AECOM

House of Representatives Standing Committee on Infrastructure and Communications

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Smart ICT in the design and planning of infrastructure

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House of Representatives Standing Committee on Infrastructure and Communications

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Appendix A – RoadRunna

Appendix B – Efficient Delivery of Infrastructure – A UK Perspective

Executive Summary

This Report provides key recommendations as to the efficient delivery of Infrastructure using key current and emerging technologies.

AECOM provide Smart ICT solutions to Government for the planning, mapping, design, monitoring and maintenance of infrastructure. In June of 2015, AECOM conducted unmanned long-range UAV flights to monitor 400km of vital road network from the sky for the McKinlay Shire Council in North West Queensland. This project was hailed as a World first. The McKinlay trial uses the latest in 3D mapping technology from photographs (photogrammetry) to perform road and infrastructure assessments in areas where traditional survey methods are comparatively expensive and time consuming. Surveys of 200km can take months whereas with UAV technology can be done in a day.

This submission has also drawn upon the experience from the UK and the US, as markets where Government action has created an imperative for change.

Phased strategic action and implementation is recommended to establish industry norms and create a national timetable for implementation. The UK experience which is summarized in the attached Paper "Efficient Delivery of Infrastructure" found the following:

> **The UK Cabinet Office, in collaboration with Her Majesty's Treasury in 2011 developed the Government Construction Strategy, calling for fundamental changes in the way capital works are procured, and for reductions in construction costs of 20%.**
>
> **Government reporting claims it was on track to meet its goal of AU$40 billion of savings (across all of government) by 2014-15 against a baseline from 2010 of the previous Government. The forward goal is to save AU$20 billion for 2017-18 and AU$30-40 billion for 2019-20**

The UK Government Construction Strategy was published by the Cabinet office on 31 May 2011. The report announced the Government's intention to require: collaborative 3D Building Information Modelling (BIM) (with all project and asset information, documentation and data being electronic) on its projects by 2016.

David Philp, AECOM Director of Building Information Modelling (BIM) for EMEA and India, is responsible for ensuring that the UK Cabinet Office's BIM requirements are delivered through the programme and will also continue his part-time secondment as Head of BIM for the UK Government's BIM Task Group, supporting the strategy for industry to use BIM Level 2 on all centrally-funded government projects by 2016.

David is available to discuss the technologies and strategy identified in this White Paper and how this may be implemented in the Australian context.

Whilst current and emerging technologies are considered building blocks; they highlight the key success factors, as follows:

- As with the UK initiative, the Government can create the imperative for change, by the following means:
  - Setting a timetable for objectives to be achieved.
  - A financial imperative for industry involved with Government to self-organize to achieve the required goals of Government as an influential buyer.
  - Create certainty in which companies will invest in new people, processes and technology to meet the imperative created by Government.

Whilst the assessment of currently available technology is important, the ability to synthesize the ideas that will transform industry and economies is of national importance.

The US as one of the most innovative technology based economies, in 2009 created the office of the Chief Technology Officer (CTO). Largely an underrepresented role, the office of the CTO creates a focal point for the following key aspects to advance the economy:

- Identify new technology
- Exploit new technologies
- Integrate new technologies

- Leverage technology across industry
- Drive the R&D investment
- Reduce cost of delivery
- Enhance communications and collaboration
- Leverage existing industries in the new information economy

This report outlines in accordance with the terms of reference key recommendations for consideration; including short-term framework initiatives and long term policy guidance:

Short Term Framework initiatives

- Creation or selection of an existing peak body agency to manage Smart use of ICT for infrastructure development initiatives.
- Create consensus body within existing Infrastructure Australia framework to engage industry.
- Create consensus based common data interchange format through Australian and/or International peak body:
    - Format to be Open/ publicly available to enable start-up innovation to displace incumbent providers - driving new cost structures.
    - Leverage the existing Government Data centre infrastructure environment – at a beneficial cost structure - creating an economy of scale.
- Use legislation or mandatory government practice standards to implement a common Building Information Modelling (BIM) industry format for all Government projects including transition timetable and independent verification umpire.
- Commission the creation of a Technology Transfer Programme (TTP) including a National Technology/ICT catalogue of infrastructure planning, design, construction and disaster planning/remediation – which is regularly updated.
    - Commercialize existing Government initiatives as part of the programme.
    - Work with international Governments / peer agencies to leverage pre-existing technologies, tools and standards.
- Creation of an online public utility infrastructure that details location, current demand and capacities as part of a Geographical Information System (GIS) search tool:
    1. Enable real-time Geographic based analysis for the planning, site selection and design to speed the development and planning process
    2. Enable reservation of in-ground and above ground corridors associated with long-term projects to minimize over-build.
- Creation of an online national disaster-related Geographical Information System (GIS) which can be updated with public and private infrastructure for disaster related planning and automated emergency warning purposes.

