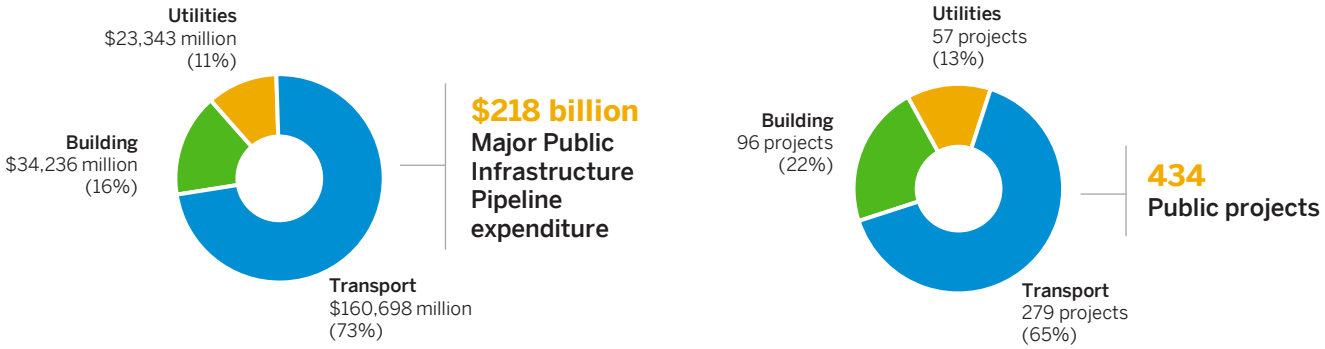
3.1 Record investment

Across Australia we are entering a phase of significant transformation, triggered by record-breaking levels of investment in transport infrastructure and rapid digital acceleration in response to COVID-19.



Source: Infrastructure Market Capacity Report (Infrastructure Australia, Oct 2021)

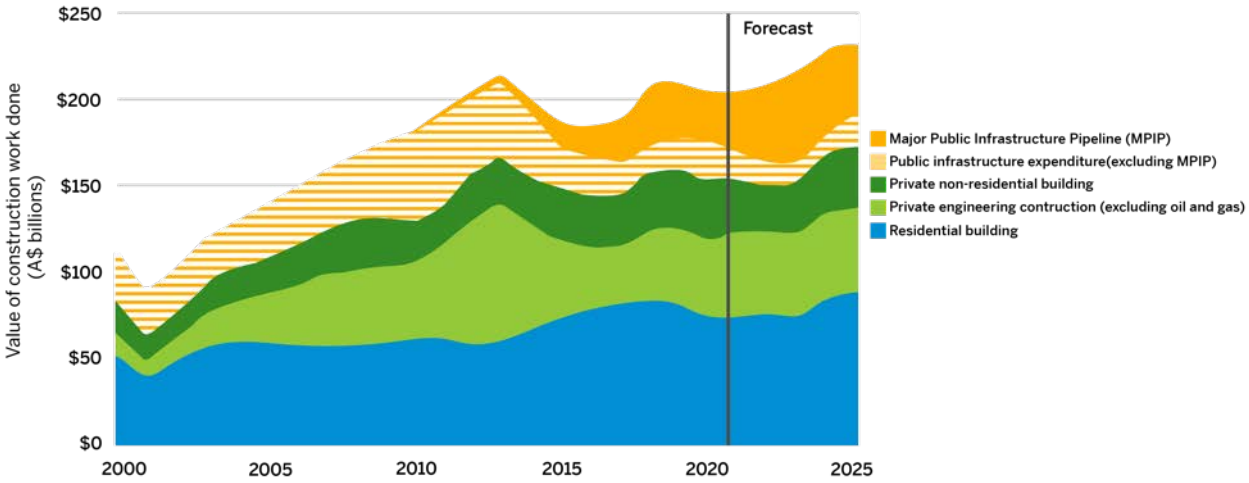
Australian Governments have made commitments toward an unprecedented wave of infrastructure investment across transport, utilities, and social infrastructure. An expected $290 billion investment is planned over the next 10 years, including an approximate doubling of investment over the next three years. Annual spending will peak in 2023 at over $52 billion. This represents approximately twice the 2020 expenditure rates.



Source: Infrastructure Market Capacity Report (Infrastructure Australia, Oct 2021)

Over the next 5 years, approximately 434 projects worth $218 billion will be completed. NSW, Queensland, and Victoria account for 87% of the activity, and are projected to consume more than 85% of projected resource demands over this period. The transport sector will dominate demand, with approximately 73% of funds allocated to transport projects.

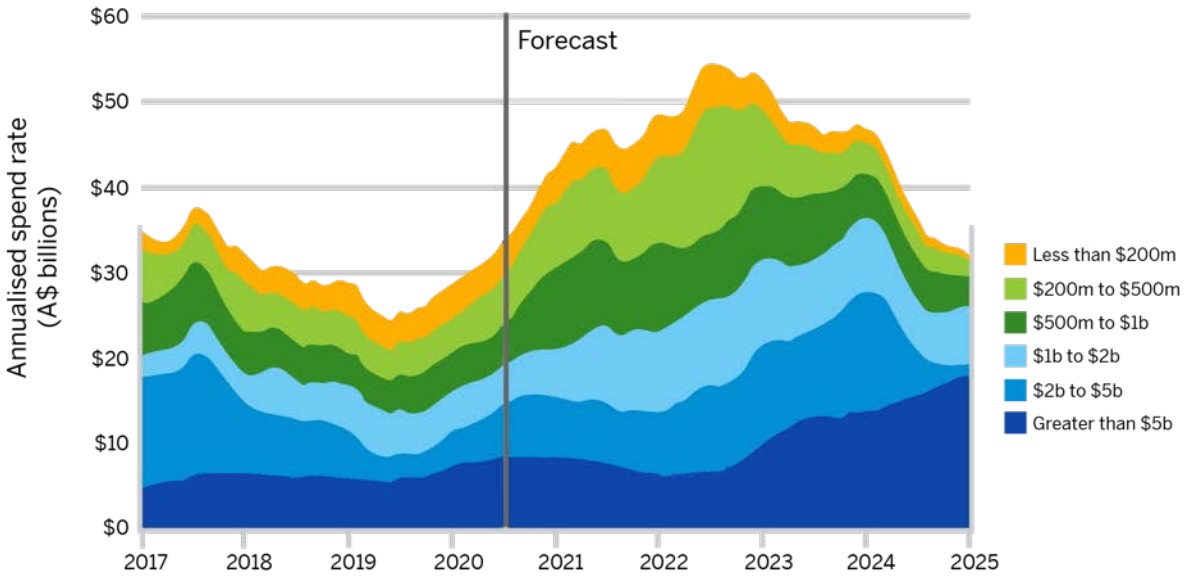
Public infrastructure projects are only part of the picture relative to total investment in construction. When taking the private sector into account, major public infrastructure expenditure will account for 20% of the total $1,095 billion engineering and construction expenditure across all sectors.



Source: Infrastructure Market Capacity Report (Infrastructure Australia, Oct 2021)

This level of investment presents a significant opportunity for both the public and private sectors and will deliver benefits to communities for many generations to come. These opportunities however will not be without their challenges.

3.2 The rise of megaprojects



Source: Infrastructure Market Capacity Report (Infrastructure Australia, Oct 2021)

These opportunities will not be without their challenges. Delivering numerous megaprojects simultaneously across Australia presents the risk of substantial time and cost overruns – that may have significant impacts to the government programs, budgets, and reputations. Commuters and the public may also be at risk, due to the negative impacts of disruption and delays if project milestones are missed and construction times overrun.

“Infrastructure Australia’s Market Capacity Intelligence System includes 80 megaprojects and represent less than 20% of the total number of projects in the Major Public Infrastructure Pipeline. Cumulatively, these projects are worth 80% of the total Major Public Infrastructure Pipeline investment over the next five years. Looking ahead, the value of megaprojects will continue to grow. Very large megaprojects represent a disproportionately large component of the Major Public Infrastructure Pipeline, particularly in 2025”.

Infrastructure Market Capacity Report (Infrastructure Australia, Oct 2021)

3.3 Public infrastructure projects are complex

Public infrastructure delivery is highly complex and requires controlled orchestration of many parties (across numerous sub-contracts), making technically complex decisions within constraints of legal/contractual requirements, time, cost, site access, staging, resourcing, community concerns.

For example, as noted in the table below, the delivery of transport infrastructure involves many interconnected layers of roles and accountabilities.

Layer	Role and Accountability
Transport Infrastructure	Involving new and existing networks of unique and specialised assets.
Transport Systems	Comprising of many interconnected safety-critical systems that span across large geographic areas.
Transport Asset Lifecycle	Involving numerous specialised processes, managed by multiple parties, with complex requirements and approvals.
Transport Infrastructure Delivery Contracts	Specifying projects with multi-billion value, communicated in dense, legal, paper documentation (i.e. analogue form).
Transport Infrastructure Projects	Involving precise coordination of numerous parties, delivering services in potentially hazardous environments within time, cost and quality constraints.
Transport Engineering	Requiring collaboration between highly specialised technical parties to deliver multidisciplinary infrastructure solutions.
Transport Construction	Building city-shaping improvements, while minimising community disruption in the complex urban brownfield environment.
Project Teams and Specialised Roles	Orchestrating numerous specialised roles, brought together to form bespoke teams for the sole purpose of delivering individual projects.
Government Agencies, Rules and Regulations	Navigating the complex web of necessary assurance and approval processes.

As a project's scale and complexity grows, so too does the risk of overruns, and with proportionally larger cost. Infrastructure projects in the urban 'brown-field' environment are highly complex, and are exposed to a vast array of risks and uncertainties during delivery, such as:

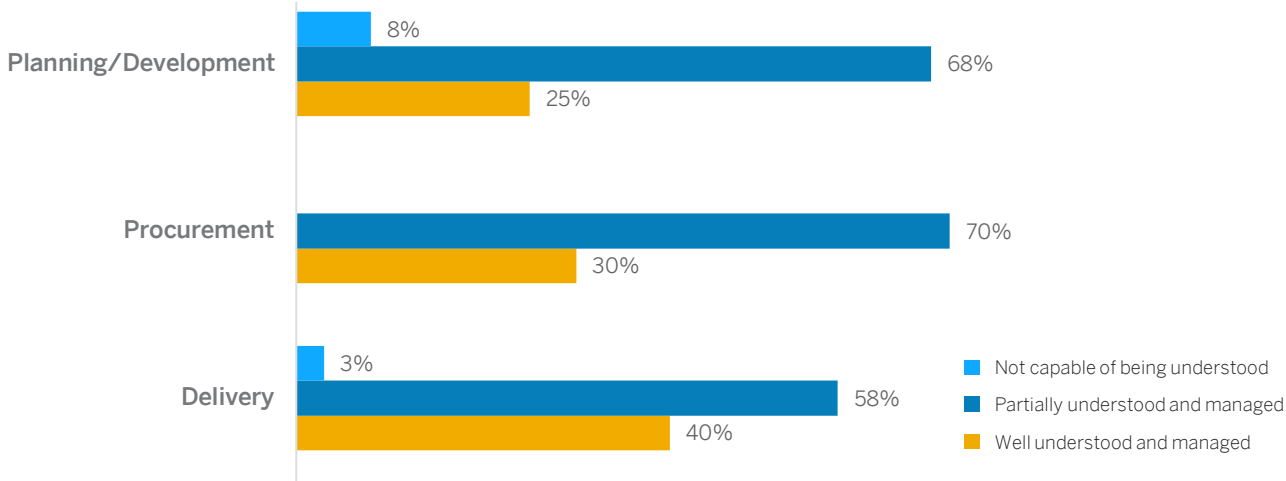
01 – INTERFACE RISK *(between work packages and other projects)*
This becomes more pronounced with the increasing size, scale, and complexity of the infrastructure pipeline.

02 – INTEGRATION RISKS
Often triggered by new infrastructure projects (with more modern technologies) requiring integration into existing systems

03 – UNPREDICTABLE GROUND CONDITIONS
This can lead to significant impacts during project delivery.

"Interface risk is becoming more pronounced with the increasing size, scale and complexity of the infrastructure pipeline".
A National Study of Infrastructure Risk (Infrastructure Australia, October 2021)

Infrastructure Australia recently undertook a market sounding survey with key stakeholders, to assess how government and industry perceive the most effective allocation of project risks. The outcomes of this survey demonstrated generally low confidence in the ability to understand critical risks, with most responses indicating that risks were "partially understood and managed" across the major phases.



Source: A National Study of Infrastructure Risk (Infrastructure Australia, October 2021)

It is now recognised that the traditional methods of project management in construction are no longer able to keep up with the level of scale and complexity on megaprojects.