Long Term Policy direction

- Increase initial government mandatory practice from BIM level 2 to BIM Level 3 – using an increasing array of smart tools to save time, cost as well as reduce energy. This type of Framework is currently in place in the UK as part of their National BIM standard.
- Increase the initial government mandatory practice from Government projects to the private sector.
- Move policy settings from a watching position to one of aiming to attract technology development for the purposes of commercialization – capturing foreign investment, R&D and associated Australian productivity benefits.
    - A key example is with Driverless car technology. The current Australian policy is considered to be a watching brief on the technology development in the US/Europe. Driverless car technology has the potential to avoid large infrastructure investment in roadside technology – through step

change costs. By moving to a more liberal model making Driverless technology legal for Australian roads; this type of technology may bring down the total cost of ownership of Australian road assets.

- A counter example is Drone technology, as the current policy setting allows the use of commercial drone technology. This has created an opportunity for Australian innovation, attracted a range of investment and enabled commercialization in this area – i.e. AECOM's Unmanned Aerial Vehicle Surveys.

AECOM provide ICT/Technology strategy services and consider that forming an industry Advisory panel could assist the Committee form a Strategic framework.

We look forward to assisting the Standing committee achieve a true step change in equipping the Australian Infrastructure industry with the platform to support more efficient ways of working.

1.0 Identifying innovative technology for the mapping, modelling, design and operation of infrastructure

1.1 Summary

There are many infrastructure technologies that are being 'blended' to provide custom solutions for clients. This can range from car sensors, video capture and GIS such as the RoadRunna application developed by AECOM (see Appendix A) to mainstream applications like Building Information Modelling, GIS and facilities management systems.

The following tables provides a sample of applications from industry, including AECOM's experience providing Unmanned Aerial Vehicle road infrastructure assessments for local Government in Queensland:

Technology		Description	Area applicable	Examples
BIM	Building Information Modelling	Object oriented software that can capture the physical, and functional characteristics of an asset from concept through Whole of Life to demolition	Mapping Modelling Design Operation of infrastructure	Cross Rail - http://www.crossrail.co.uk/benefits/design-innovation/
	City scale modelling	Use of regulatory data and requirements to provide real time inputs when modelling infrastructure proposals	Mapping Modelling Design	Google Flux https://flux.io/
GIS	Geographic Information Systems	A geographic information system (GIS) is a system designed to capture, store, manipulate, analyse, manage, and present all types of spatial or geographical data	Mapping Modelling Design Operation of infrastructure	Google Earth
Reality Capture	360 interactive video and Virtual Reality (VR)	Multi-dimensional computer based world that a person can be immersed in to view and manipulate objects	Mapping Modelling Design Operation of infrastructure	https://www.google.com/get/cardboard/jump/ http://www.intechopen.com/books/the-thousand-faces-of-virtual-reality/building-bridges-activity-within-a-virtual-environment

	Augmented reality (AR)	Integration of digital sensors and the real world in real time	Mapping Modelling Design Operation of infrastructure	http://monet.cs.columbia.edu/projects/armar/
	Augmented reality (AR)	Microsoft HoloLens	Mapping Modelling Design Operation of infrastructure	https://www.microsoft.com/microsoft-hololens/en-us/commercial
	Point Clouds	Point clouds captured via laser scanning or digital photographs (photogrammetry).	Mapping Modelling Design Operation of infrastructure	
	LIDAR for mobile devices	Small, cheap and easy to use LIDAR sensors to allow anyone to create and collect 3D data	Mapping Modelling Design Operation of infrastructure	http://structure.io/ Google Project Tango
3D **Online** mapping				
	Self-aware Drones	Clusters of drones aware of itself and its surroundings	Operation of infrastructure	http://www.wired.com/2014/07/the-next-big-thing-you-missed-drones-as-a-cloud-service-that-actually-flies/
	Long range unmanned aerial vehicle (UAV) mapping	AECOM conducted unmanned long-range UAV flights to monitor 400km of vital road network from the sky for the McKinlay Shire Council in North West Queensland which was hailed as a world first. The McKinlay trial will utilise the latest in 3D mapping technology from photographs (photogrammetry) to perform road and infrastructure assessments in areas where traditional survey methods are comparatively expensive and time consuming	Mapping Modelling Design Operation of infrastructure Monitoring and Maintenance	http://www.queenslandcountrylife.com.au/news/agriculture/general/news/world-first-drone-check-on-shire-roads/2736046.aspx

	API accessibility	More and more API are being exposed, this allows the integration of different technology and data to allow integrated business platforms	Mapping Modelling Design Operation of infrastructure	http://www2.deloitte.com/au/en/pages/technology/articles/tech-trends-2015-what-is-api-economy.html
The Internet of things, smart sensors, Big data		Everyday objects have network connectivity, allowing them to send and receive data	Mapping Modelling Operation of infrastructure	http://www.academia.edu/7478224/Winter_Road_Maintenance_and_the_Internet_of_Things http://www.bigfootcmms.com/iot-maintenance/
Cognitive systems/technology		Technologies that use natural language processing and machine learning - AI) – We can program computers to make complex decisions based on large amounts of big data being consumed at a rapid rate.	Design Operation of infrastructure	IBM Watson

1.2 Recommendations

Key recommendations are as follows:

- Commission the creation of a Technology Transfer Programme (TTP) including a National Technology/ICT catalogue of infrastructure planning/design and construction technologies/tools – which is regularly updated. These programmes enable existing Government initiatives to be commercialized as well as promoting global solutions across all levels of Government.
    - Commercialize existing Government initiatives as part of the programme.
    - Work with international Governments / peer agencies to leverage pre-existing technologies, tools and standards.

Similar work has been commissioned in the US, UK and Europe across a range of agencies. Examples include:

- US National Security Agency Technology Catalogue: https://www.nsa.gov/research/_files/tech_transfers/nsa_technology_transfer_program.pdf
- NASA technology transfer program http://technology.nasa.gov/
- Innovate UK (formerly the Technology Strategy Board) which competitively funds, supports and connects innovative businesses to accelerate sustainable economic growth https://www.gov.uk/government/organisations/innovate-uk
- US Government Office of Technology Assessment – 1972 to 1995 http://www.princeton.edu/~ota/
- European Parliament Science and Technology Options Assessment http://www.stoa.europarl.europa.eu/stoa/

- Creation of an online public utility infrastructure that details location, current demand and capacities as part of a Geographical Information System (GIS) search tool:
    1. Enable real-time Geographic based analysis for the planning, site selection and design to speed the development and planning process.
    2. Enable reservation of in-ground and above ground corridors associated with long-term projects to minimize over-build or disruption of assets.

Various examples of this technology include:

- Google Maps: https://www.google.com.au/work/mapsearth/utilities/
- OpenEI – Open Energy Information http://en.openei.org/wiki/Main_Page
- US Government Mapathon is a Citizen Science and crowd sourcing project. In just three hours, more than 80 citizen mappers edited more than 400 roads and 1,000 buildings in OpenStreetMap, and collected power outage info on 152 power utilities. The mapathon focused on three main projects: humanitarian mapping efforts, mapping U.S. parks, and power outage mapping. https://www.whitehouse.gov/blog/2015/05/28/citizen-cartographers-unite-report-first-white-house-mapathon
- City SDK http://uscensusbureau.github.io/citysdk/index.html
- Australian Telstra Exchange listing. The Telstra exchange listing is Crowd sourced http://whirlpool.net.au/wiki/australian_exchange_guide and enables development planners to locate the nearest exchange to a planned development.