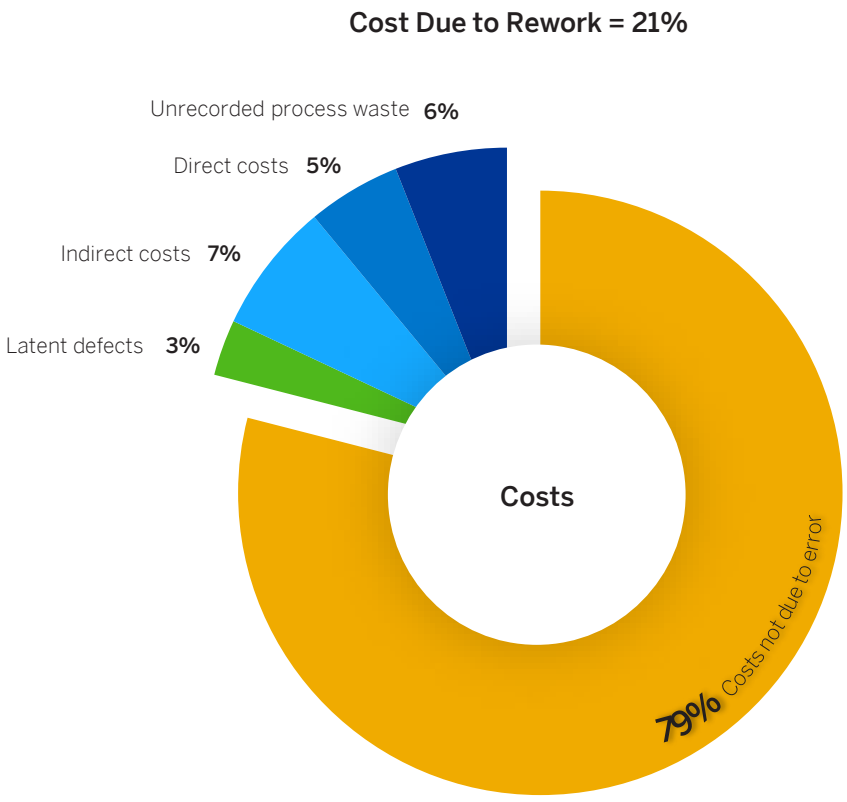
3.4 Risk of project overruns

When the risk of delays and errors from this complexity are combined with large project size the consequence is proportionally larger cost overruns. The domestic and international evidence of project overruns is well documented. Selected data points are noted below.

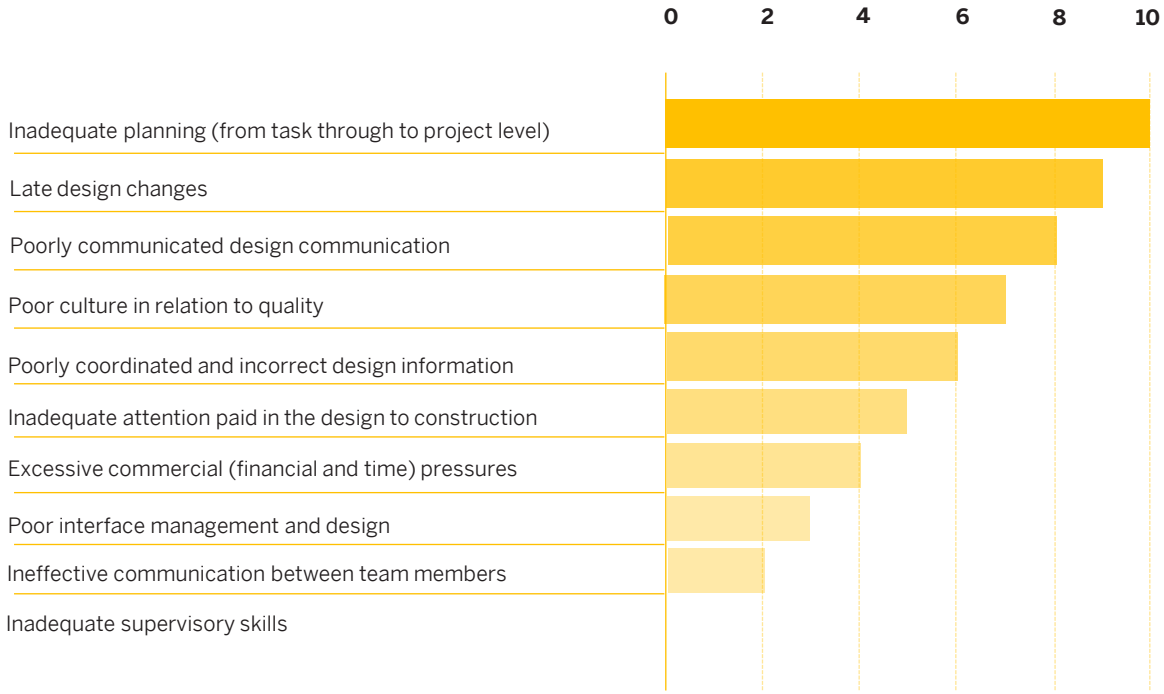
- Australian Constructors Association – 'Changing the Game' (Nov 2019) studied 23 government-led Australian megaprojects and found:
  - Average Project Delay: 27.6%
  - Average Cost Overrun: 20.2%
  - Less than 50% were on-time and on-budget

- Grattan Institute – 'The Rise of Megaprojects – Counting the Costs' (Nov 2020) studied 77 transport projects valued over $20 million throughout Australia from 2001-2020 and found:
  - Average Cost Overrun: 21%
  - This adds up to an overall overrun: $34 billion (net)

- In the UK, the Getting It Right Initiative (GIRI) has explored the topic of project re-work in detail to determine the root causes of project variations and rework. In publishing the "Call to Action" Paper in 2016, they provided the following diagrams as presented below



Root Causes of Rework *(by ranking)*



It is important to note, that the GIRI research has estimated a figure around 21% impacting the cost performance of construction projects due to both direct and indirect costs. The reasons for rework are varied, with several of the 'top-ten' causes relating to design information and design management.

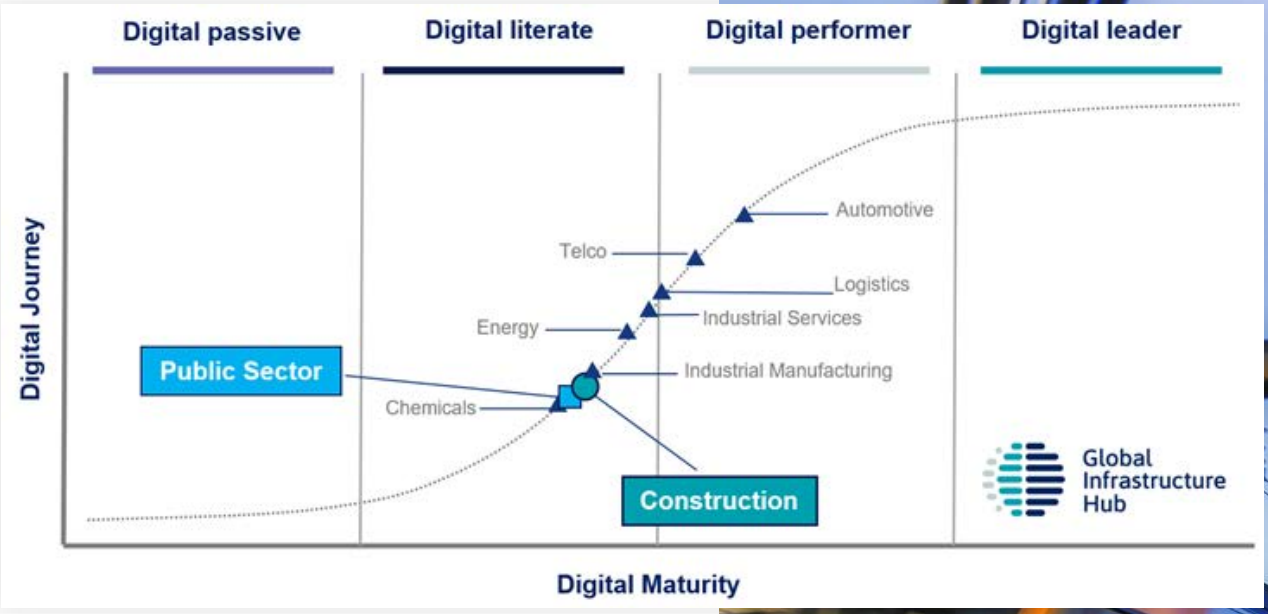
The research highlights significant and recurring issues with scope and design change, and design management of public infrastructure projects. These issues have a close correlation with design information and the inadequate tools and processes currently being employed on projects worldwide. If the sector is ever going to change and begin to improve its digital capability – information management is where to begin.

3.5 Stagnant productivity

All sectors in the economy are experiencing varying levels of digital transformation, fuelled by rapid advances in new technologies, coupled with the recognition that data has immense value to businesses.

However, productivity in the infrastructure construction sector is notable as it has remained stagnant for many years. Over the past 30 years, the infrastructure sector has become 25% less productive compared to other Australian sectors such as mining, manufacturing, retail, and transport. Infrastructure Market Capacity Report (Infrastructure Australia, Oct 2021)

Numerous studies indicate low digital maturity in the infrastructure delivery sector.



Source: Infratech stocktake (Global Infrastructure Hub, July 2020)

Productivity may be improved by addressing the sector's low levels of investment in training and education. More critically, the transformation of the workforce to promote higher levels of digitisation will present new opportunities to improve productivity. Australian Infrastructure Audit 2019, Infrastructure Australia

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4.0

Root Causes of Poor Project Performance

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4.0 Root Causes of Poor Project Performance

4.1 Infrastructure agencies have nascent information management

Traditionally government agencies responsible for delivering major infrastructure projects have been focusing their efforts on delivering physical assets. At the same time, there has traditionally been little attention or value placed on the opportunities presented from the "digital assets" delivered on projects (in the form of structured data), that are critically important for driving successful project outcomes.

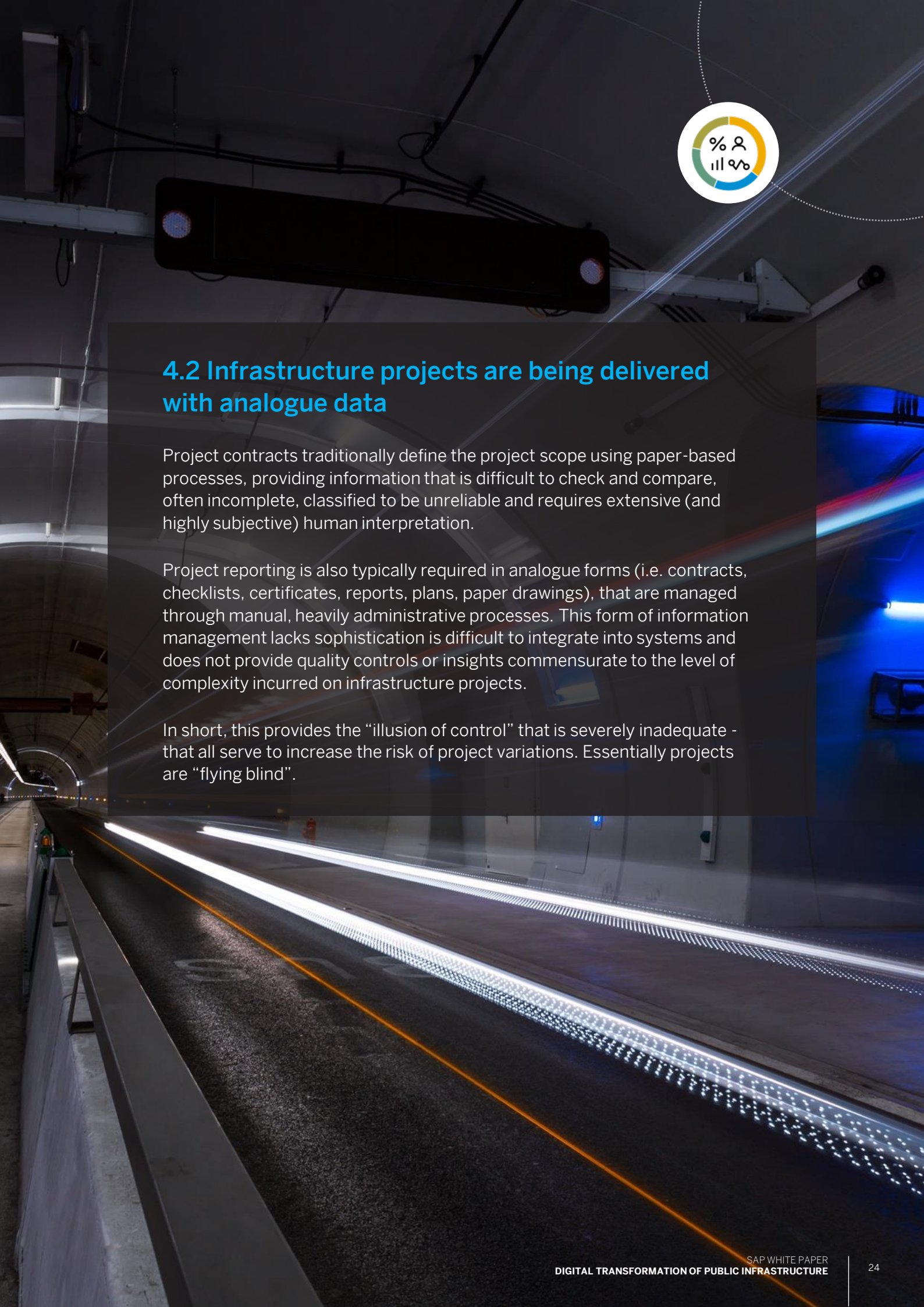
Information has typically been gathered and communicated to meet legal, reporting, procedural and/or records keeping requirements. Without a broader digital ecosystem for creating, managing, and exchanging project information, governments will miss out on the transformative value/insights provided from strategic data management.