2.0 Identifying the new capabilities smart ICT will provide

2.1 Summary

There are many exciting fusions of existing and new technologies coming to market. The integration of Augmented Reality and Virtual Reality in products such as Samsung Gear VR and Microsoft Hololens are two such examples.

Real time or near real time access to physical asset information for design, monitoring and real time analysis provides a significant opportunity for Government as it enables:

- Asset condition to be determined in hours not weeks or months.
- Infrastructure that can tell owners information about its condition.
- Total cost of ownership optimization. This may take many forms, including trend analysis. E.g. A public housing agency with tens of thousands of properties could use IBM Waston to access existing records to answer question like, what is the life expectancy of the hot water cylinder in use. The computer in a matter of minutes will provide a list of brands and average life for that product. Maintenance then can be more accurately scheduled and smarter decisions can be made.

- In-office tools that will help emulate to outside environments
  - Google Jump https://www.google.com/get/cardboard/jump/
- Field tools to help emulate a proposed or underground environment.
- Integrated platforms with easy access to all digital information in a central interface.
- Platforms that enable location in 3D space, such as Google Tango https://www.google.com/atap/project-tango/

2.2 Digital/paperless everyday workflow

Paperless and Paperlite workflow has accelerated in the last 10 years and the norm is for Adobe PDF products in the form of 2D Drawings and Specifications along with 3D models in their native formats to be exchanged digitally.

Reduce manual code compliance checking

Online submission of 3D models for infrastructure projects, rather than 2D paper or PDF based deliverables. Singapore has done this with the ePlan check system https://www.corenet.gov.sg/general/corenet-e-submission-system.aspx and Statsbygg in Norway (Norwegian government's advisor in construction and property affairs, building commissioner, property manager and property developer) also has an online checking system of models http://www.statsbygg.no/Files/publikasjoner/manualer/StatsbyggBIM-manual-ver1-2-1eng-2013-12-17.pdf

2.3 Examples of new capabilities in Smart ICT

Where	Details	Link
Singapore	Smart NationVision	http://www.ida.gov.sg/Tech-Scene-News/Smart-Nation-Vision

2.4 Recommendations

Key recommendations are as follows:

- Creation of (or selection of an existing) peak body agency to manage Smart use of ICT for infrastructure development initiatives.

An example of a newly created peak body to facilitate Government initiatives in the UK includes:

- UK Building Information Modelling Task Group http://www.bimtaskgroup.org/ The Building Information Modelling (BIM) Task Group support the delivery of the objectives of the UK Government Construction Strategy and the requirement to strengthen the public sector's capability in BIM implementation with the aim that all central government departments will be adopting, as a minimum, collaborative Level 2 BIM by 2016.

3.0 Examining the productivity benefits of smart ICT

3.1 Summary

There have been many reports and examples (noted below) of the productivity benefits of using smart ICT approaches such as BIM technologies. Couple this with other processes and procurement methods, Australia could sustainably increase its productivity in the construction industry.

In June 2015 the Australasian Procurement and Construction Council (APCC) and Australian Construction Industry Forum (ACIF) released a document titled "Building and Construction Procurement Guide: Project Team Integration and Building Information Modelling" to promote the use of BIM and collaborative working to achieve efficiency gains.

The National BIM Initiative (buildingSMART Australasia) suggested the following items needed to be addressed

- Procurement (new collaborative contracts and how to manage risk)
- BIM Guidelines (clear standards for Australian BIM users)
- Education (a new multi-disciplinary approach to educating building professionals is required)
- Product Data and BIM Libraries (the building supply chain needs to get involved and start digitising components for inclusion in intelligent building models)
- Process and Data Exchange (there are insufficient accepted universal standards in place for exchange of BIM data for collaboration)
- Regulatory Framework (planners, local government and other regulatory bodies need guidance on assessing and approving BIM-based projects)

3.2 Key publications demonstrating productivity benefits of smart ICT

Region	Focus Area	By	Link
AUS	Project Team Integration and Building Information Modelling	ACIF/ APCC	http://www.apcc.gov.au/ALLAPCC/Building%20and%20Construction%20Procurement%20Guide%20-%20Project%20Team%20Integration%20and%20BIM.pdf
AUS	Productivity in the Buildings network	Allen Consulting report	http://www.acilallen.com.au/cms_files/acgbuildingsproductivity2010.pdf
AUS	The National BIM Initiative (NBI)	buildingSMART	http://buildingsmart.org.au/campaigns/the-national-bim-initiative-nbi/#.VZDfpJ1-_q4