An unfortunate consequence of this traditional way of thinking is that Information currently managed by government agencies (through analogue processes) is typically encumbered with the following issues:

- Siloed, uncontrolled, unsecure, unstructured, unrelatable, inaccessible
- Subjective, unverifiable, unreliable, and little consideration for re-use

Government-led infrastructure projects are worth billions, and the implications of project variations can lead to significant impacts such as delays, overspend, customer disruption and damaged political reputation. All decisions should therefore be supported by irrefutable data that is transparent, verifiable, and comparable.

Projects often commence with a limited understanding of what is required and how the project will be delivered. Essentially there are numerous 'unknown unknowns' that are only discovered once the project commences.



4.2 Infrastructure projects are being delivered with analogue data

Project contracts traditionally define the project scope using paper-based processes, providing information that is difficult to check and compare, often incomplete, classified to be unreliable and requires extensive (and highly subjective) human interpretation.

Project reporting is also typically required in analogue forms (i.e. contracts, checklists, certificates, reports, plans, paper drawings), that are managed through manual, heavily administrative processes. This form of information management lacks sophistication is difficult to integrate into systems and does not provide quality controls or insights commensurate to the level of complexity incurred on infrastructure projects.

In short, this provides the “illusion of control” that is severely inadequate - that all serve to increase the risk of project variations. Essentially projects are “flying blind”.

4.3 Low levels of investment for innovation and skills in public infrastructure delivery

Despite the lower productivity there has been limited investment from governments in technological innovation or consideration for new, more digital ways of working, that will improve the capability and delivery of major public infrastructure projects.

Infrastructure project delivery has been largely overlooked, with dedicated digital roles or data management capabilities being uncommon and notably absent from government infrastructure project teams.

"Fog of project delivery"

- In the 'fog of project delivery', project teams and their supply chain work in a relatively uncontrolled environment. Projects are often managed using unreliable data, opaque processes, disconnected workflows, and subjective reporting.
- This results in a lack of true insight into the state of the project, enabled by a lack of data-driven oversight of project performance. This allows projects to overrun, budgets blowout, services are disrupted, impacts to the public and a loss confidence/trust in the government.
- This cycle will continue unless the root cause is addressed.

Critical project decisions must all be based on structured data that is objective, comparable, verifiable, and reliable, all enabled through the digital transformation of public infrastructure.

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5.0

Public Infrastructure Needs Digital Transformation

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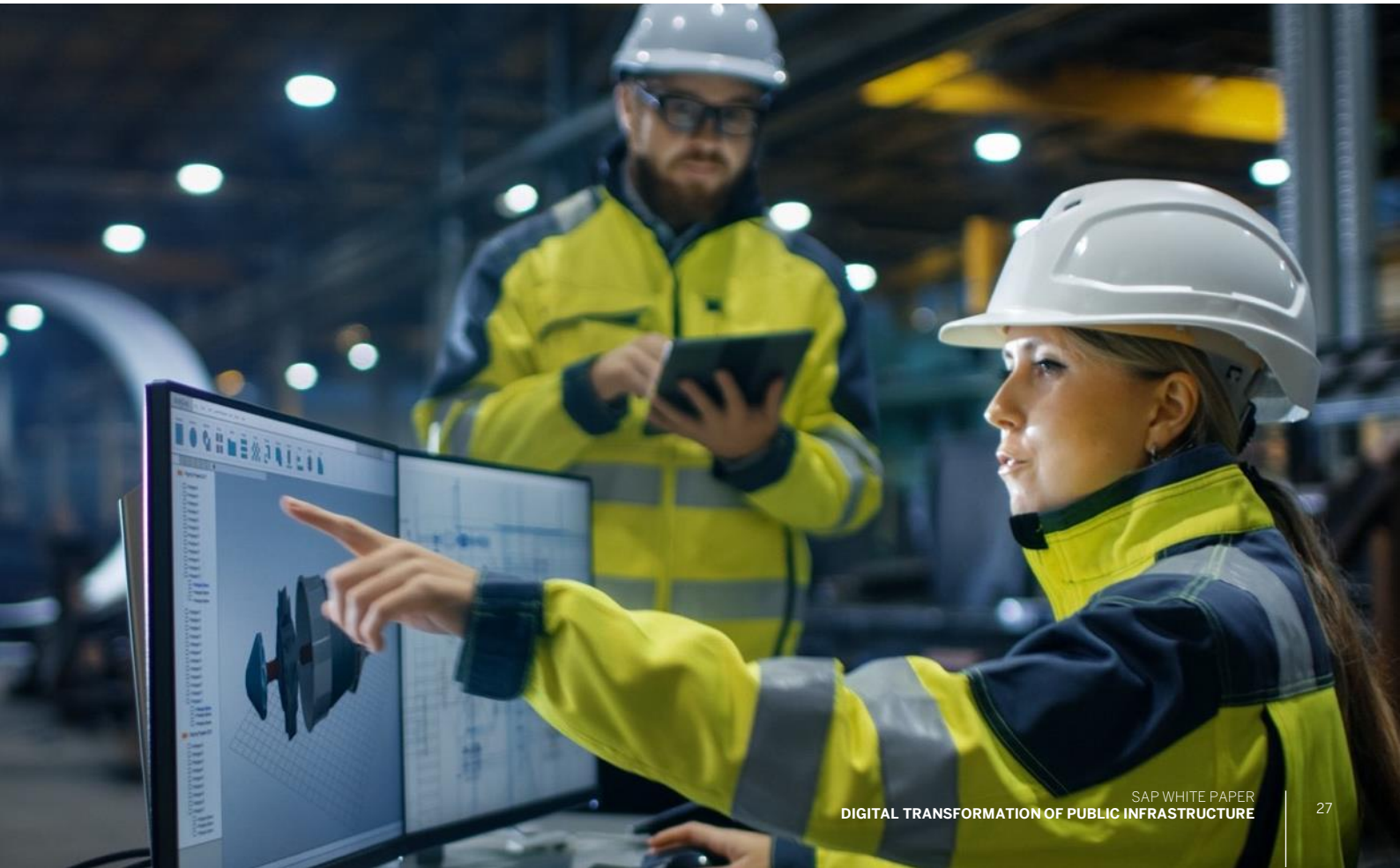
5.0 Public Infrastructure Needs Digital Transformation

5.1 Infrastructure agencies need improved data management

Infrastructure projects are currently delivered with relatively low data management maturity, with government agencies generally lagging private sector digital capabilities. Low data awareness, coupled with nascent digital competence and capability, is a critical issue for the industry. Poor data management is a primary cause of poor project outcomes and may negatively impact future efforts to establish the digital asset lifecycle or to build digital twins for public infrastructure.

In the current business environment, leading sectors that have undergone successful digital transformation have concentrated efforts on improving their data management capabilities. When harnessed correctly, data enables businesses to derive insights, mitigate risk and make more informed decisions, at all levels of the enterprise.

The first major step for public infrastructure agencies is to recognition that all business activities over the asset lifecycle are by nature 'data management' activities.



5.2 Infrastructure agencies need the digital thread

In a digital age, the key to innovation is structured data, not just at a point in time, but across the complete end-to-end asset lifecycle. To capture reliable data across an asset's lifecycle requires a digital thread from planning to construction/commissioning, through operations and refurbishment, eventually to disposal/decommission. This digital thread should capture information such as how the asset was designed, how it was constructed, how it is being used, how it has been (and should be) maintained, when it needs maintenance, and how the asset could be improved. Enabling this digital thread takes more than collaboration between teams, it requires end-to-end integration of business processes and the systems involved.

When delivering infrastructure projects, we need a new approach that will ensure all project data is:

- Connected, controlled, secure, structured, related, accessible
- Objective, comparable, verifiable, and reliable to maximise re-use

This approach will support more reliable, 'data driven' decision making over the complete asset lifecycle.

Data governance, standards and consistent ways of working are also essential for collective government improvement and to make it easier for industry to work with government. The greatest benefits will be realised when Australian governments breakdown existing digital silos, and begin to collaborate on common policies, conventions, and standardisation.

Some governments are now starting to act, with digital information management policies for public infrastructure emerging around the globe.

- Digital Built Britain program (2019) was designed to transform how the UK construction industry and operations management professionals plan, build, maintain and use infrastructure through digital technology. The program is forecast to unlock a 0.5 to 0.7 per cent increase in annual GDP over a 5-year period, rising to 1 to 2.7 per cent over the subsequent 10 years, and growing to 3 to 6 per cent after 15 years.
- Updated UK 'information management' mandate (released Sept 2021) to support investment of 650bn GBP of new infrastructure over the next 10 years.
- BIM has been a catalyst for change – with mandatory BIM polices and standards emerging around the globe over the past 10 years.
- Most major infrastructure projects are now being delivered using digital technologies, however this is largely being led by industry, due to a lack of consistent government capability.

5.3 There is an urgent need for digital transformation of public infrastructure

The pace of change with new technologies is growing rapidly, however the level of adoption is unevenly spread across sectors. Companies are now challenged with the widening gap between individuals and the rapid acceleration of the technology sector.

Most critically is the need for ongoing investment by government in digitisation to maintain parity with business sector. Governments are traditionally the slowest to adapt and respond in the ever-changing landscape of new technologies. This is even more pronounced in the delivery of public infrastructure, where the use of digital technologies to date remains nascent.

With increasing demand for greater certainty of project time and transparent cost outcomes, improved technologies and more digital ways of working are now essential for modern project delivery. Together these will transform how project data and information are managed, not only during project delivery, but over the complete lifecycle of infrastructure assets.

Government consideration of new technologies and improved data management for public infrastructure has typically directed towards incremental ICT improvements or have been focussed on improving customer technologies for more personalised services.

Construction of public infrastructure however has been largely overlooked, with dedicated digital roles or data management capabilities being uncommon and notably absent from government infrastructure project teams. The nascent levels of data literacy and data management capability means that the infrastructure sector is missing out on the significant opportunities and benefits of digital transformation.

The infrastructure sector has been left behind, productivity has not improved, and project performance continues to impact on government reputation. If nothing changes, public infrastructure projects will continue to incur these same issues – placing the unprecedented pipeline of infrastructure projects at significant risk of overruns.

“Only 8% of construction companies globally categorise themselves as technologically adept”.

“The inability to effectively design for emerging technologies limits the potential benefits of infrastructure and reduces their effective lifespans”.

A National Study of Infrastructure Risk (Infrastructure Australia, Oct 2021)

A need for Governments and Industry to work collaboratively

Infrastructure Australia Chief Executive **Romilly Madew** recently stated that there is a *"need for governments and industry to work collaboratively, to advance sector-wide reform and reduce the risk of cost escalation and delays in the delivery of major infrastructure projects.*

The challenge of driving a step-change in infrastructure productivity and innovation is a shared one – it cannot be solved by governments or industry alone".

Australia Faces Major Shortages on Record Infrastructure Build (Sourceable, Oct 2021)

> **"If we could halve the gap in productivity growth between the construction industry and other industries over the past 30 years, we could construct an extra $15bn of infrastructure every year for the same expenditure and employ an extra 15,000 people. That's the equivalent of three extra Western Sydney Airports every year."**
> Jon Davies, Australian Constructors Association Nov 2021

5.4 The opportunity

We are entering a phase of unprecedented levels of investment in megaprojects throughout Australia. This coincides with the availability of modern cloud based digital tools which if leveraged will reduce risks of time/cost overruns, customer disruption and government reputational damage.

We now have an opportunity act by leveraging these tools and transforming the sector to drive a step change in productivity through digital technologies

> **"These risks, the scale of the forecast pipeline, the associated demand for skills and materials and future supply constraints further reinforce the importance of governments unlocking productivity to support infrastructure delivery through policies supporting increasing portfolio management, digitalisation, frontend engagement and innovation."**
> Infrastructure Market Capacity Report (Infrastructure Australia, Oct 2021)

On the flipside, a failure to act will miss a significant opportunity for cross-sector improvement with emerging digital technologies. Public infrastructure will be further left behind, government will lose talent and projects will be exposed to the same re-occurring risks and issues that impact the productivity and performance currently.

Rapid transformation of the infrastructure sector, enabled through new digital capabilities and the latest digital technologies, will unlock significant value and benefits for infrastructure project delivery.