UK	UK Government Construction Strategy	UK Cabinet Office	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/61152/Government-Construction-Strategy_0.pdf
ANZ	The Business Value of BIM in Australia and New Zealand: How Building Information Modelling is Transforming the Design and Construction Industry	McGraw Hill documents	http://www.autodesk.com/temp/pdf/McGraw_Hill_Business_Value_of_BIM_ANZ.pdf

3.3 Recommendations

Key recommendations are as follows:

- Create consensus body within existing Infrastructure Australia framework to engage industry, similar to the BIM Task Group in the UK http://www.bimtaskgroup.org/
- Use legislation or mandatory government practice standards to implement a common Building Information Modelling (BIM) industry format for all Government projects including transition timetable and independent verification umpire.

4.0 Harmonising data formats and creating nationally consistent arrangements for data storage and access

4.1 Summary

Building Information modelling is considered to be one of the first global digital construction technologies very soon to be deployed in every country in the world. The use of digital electronic Building Information Modelling (BIM) has been compared to the transformation that has already occurred in the aircraft, microprocessor, and automotive industries.

The UK National BIM Strategy is one of the most ambitious and advanced centrally driven programs in the world. Under this programme Government, Construction Industry Council (CIC) and industry have:

- Established a Government/Industry delivery team with support from Cabinet Office and British Standards Institution (BIS) to assist all Government Departments to develop their own BIM adoption strategies in order to meet the Government's BIM mandate. Progress of these strategies is reported back to the Government Construction Board.
- Established a wide number of working groups and other structures to work on key themes to ensure that the UK will have a smooth transition to BIM enablement.
- Engaged with a number of professional and trade bodies to ensure that BIM can be embraced by all communities within the construction sector, especially SMEs.
- Worked with a number of private sector clients to ensure that the benefits of BIM are shared across the entire client base and where possible to create a consistent presentation of requirements to the supply chain.
- Established 'Regional BIM Hubs' to enable SME and smaller clients to get advice from local networks.
- Worked with BSI and other organisations to assist in the development of robust standards including Publically Available Specification **PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling** and **PAS 91 Construction prequalification questionnaires**.
- laid the foundation for the production of a 'digital plan of works' which will help to inform an industry aligned process.
- Established a '2050 Group' to enthuse and capture the technical expertise of the young generation within the construction industry and its clients who represent the future.
- Developed a core set of skills and training requirements.
- Incorporated Government Soft Landings into the BIM Programme.

Figure 1 below highlights the UK's initiative that all central government departments will be adopting, as a minimum, collaborative **Level 2 BIM by 2016** as defined in PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling.

Level 2 BIM requirements include "provision of a single environment to store shared asset data and information, accessible to all individuals who are required to produce, use and maintain it" and "the shared use of individually authored models in a common data environment."

The Level 2 BIM specification also cites technology approaches to the provision of information models in a single environment, which include:

- "Web-based file sharing applications or sophisticated enterprise bridge software"
- "Disciplined-based software, with individual proprietary databases" and "associated design analysis software" that have limited or full interoperability
- "Single source platform software, with a single external relational database, and associated design analysis software that are fully interoperable."

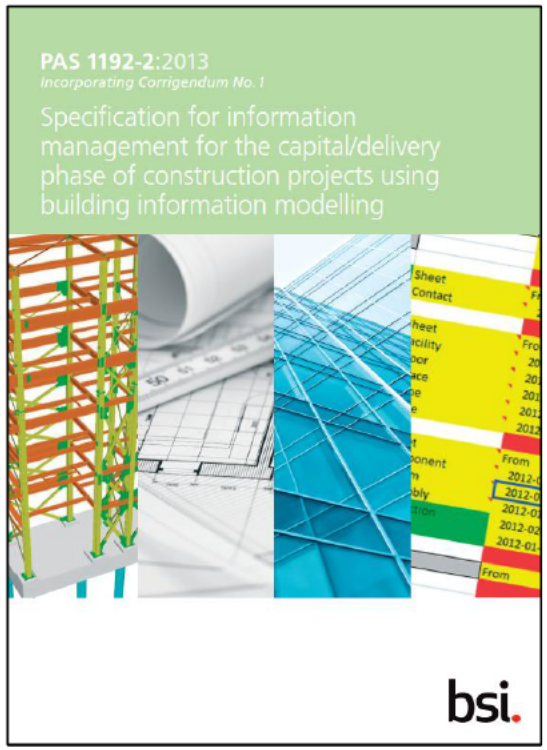

Figure 1 – PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling

Level 3 BIM currently represents full collaboration between all disciplines by means of using a single, shared project model which is held in a centralized repository. All parties can access and modify that same model, and the benefit is that it removes the final layer of risk for conflicting information.

This is known as 'Open BIM', and the UK government's target date for public-sector working is understood to be 2019.

The US also has a model in place to develop a National BIM Standard however, does not yet have the open standards and infrastructure in place to capture, organize, distribute, and mine that information.

Examples include:

- UK BIM Task Group http://www.bimtaskgroup.org/
- PAS 1192-2 Specification for information management for the capital/delivery phase of construction projects using building information modelling http://shop.bsigroup.com/forms/PASs/PAS-1192-2/
- Virtual Australia and New Zealand – Vanzi - http://www.vanzi.com.au/
- INSPIRE – Infrastructure for Spatial Information in the European Community -

4.2 Digital/paperless everyday workflow

The following list represents a small snapshot of key issues in this domain:

- Data storage – communal access to large and secure storage with low latency.
- Accessibility – ability to access file stores across security zone/organizations.
- Analytical Consumability – Cheap Cloud based processing.
- Revision control – ability to manage changes in the model that affects others.
- Copyright issues – need for software originator/read/write permissions.
- Liability issues – shared risk procurement routes such as partnering.

Benefits

- Streamline workflows
- Cost and time savings
    - Analytical and automation tools work across the entire framework.
    - Higher return on solutions being developed on top of the data framework.
    - Reduced risk for data creators and solutions providers as the format is set.
- Uniform data and enforced data schema and format.

International examples

- LINZ (Land Information NZ) - http://www.linz.govt.nz/
- UK Councils – example - https://www.cornwall.gov.uk/community-and-living/mapping/
- European Commissions: INSPIRE - Infrastructure for Spatial Information in the European Community - http://inspire.ec.europa.eu/index.cfm/
- USA – Data.gov - http://www.data.gov/

4.3 Examples of 'open' file formats

Format	Created/managed by	Use	Link
COBie (Construction Operations and Buildings Information exchange)	National Institute of Building Sciences	Common format information specification for Facilities Managers. Information generated during Design and Construction can be outputted from BIM and other information stores into a common COBie format for insertion into an FM CAFM system – reducing manual data entry	http://www.nibs.org/?page=bsa_cobie
IFC (Industry Foundation Classes)	buildingSMART International	3D vendor neutral file format that is interoperable with BIM/CAD software. Facilitates the exchange of 3D and associated data between packages	http://www.buildingsmart-tech.org/specifications/ifc-overview

4.4 Recommendations

Key recommendations are as follows:

- Create consensus based common data interchange format through Australian and/or International peak body:
    - Format to be Open/ publicly available to enable startup innovation to displace incumbent providers driving new cost structures.
        - Leverage the existing Government Data centre infrastructure environment – at a beneficial cost structure creating an economy of scale.

5.0 Identifying international best practice in the use of smart ICT in the design and planning of infrastructure;

5.1 Summary

David Philp, AECOM Director of Building Information Modelling (BIM) for EMEA and India, is responsible for ensuring that the UK Cabinet Office's BIM requirements are delivered through the programme. He also manages: the stakeholder and communications strategy (both internal and external), laser scanning WP, SME BIM awareness WP and chairs the BIM2050 Group. He will also continue his part-time secondment as Head of BIM for the UK Government's BIM Task Group, supporting the strategy for industry to use BIM Level 2 on all centrally-funded government projects by 2016.