Together we can realise the digital transformation of public infrastructure.

6.0

SAP WHITE PAPER

Where Are We along the Digital Maturity Journey

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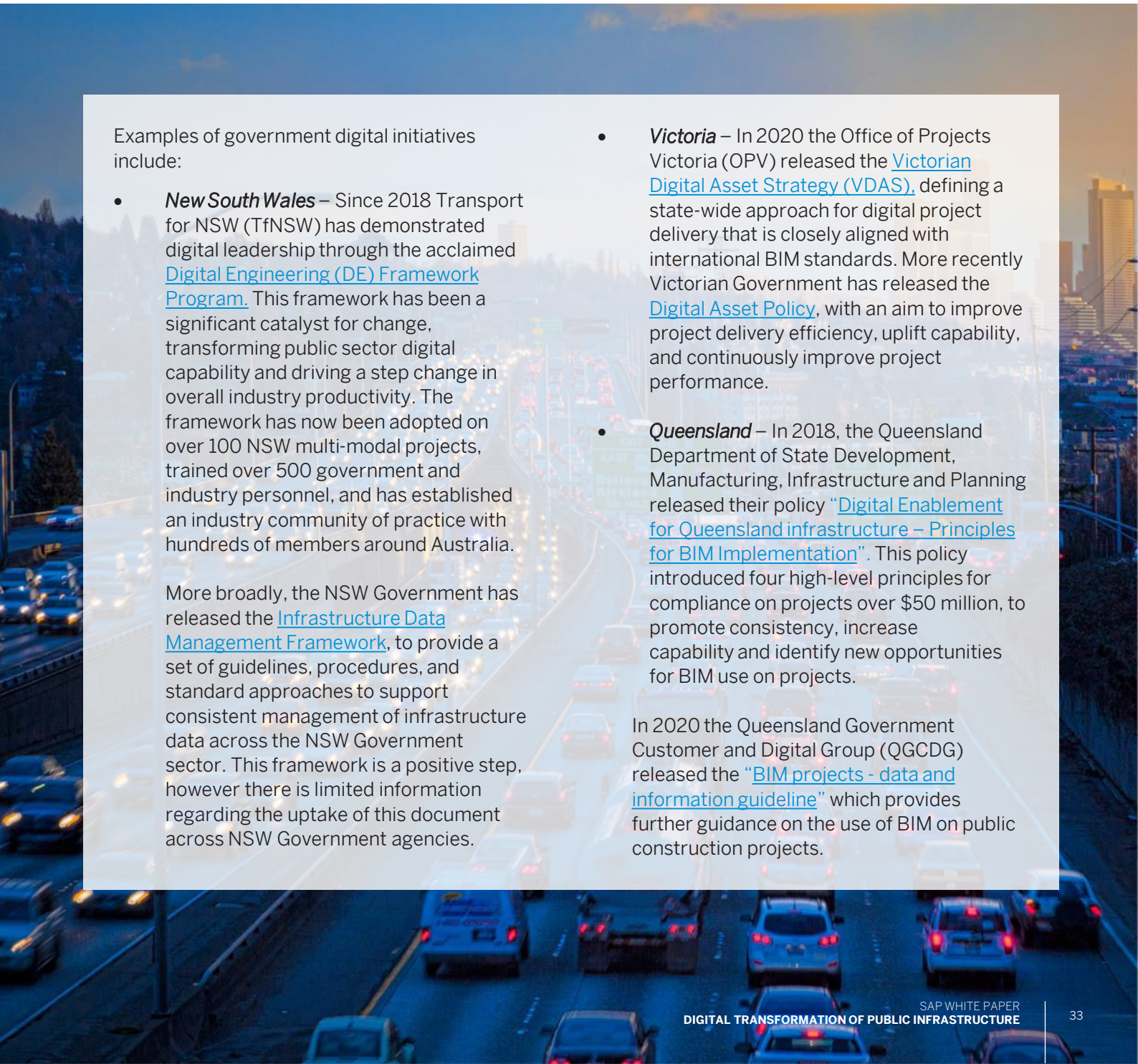
6.0 Where Are We along the Digital Maturity Journey

6.1 Introduction

The public infrastructure agencies are not starting from scratch. There is already a large amount of digital project delivery and business improvement taking place in the sector – however the maturity across Australian government agencies is mixed.



Examples of government digital initiatives include:

- *New South Wales* – Since 2018 Transport for NSW (TfNSW) has demonstrated digital leadership through the acclaimed Digital Engineering (DE) Framework Program. This framework has been a significant catalyst for change, transforming public sector digital capability and driving a step change in overall industry productivity. The framework has now been adopted on over 100 NSW multi-modal projects, trained over 500 government and industry personnel, and has established an industry community of practice with hundreds of members around Australia.

  More broadly, the NSW Government has released the Infrastructure Data Management Framework, to provide a set of guidelines, procedures, and standard approaches to support consistent management of infrastructure data across the NSW Government sector. This framework is a positive step, however there is limited information regarding the uptake of this document across NSW Government agencies.

- *Victoria* – In 2020 the Office of Projects Victoria (OPV) released the Victorian Digital Asset Strategy (VDAS), defining a state-wide approach for digital project delivery that is closely aligned with international BIM standards. More recently Victorian Government has released the Digital Asset Policy, with an aim to improve project delivery efficiency, uplift capability, and continuously improve project performance.

- *Queensland* – In 2018, the Queensland Department of State Development, Manufacturing, Infrastructure and Planning released their policy "Digital Enablement for Queensland infrastructure – Principles for BIM Implementation". This policy introduced four high-level principles for compliance on projects over $50 million, to promote consistency, increase capability and identify new opportunities for BIM use on projects.

  In 2020 the Queensland Government Customer and Digital Group (QGCDG) released the "BIM projects - data and information guideline" which provides further guidance on the use of BIM on public construction projects.

- *Federal* – In 2016 the Department of Infrastructure, Transport, Regional Development and Communications (DITRDC) published the National Digital Engineering Policy Principles, with an aim to promote greater harmonisation and consistency in data requirements across governments, when planning and procuring major land transport infrastructure projects.

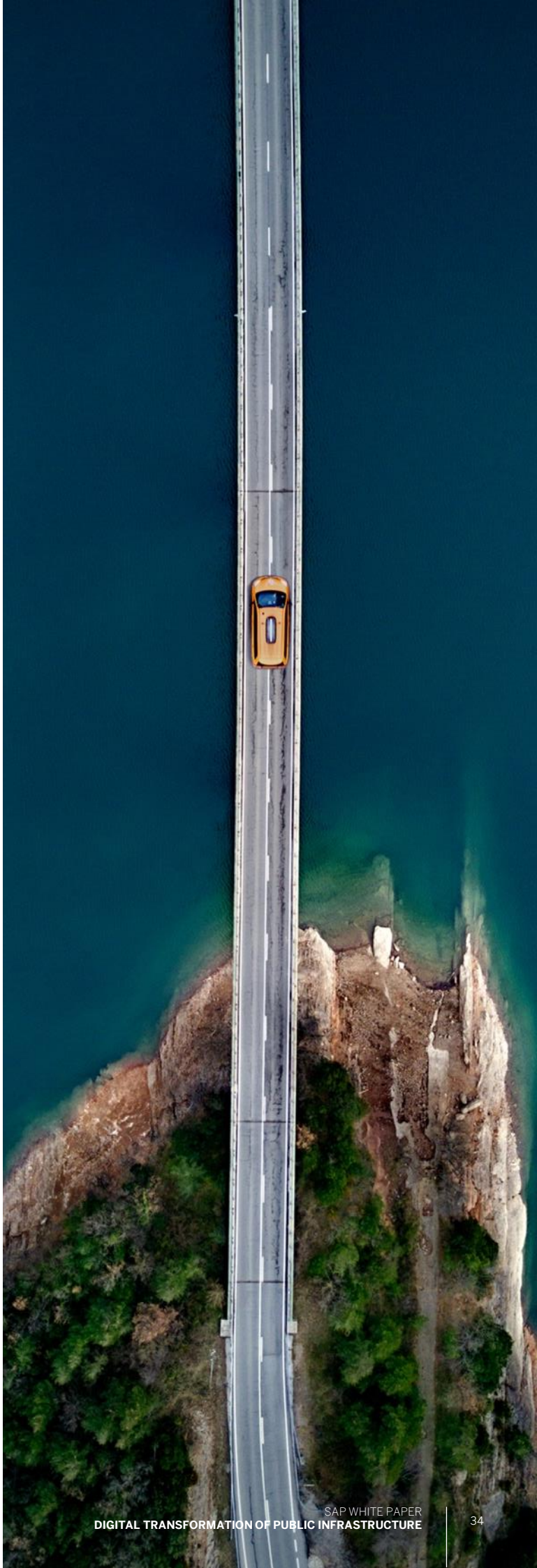
These principles were developed by the former National Digital Engineering Working Group and were formally endorsed by the Council of Australian Governments' (COAG) Transport and Infrastructure Council (TIC). In the time since then however, there has been no further development or central governance to oversee the implementation of this policy.

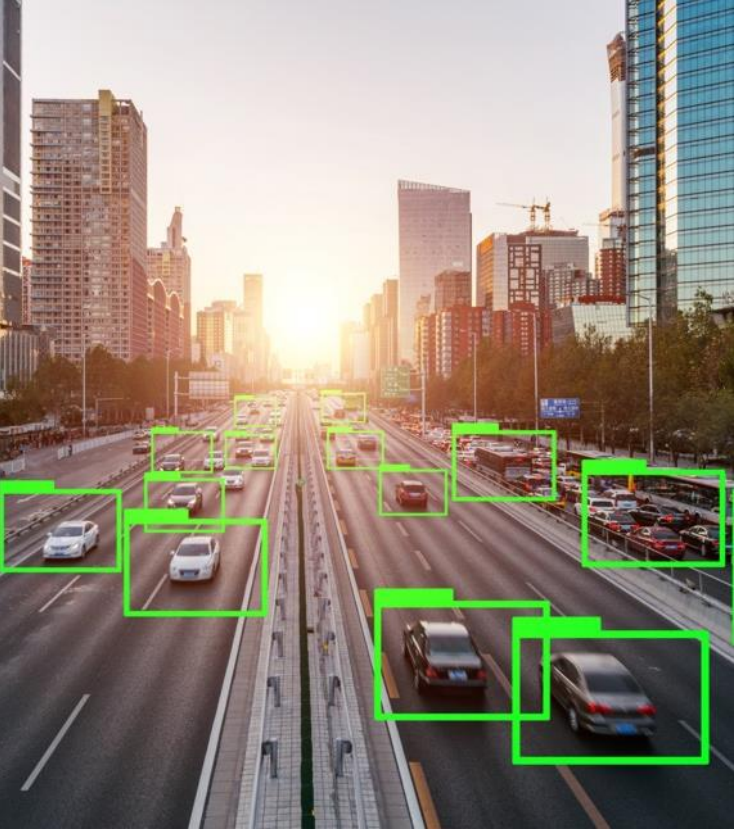
More generally, in July 2021 National Cabinet signed the Intergovernmental Agreement on data sharing between Commonwealth and State and Territory governments. This agreement commits all jurisdictions to share public sector data as a default position, where it can be done securely, safely, lawfully, and ethically.

The agreement recognises data as a shared national asset and aims to maximise the value of data to deliver outstanding policies and services for Australians.

The above list provides examples of the more high-profile government initiatives that promote digital project delivery. Throughout Australia there are an assortment of agency guidelines, specifications and tender requirements that are currently being prescribed on infrastructure projects.

This is a great start and demonstrates the high level of government interest in this space. However, much of this activity is still reasonably low maturity. Apart from Transport for New South Wales and a few others, there has been marginal investment by government agencies to take control of their digital transformation journey, and to lead the internal business change required for more advanced data management capabilities.





There is a lack of consistency across public infrastructure agencies, in terms of requirements, technologies and data management capabilities. This includes common terms, definitions and naming conventions which are ad-hoc across projects, agencies, and jurisdictions.

This makes it challenging for industry to do business with government since it must interpret and configure their systems for an ad-hoc landscape of data requirements. Suppliers may simply revert to using their own internal digital methodologies when there are no requirements provided by the client.

This also makes it difficult for executives to establish a portfolio view of projects and restricts agencies from digital collaboration or effective data sharing

6.2 What will this involve? Progression of digital maturity

Digital transformation can seem like a complex challenge. It requires organisations to be open to venturing beyond their traditional domain and be willing to explore the digital unknown. For this reason, it is often described as a journey, as organisations embark on a path of discovery and business change.

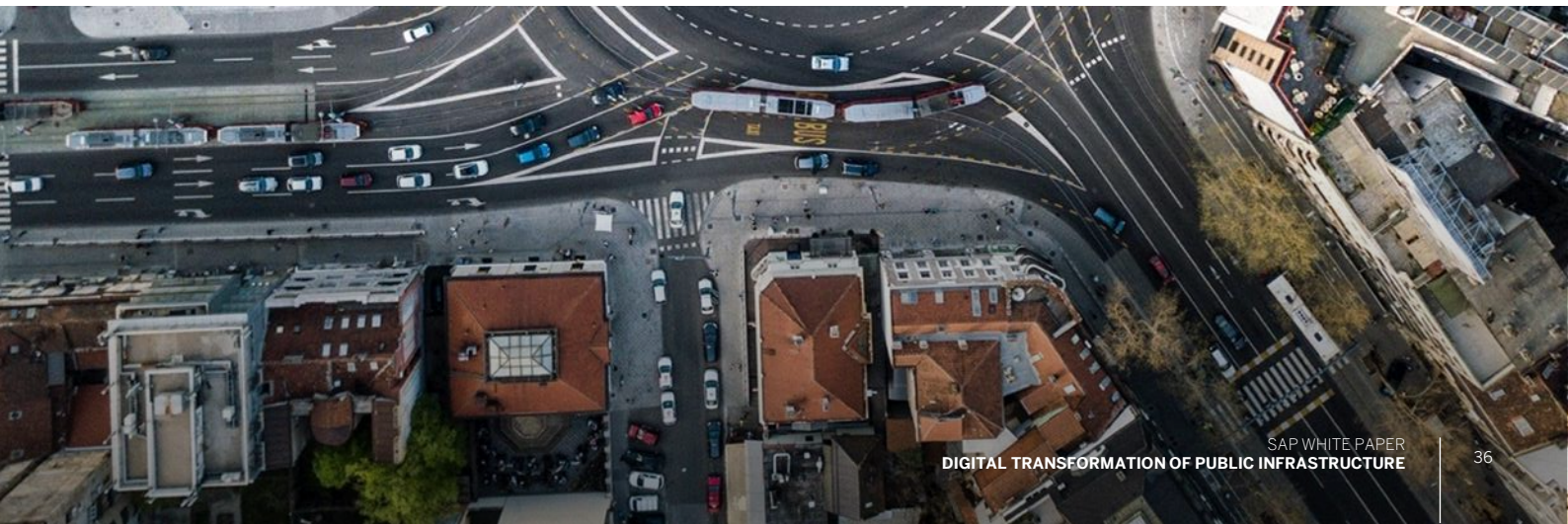
For those at the beginning of this journey, digital transformation may seem daunting, with potential for countless uncertainties and technical challenges. It is therefore important to breakdown the journey into a series of strategic activities, with progressive milestones along the way. This may include planning, discovery, and optimisation, through to forming a new target state and unlocking benefits with performance and productivity.

This paper provides a five-level maturity model to assist government infrastructure agencies with successful digital transformation.

The five levels are summarised in the table below, with full details provided overpage.

Level 1	Level 2	Level 3	Level 4	Level 5
Digital Passenger	**Digital Explorer**	**Digital Navigator**	**Digital Transformer**	**Digital Pioneer**
Do nothing	*Learning*	*Initiating*	*Transforming*	*Optimising*

Workstream	**Digital Passenger** *Do nothing*	**Digital Explorer** *Learning*	**Digital Navigator** *Initiating*	**Digital Transformer** *Transforming*	**Digital Pioneer** *Optimising*
Leadership	Low or passive support from executive. Transformation occurring around organisation, with only vague awareness of digital opportunities. Digital project delivery being led by industry partners, with no direction or reactive participation from client.	Executive exploring opportunities for digital transformation. Considering future-state and steps required for successful organisation change. Researching and identify leading digital practices from more progressive organisations, market leaders and technology providers.	Developing policy to manage data as an asset, with supporting principles. Setting clear objectives for digital transformation, that define 'what does good look like'. Developing strategy and business-case for business improvement, including long-term transformation and 'quick-wins'.	Executives providing clear direction, commitment, and public support to digital transformation. Commencing organisational program of digital transformation. Establishing the foundation for digital twins, smart infrastructure, smart cities etc	Executives enjoy and promote success of digital transformation. Established reputation as market leader. Embraced culture of 'digital by default'.
Data management	Unaware of data management capability. Disconnected data handovers between business groups, requiring heavy reporting administration. Project management and reporting using traditional document-based processes (checklists, monthly reports, certificates etc).	Determining current data management capability. Identifying current issues with data management. Initial research into global best practice.	Fostering culture of digital collaboration and collective improvement. Scoping up program to improve data management capability.	Standardising data requirements and specifications. Developing processes for data-driven insights. Establishing digital asset lifecycle (i.e. digital thread) throughout overall organisation.	Digital ecosystem built on structured data. Real-time reporting and control across project portfolio. Intelligent enterprise with advanced analytics.

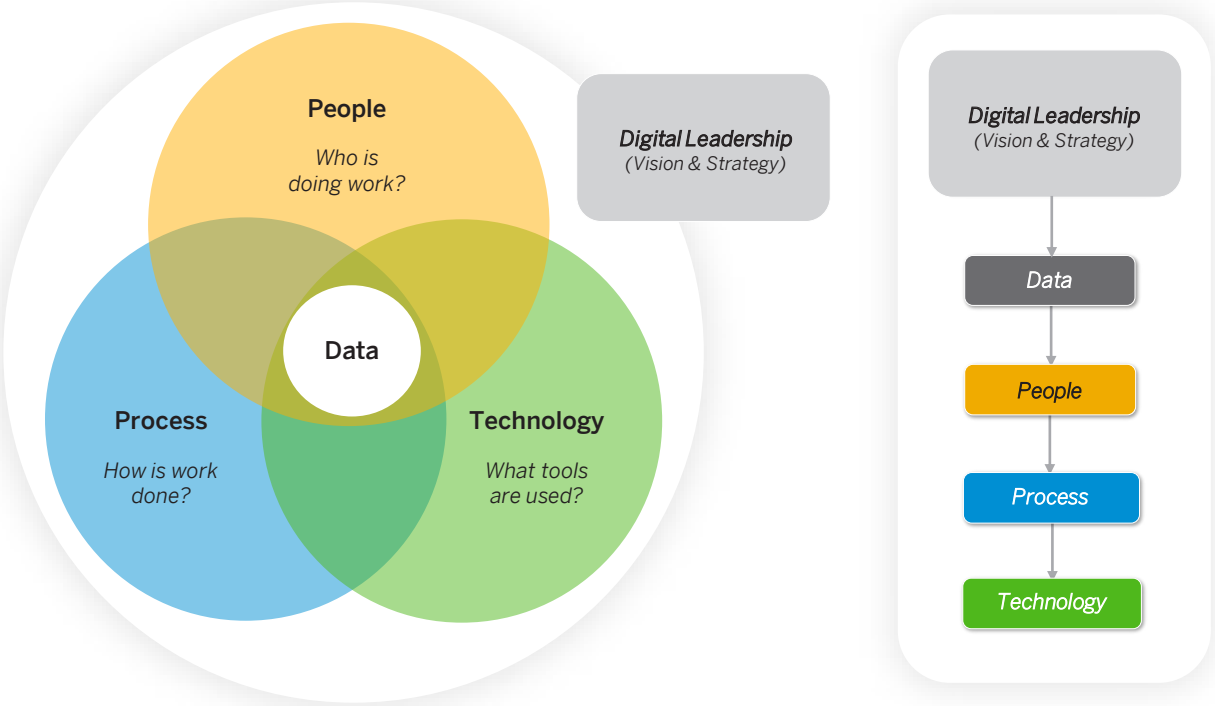


Workstream	 **Digital Passenger** *Do nothing*	 **Digital Explorer** *Learning*	 **Digital Navigator** *Initiating*	 **Digital Transformer** *Transforming*	 **Digital Pioneer** *Optimising*
People	Major focus on delivering physical infrastructure assets only. Lack of dedicated digital or data management resources.	Assigning in-house digital champion. Forming internal working group to foster collaboration. Seeking industry advice/expertise.	Engaging specialist digital expertise to prepare roadmap. Internal training to raise awareness, reinforce vision, build capability, and assign new roles.	Assigning dedicated team to build new operating model and create data-centric business processes. Training staff to equip them with new tools, processes, competence.	Digital culture attracts leading talent. Creating new opportunities to reinvent and improve digital capability. Data literacy and data management capability normalised across organisation.
Process	Unable to interact with digital deliverables, when provided from industry partners and suppliers.	Exploring how digital technologies are now being adopted by industry partners. Undertaking lessons learned with projects producing digital deliverables.	More advanced specification of new technologies on public infrastructure projects. Monitoring and feedback to calibrate project digital requirements.	Real-time project reporting based on structured data that is reliable and re-usable.	All projects now providing consistent, meaningful, and reliable data. Agencies enabled with data driven insights to optimise projects and overall portfolio. Building and interreacting with infrastructure digital twins.
Technology	Ad-hoc technologies within organisation. Procurement of current technology led by in-house ICT, with little-to-no consideration of data flow or the overarching business operating model.	Investigating limitations with existing technologies. Engaging with software vendors to understand new project capabilities. Consider rapid trials with new technologies.	Leading agile program of pilot projects, trialling digital technologies on infrastructure projects.	Integrating technologies to manage and exchange structured data. Working to establish best practice digital technologies as the norm.	Automated flow of information between stakeholders in the design, construct and operate stages of the asset lifecycle. As-designed, as-built, as-maintained, and as-operating information from all sources connected and available to relevant stakeholders.

6.3 Current gaps in the digital ecosystem of Australian public infrastructure

Our maturity model provides a broad framework to analyse the digital maturity of government infrastructure agencies. The workstreams in this table are interrelated and work collectively to build organisational improvement and drive business change.

The diagram below highlights the interrelationship between the workstreams, starting broadly with the digital vision and strategy of the organisation. Central to this model is 'data', due to the critical role of data management capability in achieving successful digital transformation.



Based on this maturity model we have identified five areas with recommended actions that would support immediate uplift for the Australian governments and public infrastructure agencies. These five actions will lead to significant gains and productivity improvements.

No.	Theme	Current Gap	Recommended Action
01	Digital Leadership	Infrastructure agencies are currently developing digital strategies in isolation, without formal collaboration, central governance, or national consistency.	**Establish a central government body, with federal, state and territory members, responsible for leading a formal national digital strategy for public infrastructure.**
02	Data	Data specified on public infrastructure projects is typically unstructured and does not support effective management over the digital asset lifecycle.	**Create national data standards that support the digital asset lifecycle and digital twins for public infrastructure.**
03	People	Infrastructure projects are currently delivered with relatively low data management maturity, with government agencies generally lagging private sector digital capabilities.	**Infrastructure agencies should build in-house digital capability, through the introduction of dedicated roles, responsible for improved data management over the digital asset lifecycle.**
04	Process	Current ad-hoc project data requires heavy administration and is not industrialised to enable the digital asset lifecycle (the digital thread).	**Infrastructure agencies should work in collaboration, defining best-practice digital processes and specifications, to 'industrialise' the digital asset lifecycle.**
05	Technology	Current platforms unable to support effective data management over the complete digital asset lifecycle.	**Invest in a technology platform that will support the digital thread across the complete digital asset lifecycle.**

SAP White Paper
Digital Transformation of Public Infrastructure

7.0

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Key Recommendations

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7.0 Key Recommendations

Theme:	1. Digital Leadership
Current Gap:	Infrastructure agencies are currently developing digital strategies in isolation, without formal collaboration, central governance, or national consistency.
Action:	Establish a national government body, with federal, state and territory members, responsible to leading a formal national digital strategy for public infrastructure.