David is available to discuss the technologies and strategy identified in this White Paper and how this may be implemented in the Australian context.

5.2 Digital/paperless everyday workflow

The following list represents a small snapshot of key issues in this domain:

- Whilst the UK Government's objective is to achieve Level 2 BIM by 2016, Level 3 is considered to be best practice and Level 2/3 is currently considered to be achievable within a limited domain. Level 3 BIM currently represents full collaboration between all disciplines by means of using a single, shared project model which is held in a centralized repository. All parties can access and modify that same model, and the benefit is that it removes the final layer of risk for conflicting information.

5.3 Examples

- LIDAR http://www.lpi.nsw.gov.au/mapping_and_imagery/lidar_satellite_imagery
- Point Cloud http://www.autodesk.com/products/recap/features/all/gallery-view
- Computer Aided Facilities Management http://www.fsifm.com.au/

5.4 Recommendations

- Commission the creation of a Technology Transfer Programme (TTP) including a National Technology/ICT catalogue of infrastructure planning, design, construction and disaster planning/remediation – which is regularly updated. These programmes enable existing Government initiatives to be commercialized as well as promoting global solutions across all levels of Government.
    - Commercialize existing Government initiatives as part of the programme.
    - Work with international Governments / peer agencies to leverage pre-existing technologies, tools and standards.

6.0 Considering the use of smart ICT in related fields, such as disaster planning and remediation

6.1 Summary

In 2014 the Queensland University of Technology published a paper (Working as one: A road map to disaster resilience for Australia. Special Report, SR73) noting that Natural disasters are costing the Australian economy $6.3 billion per year, and those costs are projected to rise incrementally to $23 billion by 2050. With more frequent natural disasters with greater consequences, Australian communities need the ability to prepare and plan for them, absorb and recover from them, and adapt more successfully to their effects. The report sets out 11 recommendations to help guide Australia towards increasing national resilience, from individuals and local communities through to state and federal agencies, including the following technological oriented solution:

- Build a national resource for disaster-related data - sharing of disaster-related information, in concert with geospatial agencies and experts, makes emergency decision-making in Australia more effective.

6.2 Digital/paperless everyday workflow

Require infrastructure projects to be integrated into a single online national resource for disaster related information.

6.3 Examples

Mapping solutions

- Queensland Globe – for Flood Management https://data.qld.gov.au/dataset/queensland-globe

Automated text based emergency warning solutions could be implemented, such as:

- Spok http://www.spok.com/solutions/emergency-notification-system

6.4 Recommendations

Key recommendations are as follows:

- Creation of an online national disaster-related Geographical Information System (GIS) which can be updated with public and private infrastructure for disaster related planning and automated emergency warning purposes.

7.0 Considering means, including legislative and administrative action, by which government can promote this technology to increase economic productivity

As with the UK initiative, the Government can create the imperative for change, by the following means:

- Setting a timetable for objectives to be achieved.
- A financial imperative for industry involved with Government to self-organize to achieve the required goals of Government as an influential buyer.
- Create certainty in which companies will invest in new people, processes and technology to meet the imperative created by Government.

Short Term Framework initiatives

- Creation or selection of an existing peak body agency to manage Smart use of ICT for infrastructure development initiatives.
- Create consensus body within existing Infrastructure Australia framework to engage industry.
- Create consensus based common data interchange format through Australian and/or International peak body:
  - Format to be Open/ publicly available to enable start-up innovation to displace incumbent providers - driving new cost structures.
  - Leverage the existing Government Data centre infrastructure environment – at a beneficial cost structure - creating an economy of scale.
- Use legislation or mandatory government practice standards to implement a common Building Information Modelling (BIM) industry format for all Government projects including transition timetable and independent verification umpire.
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  - Commercialize existing Government initiatives as part of the programme.
  - Work with international Governments / peer agencies to leverage pre-existing technologies, tools and standards.
- Creation of an online public utility infrastructure that details location, current demand and capacities as part of a Geographical Information System (GIS) search tool:
  1. Enable real-time Geographic based analysis for the planning, site selection and design to speed the development and planning process
  2. Enable reservation of in-ground and above ground corridors associated with long-term projects to minimize over-build.
- Creation of an online national disaster-related Geographical Information System (GIS) which can be updated with public and private infrastructure for disaster related planning and automated emergency warning purposes.