Current Gap:

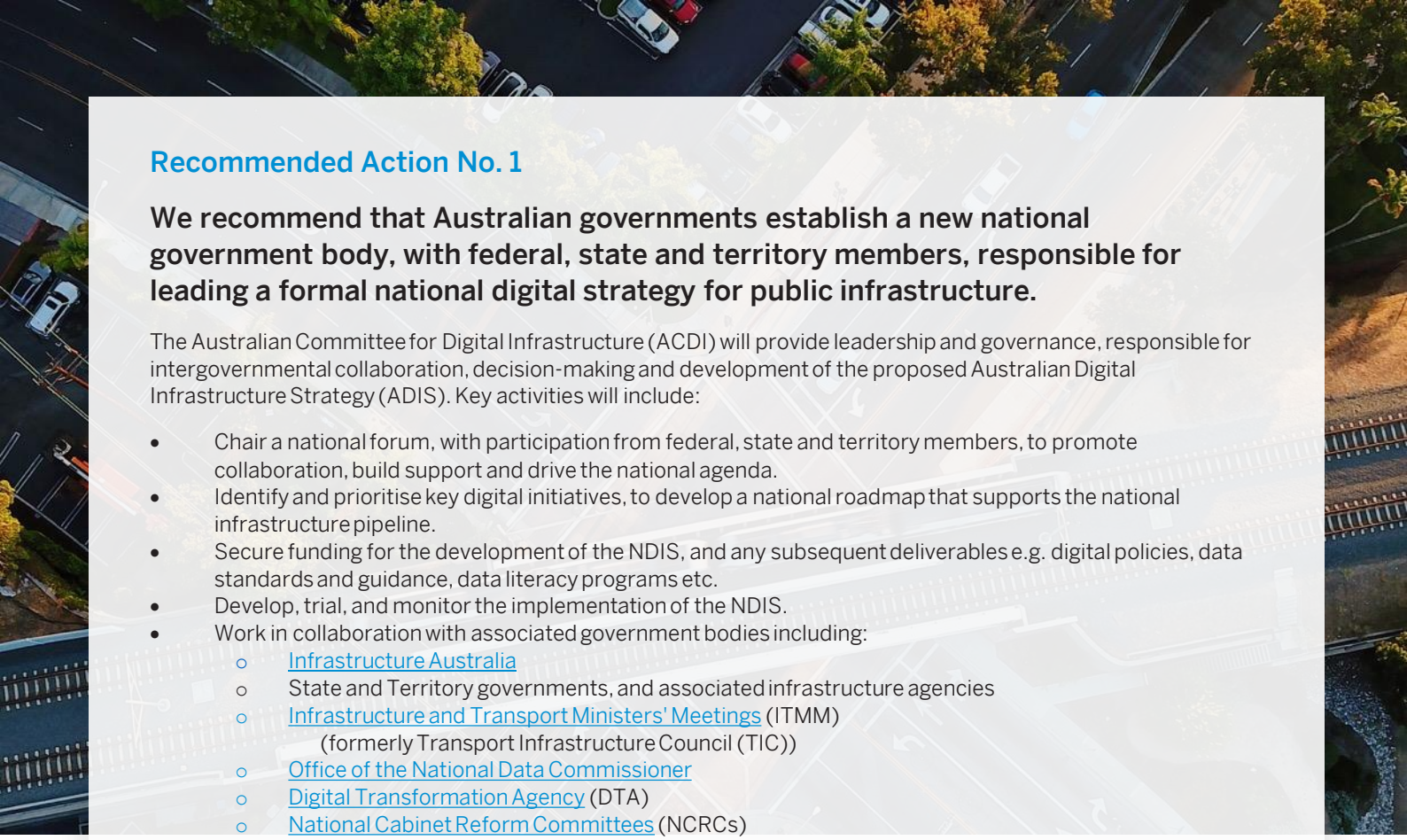
Infrastructure agencies across Australia are currently developing digital strategies in isolation, without formal collaboration, central governance, or national consistency. Pockets of digital excellence are emerging (as noted earlier), however there is currently no central governance or dedicated parties responsible for an agreed, nationally consistent strategy.

Given the record levels of investment taking place nationally, there is now an urgent need to formally establish a national strategy for the digital transformation of public infrastructure.

This challenge is bigger than any one government alone. It is imperative that governments throughout Australia begin to work in collaboration, to ensure all jurisdictions collectively benefit from the opportunities of digital transformation. This will also pave the way for greater intergovernmental sharing of infrastructure data and will support broader opportunities such as a national digital twin and or a national digital thread..

There is already much support for this goal, with recent publications from both Infrastructure Australia and the Australian Information Industry Association (AIIA) recommending the Federal Government establish a national office and oversee a national roadmap to improve digital maturity of infrastructure agencies. Furthermore, National Cabinet is fostering greater data sharing across governments through the recently approved Intergovernmental Agreement.

As noted by Infrastructure Australia's 2021 Australian Infrastructure Plan, "*as regulators, owners, funders and benefactors of public infrastructure, can play a lead role in the transition away from 'digital by exception' towards 'digital by default'*" . 2021 Australian Infrastructure Plan – Infrastructure Australia, Sept 2021



Recommended Action No. 1

We recommend that Australian governments establish a new national government body, with federal, state and territory members, responsible for leading a formal national digital strategy for public infrastructure.

The Australian Committee for Digital Infrastructure (ACDI) will provide leadership and governance, responsible for intergovernmental collaboration, decision-making and development of the proposed Australian Digital Infrastructure Strategy (ADIS). Key activities will include:

- Chair a national forum, with participation from federal, state and territory members, to promote collaboration, build support and drive the national agenda.
- Identify and prioritise key digital initiatives, to develop a national roadmap that supports the national infrastructure pipeline.
- Secure funding for the development of the NDIS, and any subsequent deliverables e.g. digital policies, data standards and guidance, data literacy programs etc.
- Develop, trial, and monitor the implementation of the NDIS.
- Work in collaboration with associated government bodies including:
  - Infrastructure Australia
  - State and Territory governments, and associated infrastructure agencies
  - Infrastructure and Transport Ministers' Meetings (ITMM) (formerly Transport Infrastructure Council (TIC))
  - Office of the National Data Commissioner
  - Digital Transformation Agency (DTA)
  - National Cabinet Reform Committees (NCRCs)
- Work in collaboration with academia and associated industry bodies.

Theme:	2. Data
Current Gap:	Data specified on public infrastructure projects is typically unstructured and does not support effective management over the digital asset lifecycle.
Action:	Create national data standards that support the digital asset lifecycle and digital twins for public infrastructure.

Current Gap:

Data specified on public infrastructure projects is typically unstructured and does not support effective management over the digital asset lifecycle. This is impacting the sector's ability to procure, manage and exchange and re-use data over the lifecycle of infrastructure assets.

Data has immense value to government agencies that, when managed correctly, supports more informed decision-making, improves overall productivity, and enables a step change in performance over the complete lifecycle of infrastructure assets. The industry must collectively recognise the critical importance of valuing and managing data as an asset.

The responsibility for data specification and management cannot be transferred to industry suppliers alone. Governments and infrastructures agencies must take ownership of their data, through a strategic uplift in data literacy, data custodianship, data specification and data management.

Work is already underway around Australia, with leading infrastructure agencies creating bespoke data standards, to support applications such as digital engineering for improved project delivery. Globally there are also numerous international standards, that provide a foundation for further development and more detailed data specification for public infrastructure.

Recommended Action No. 2

We recommend that the Australian Government creates national data standards that support the digital asset lifecycle and digital twins for public infrastructure.

This body of work should be led by the proposed ACDI, working in collaboration with government agencies, to create a new suite of data standards (including guidance and specifications) that will define best practice for the Australian infrastructure sector.

This will require concerted effort from numerous technical parties, to foster collaboration, identify opportunities and accelerate the formal development of standards based on leading initiatives, both locally and globally. Key activities should include:

- Nomination of technical teams from the infrastructure sector to lead development of new standards.
- Identification of best-practice standards, both locally and globally.
- Preparation of a strategy for research and authoring of new standards, including necessary commitments for budget and resources.
- Leading consultation with relevant parties.
- Collaboration with the following bodies:
    - State and Territory governments, and associated infrastructure agencies
    - Private infrastructure asset owners and representative organisations
    - Standards Australia and associated standards bodies (both local and global)
    - Academia and associated industry bodies (both local and global)
    - Global government agencies

Theme:	**3. People**
Current Gap:	Infrastructure projects are currently delivered with relatively low data management maturity, with government agencies generally lagging private sector digital capabilities.
Action:	Infrastructure agencies should grow in-house digital capability, through the introduction of dedicated roles, responsible for improved data management over the digital asset lifecycle.

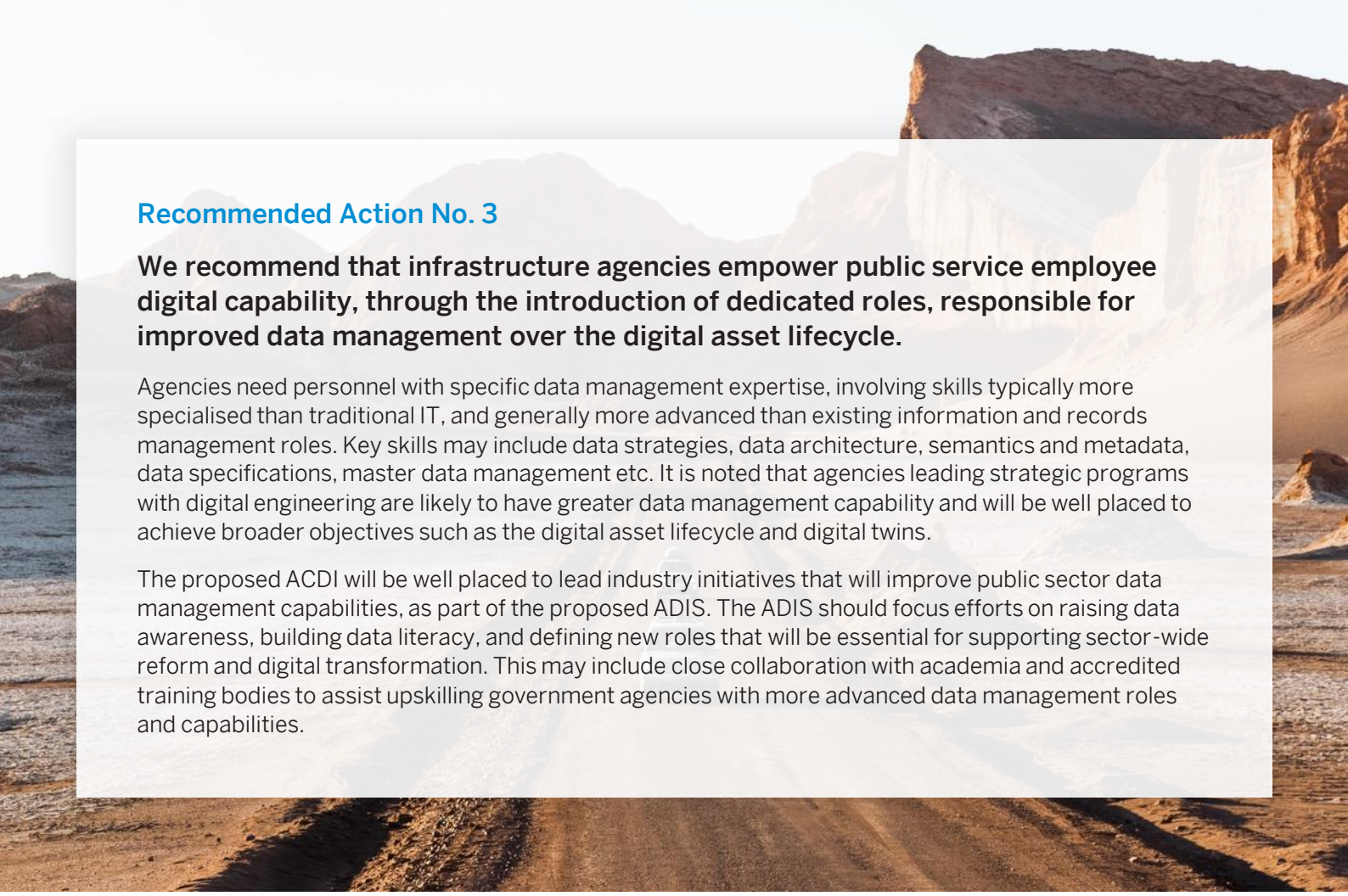
Current Gap:

Project teams responsible for delivering new public infrastructure are filled with a vast array of professional and specialist roles. The people engaged to deliver new infrastructure are often employed specifically for the life of an individual project, with team collaboration rarely extending beyond project completion.

Infrastructure project roles are often filled by personnel with traditional technical engineering and project management skills. These skills are essential for ensuring that new infrastructure is delivered safely and efficiently, is configured correctly, and will be fit for purpose over the complete asset lifecycle. While this has served project teams well in the past, there is now a growing need for new skills, to properly manage project complexity and the significant risk of overruns on major public infrastructure projects.

Infrastructure projects are currently delivered with relatively low data management maturity, with government agencies generally lagging behind private sector digital capabilities. Low data awareness, a general lack of data literacy, and low maturity digital capability are critical issues for government.

There is now a significant opportunity to create jobs and introduce new capabilities in the public service who are responsible for improving data and digital capabilities on public infrastructure projects. These new skills will enable a step change in project performance and will enable future efforts to establish the digital asset lifecycle or to build digital twins for public infrastructure.



Recommended Action No. 3

We recommend that infrastructure agencies empower public service employee digital capability, through the introduction of dedicated roles, responsible for improved data management over the digital asset lifecycle.

Agencies need personnel with specific data management expertise, involving skills typically more specialised than traditional IT, and generally more advanced than existing information and records management roles. Key skills may include data strategies, data architecture, semantics and metadata, data specifications, master data management etc. It is noted that agencies leading strategic programs with digital engineering are likely to have greater data management capability and will be well placed to achieve broader objectives such as the digital asset lifecycle and digital twins.

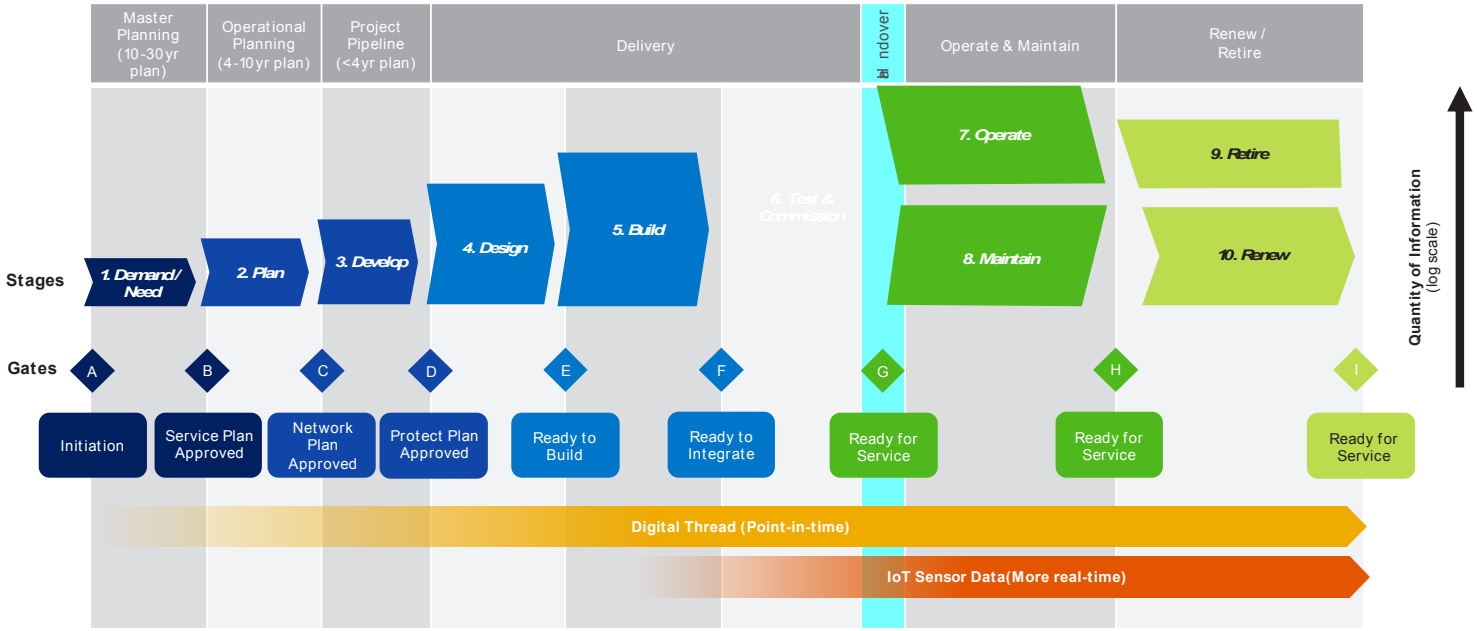
The proposed ACDI will be well placed to lead industry initiatives that will improve public sector data management capabilities, as part of the proposed ADIS. The ADIS should focus efforts on raising data awareness, building data literacy, and defining new roles that will be essential for supporting sector-wide reform and digital transformation. This may include close collaboration with academia and accredited training bodies to assist upskilling government agencies with more advanced data management roles and capabilities.

Theme:	**4. Process**
Current Gap:	Public infrastructure data management practices are currently ad-hoc, with no commonly agreed digital processes across governments, agencies, and projects.
Action:	Infrastructure agencies should work in collaboration, defining best-practice digital processes and specifications, to 'industrialise' the digital asset lifecycle.

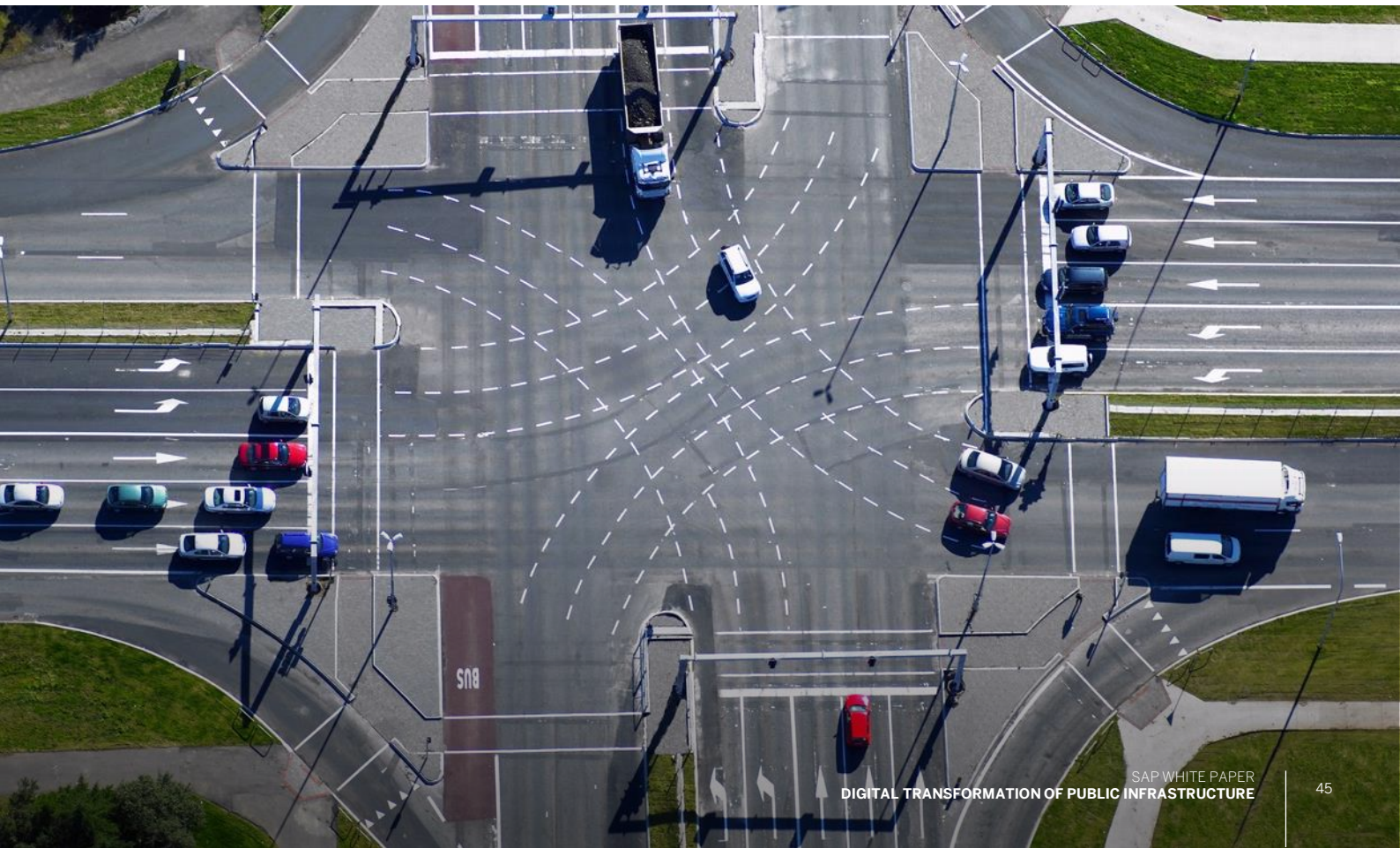
Current Gap:

Public infrastructure data management practices are currently ad-hoc, with no commonly agreed digital processes across governments, agencies, and projects. This results in poor low quality data that requires heavy administration to manage and exchange data over the asset lifecycle.

The lack of common processes and specifications prevents effective data sharing and leads to data loss and duplication. This inefficiency is pronounced at project milestones or assurance gates, where data is typically exchanged from one project team to the next. The additional effort required to administer data generated in this way leads to significant time and cost burden to projects, and places projects at risk of poor decision-making based on error prone and unreliable project data.



The impact on industry suppliers must not be underestimated. The current ad-hoc landscape of low maturity and inconsistent agency processes is particularly challenging for industry. Government tenders for infrastructure projects currently specify an assortment of bespoke digital specifications with inconsistent terms, definitions, and requirements. This variety creates additional cost to industry to manage, that is eventually transferred back to the agencies in the form of increased tender costs.



Recommended Action No. 4

We recommend that infrastructure agencies work in collaboration, defining best-practice digital processes and specifications, to 'industrialise' the digital asset lifecycle.

More consistent digital processes and data management specifications will enable agencies to optimise all activities over the infrastructure digital asset lifecycle. Resource heavy processes may be automated, data quality will be improved, and the overall digital thread will resemble an industrialised production line.

In practice, this may combine leading digital engineering strategies, coupled with data management processes from relevant government bodies (e.g. Office of National Data Commissioner etc.).

The proposed ADCI will be well placed to lead collaborative research, identify best practice, and develop collaborative guidelines for infrastructure agencies - as part of the proposed ADIS. This group will also work closely with leading parties and industry bodies to ensure successful acceptance and uptake of new digital processes.

Theme:	**5. Technology**
Current Gap:	Current platforms unable to support effective data management over the complete digital asset lifecycle.
Action:	Invest in technology that will support a digital thread across the complete digital asset lifecycle.

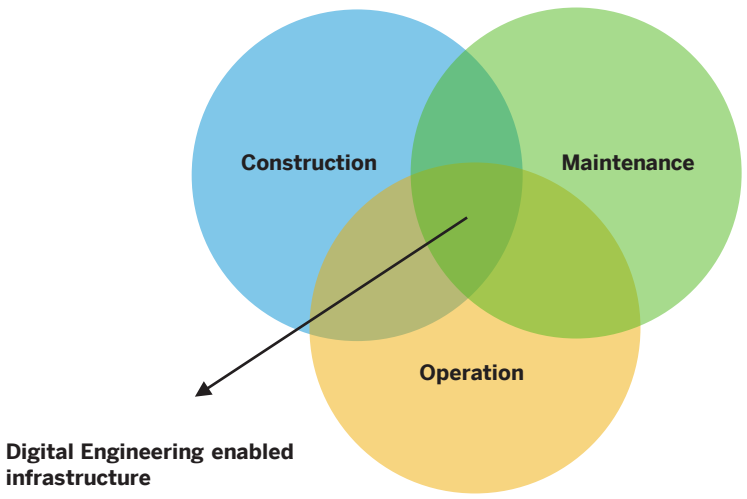
Current Gap:

Traditionally, stakeholders are dealing with different design and maintenance tools with data sitting in siloed repositories. This makes analysing the data inefficient and leads to missed opportunities. This problem is exacerbated when a new infrastructure is being added to existing infrastructure.

When faced with this type of challenge, how can stakeholders quickly decide the best path forward? How do they see and understand all the information that is relevant to the construction, operation and maintenance of the infrastructure?

What is required is a technological approach that harmonises and combines different types of information, including legacy utility and asset information into a shared place. One that can collate the data, establish relationships between data, deliver visualisations and will allow collaboration between stakeholders not just in a point in time but across the whole life cycle of the infrastructure.

We call this the digital thread.



The scenarios below outline how the digital thread can be applied to the delivery of new public infrastructure. For example, adding a new building to an existing sporting precinct

Construction of Infrastructure

When a new building will sit alongside existing utilities and transport, decisions need to be made about how the building will integrate with existing facilities.

As the digital thread harmonises and combines data from different systems, it allows the project manager to relate the existing infrastructure in the sporting precinct to the proposed design work for the new building. As a result, it is possible to make an informed decision about the most efficient way to proceed.

To understand the impact of new buildings on existing infrastructure such as transport connections, pedestrian flows, and utilities, there needs to be a way to consolidate and harmonise all the available information. For example, combining data about the new build, like the access points for the public, with the existing data of the sporting precinct, such as electrical supply and stormwater, stakeholders can make better informed decisions about not just the design, but the staging and integration of the new works. Designers and planners are consequently able to make effective design changes (to either the new build or alternatively to existing infrastructure) digitally before the build phase.

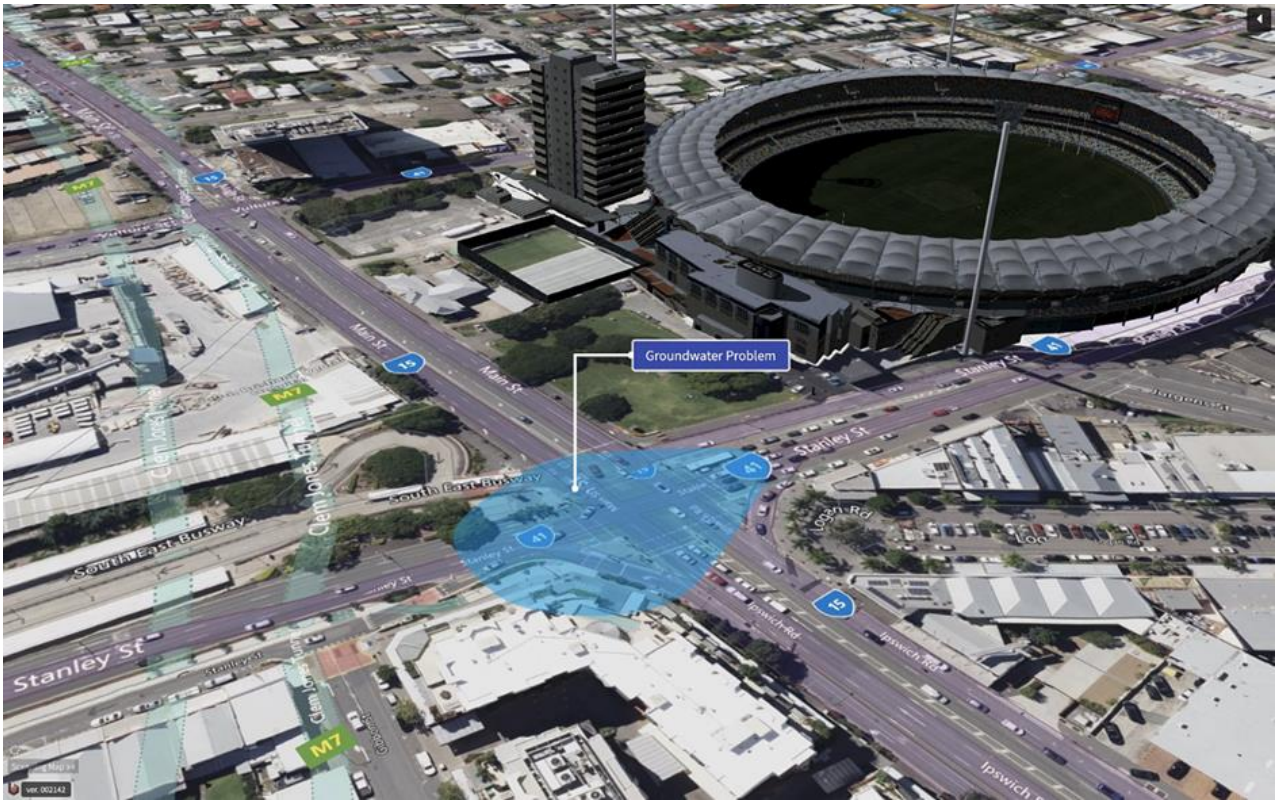
Obtaining this insight in a timely way has not been possible under traditional practices because the information is held in different systems in different formats. Early insight can mitigate expensive rework, and time and cost overruns during construction.

Maintenance of Infrastructure

The digital thread doesn't stop at the design and construction phases of the infrastructure project. It continues throughout the lifecycle of the asset.

The infrastructure asset now moves into the operations and maintenance phase following the infrastructure construction scenario discussed above. To illustrate the value of the digital thread in the operations and maintenance phase consider a scenario where the stadium encounters a major ground water problem in its vicinity.

Following a storm event the operators of the infrastructure find water is pooling in a public walkway impacting on pedestrian flows and creating a potential health problem. Maintenance personnel need to quickly diagnose the source of the leakage without invasive methods, spaces such as digging up utilities, to avoid impacting public spaces.



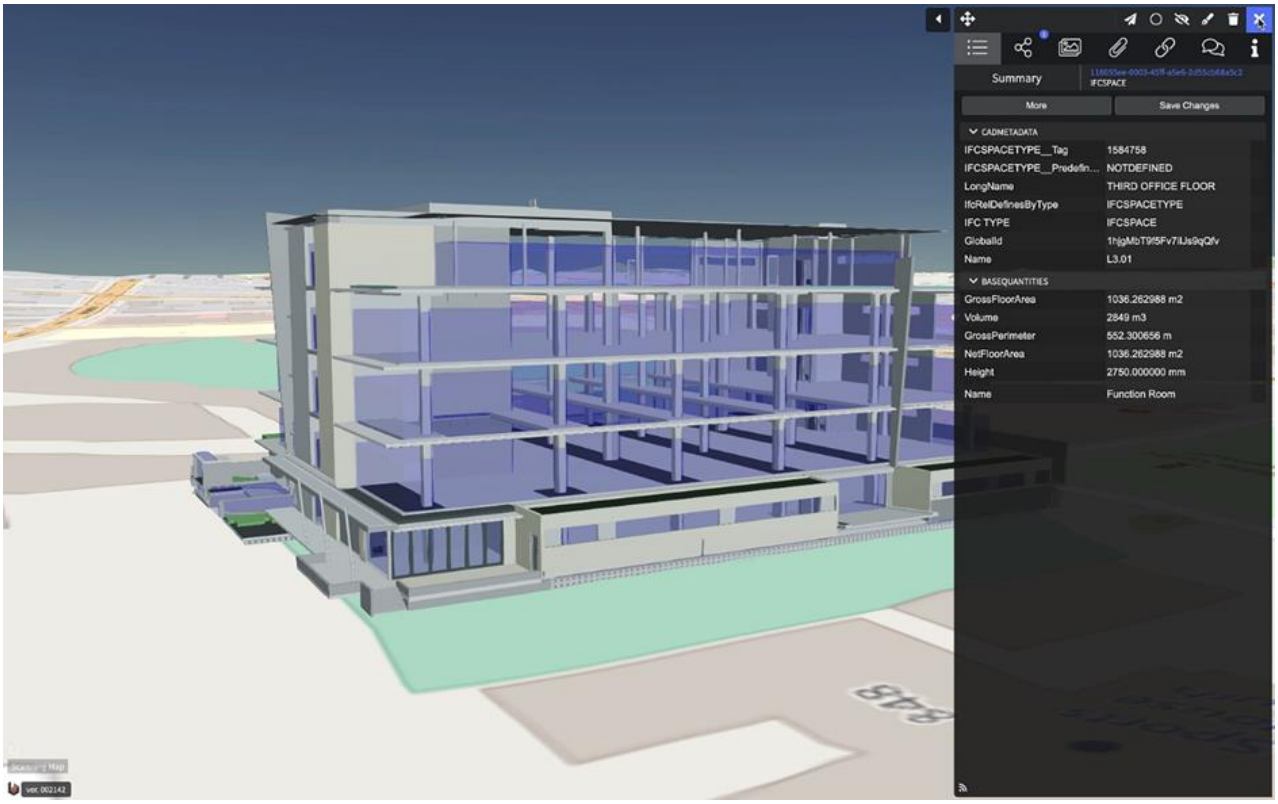
As the digital thread also contains data on storm water management (pipes, pumps and water outflows), water supply and ground water tables from the nearby river, engineers have a holistic view of all the important factors.

By bringing all this information together, it's possible to analyse the standing water issue and identify the root cause. In this scenario, an underperforming pump is identified the cause of the pooling water. By examining the design and specifications of the pump and how it has been installed, repairs can be appropriately organised. All this information is available to engineers via the digital thread.

Refurbishment of Infrastructure

Finally, the digital thread also allows infrastructure owners to continuously adapt and improve. By capturing information about design ("as built") and operational data ("as-is") in once space, it can easily be visualised and interpreted to assist with the refurbishment of existing investments.

Now consider the scenario where some years after completion of the new build, new health standards are introduced relating to the air flow within a public space. As a result, the infrastructure owner needs to understand if the design and condition of the air flow systems meet these new standards.



The digital thread allows the infrastructure owner to bring together original design information with operating information and test it against the new standards and make informed design decisions for any necessary upgrades.

For example, operational information about the performance of the existing heating, ventilation, air conditioning is available from sensors attached to the equipment and the rooms throughout the building. This information can be compared to the manufacturer's specifications of the equipment as supplied and installed that was captured during the construction phase on the digital thread.

Based on the new standards and the information in the digital thread it is concluded that additional filtering and air flow must be achieved to meet the new health requirements. This will require collaboration between the manufacturer, the building operator and the contractor responsible for installing the new filters.

This collaboration is enabled by the digital thread which is designed to allow sharing information with all approved stakeholders. Using web-based technologies, design and specification data can be shared digitally. The manufacturer can suggest specific changes to the configuration of cooling and filtering systems based on the current configuration. These recommendations can be reviewed digitally and approved by the building operator for installation. Finally, the changes are captured on the digital thread and are available for a contractor to implement.

Crucially, these changes are not lost on completion of the refurbishment activity. The updates are reflected in the operations and monitoring environment of the digital thread, so no data is lost. This allows for ongoing tracking of improvements and identification of future improvements

Recommended Action No. 5

We recommend that Australian governments invest in technology pilots to support a digital thread across a public infrastructure asset lifecycle.

Harmonising information from almost any digital source is a key capability of SAP's model that directly addresses the challenge of current platforms unable to support effective data management over the complete digital asset lifecycle. We recommend Australian governments invest in digital thread technology pilots that will:

- Interconnect asset owners, operators, maintainers, service providers, constructors, and other suppliers.
- Support multiple phases of an infrastructure asset lifecycle, such as construction and operations, regardless of the project or operating model. It's important to note that the collaboration platform does not replace existing enterprise project management, asset management, engineering, GIS, enterprise content management and procurement and supply chain systems, but connects all these stakeholders together in new ways.
- Provide a single system of record containing all information on a project, from idea through to commissioning, and it will allow effective exchange of information and collaboration on the design, construction, commissioning, and operation of the asset.
- Fulfil regulatory obligations for customer and SAP assets designated as Critical Infrastructure (CI). These are highly-regulated assets that are deemed essential for a nation's economy, societal harmony or national security (e.g. a major port, a city's water supply, and the operational and information technologies necessary for delivery of such essential services).

The pilots should be a multi-disciplinary exercise combining technology, engineering, digital twin, and infrastructure management expertise. We recommend that government convene a working group with interested industry partners to scope out public infrastructure that would be suitable for a digital thread technology pilot.

SAP White Paper
Digital Transformation of Public Infrastructure

8.0

SAP WHITE PAPER

Conclusion

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8.0 Conclusion

We are entering a phase of unprecedented levels of investment in megaprojects throughout Australia. If government fails to act, they will be exposing these projects to significant risk of time/cost overruns, customer disruption and government reputational damage.

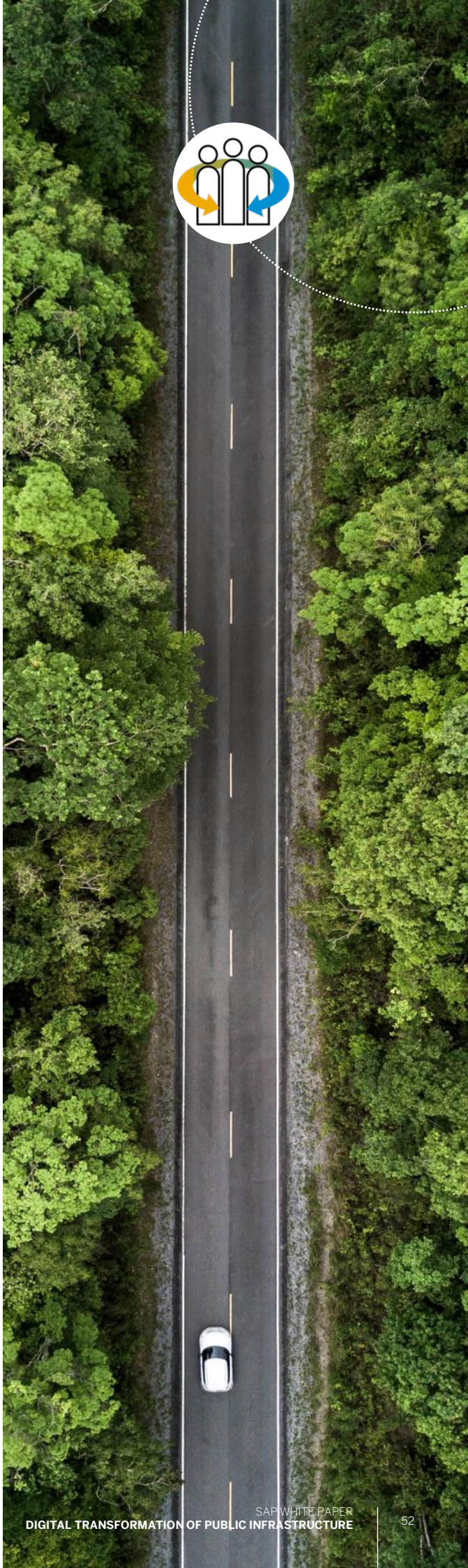
We now have an opportunity to address these project risks, by transforming the sector and driving a step change in productivity through digital technologies.

> **"These risks, the scale of the forecast pipeline, the associated demand for skills and materials and future supply constraints further reinforce the importance of governments unlocking productivity to support infrastructure delivery through policies supporting increasing portfolio management, digitalisation, frontend engagement and innovation."** Infrastructure Market Capacity Report (Infrastructure Australia, Oct 2021)

A failure to act will miss a significant opportunity for cross-sector improvement with emerging digital technologies. Public infrastructure will be further left behind, government will lose talent and projects will be exposed to the same re-occurring risks and issues that impact the productivity and performance currently.

With strong leadership, rapid digital transformation of the infrastructure sector, enabled through new digital capabilities, digital skilling of the public sector workforce, and the innovative digital technologies, will unlock significant value and benefits for infrastructure project delivery.

Together we can realise the digital transformation of public infrastructure.



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