Long Term Policy direction

- Increase initial government mandatory practice from BIM level 2 to BIM Level 3 – using an increasing array of smart tools to save time, cost as well as reduce energy. This type of Framework is currently in place in the UK as part of their National BIM standard.
- Increase the initial government mandatory practice from Government projects to the private sector.
- Move policy settings from a watching position to one of aiming to attract technology development for the purposes of commercialization – capturing foreign investment, R&D and associated Australian productivity benefits.
    - A key example is with Driverless car technology. The current Australian policy is considered to be a watching brief on the technology development in the US/Europe. Driverless car technology has the potential to avoid large infrastructure investment in roadside technology – through step change costs. By moving to a more liberal model making Driverless technology legal for Australian roads; this type of technology may bring down the total cost of ownership of Australian road assets.
    - A counter example is Drone technology, as the current policy setting allows the use of commercial drone technology.. This has created an opportunity for Australian innovation, attracted a range of investment and enabled commercialization in this area – i.e. AECOM's Unmanned Aerial Vehicle Surveys.

Appendix A – RoadRunna

ROADRUNNA

AECOM

Road Data Visualisation

RoadRunna elevates GPS based road dataset visualisation to the next level.

Load all your vehicle collected information into one easy to navigate dashboard and access road condition information directly at your desk. Share information with colleagues on screen, verify complaints and assist in stakeholder engagement, help build a business case to secure funding, compare last year's assessment with current collections side by side to verify deterioration or improvements of reconstruction efforts. These are just a few of the use cases where *RoadRunna* can make your life easier.

If you are using smart devices to collect information about your gravel and paved roads on a regular bases and find compiling the collected information into a usable format cumbersome, make *RoadRunna* your best mate.

Loadable datasets include:

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Appendix B – Efficient Delivery of Infrastructure – A UK Perspective

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Efficient Delivery of Infrastructure
Queensland Government
17July 2015

Efficient Delivery of Infrastructure

UK Perspective

Revision A – 17 July 2015
Prepared for – Queensland Government – ABN: 75 818 456 675

Efficient Delivery of Infrastructure

UK Perspective

Client: Queensland Government

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Reviewed by Richard Morwood

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1.0 Introduction

As highlighted in the recent Australian Infrastructure Audit Report, the delivery of infrastructure requires continuous review and improvement to match changing community expectation. Whether in the public or private sector, the efficient and sustainable delivery of infrastructure is critical to a healthy and productive economy.

In Australia and the United Kingdom (UK), the construction industry is changing in response to four key drivers of change [1].

1. Clients seeking greater value from their investment in capital works
2. Recognition that there is considerable wasted effort embedded in the industry
3. Technological change, in particular the use of Building Information Modelling (BIM)
4. Better integrated delivery models brought about by changes in the insurance industry.

In the UK, the Government has set the target of 20% cost savings in the procurement of their major projects, across all departments. To achieve this, they have embarked on a change management campaign including lean procurement methodologies, fostered collaboration in the supply chain and mandated the use of technological innovations such as BIM.

In the future, infrastructure delivery in Australia is likely to change in a similar manner to address challenges such as funding constraints, a need for more transparent cost-benefit-analysis, a move to minimise politically-driven decision-making, and more innovative procurement practices.

This document summarises recent developments in the UK, drawing parallels between initiatives of the UK Government and findings in recent Australian Government inquiries such as the Australian Infrastructure Audit and the Productivity Commission.

2.0 Context

In 2004 a North American study[2] carried out by the Construction Industry Institute found that as much as 57% of time, effort and material invested in a construction project adds no value to the final product, as compared to a figure of only 26% in the manufacturing industry.

Other efficiency studies[3] suggest the construction industry in Australia and overseas wastes over 30% of its efforts. Key industry publications [4] point to the common denominators in wasted effort, including:

- designs typically require multiple information inputs, leading to several iterations of the design;
- uncertain cost budgets lead to several iterations of a design to bring the design within budget;
- up to 40% of the design documentation is not used by the trade contractors for whom it is intended;
- poor coordination of designs by different designers and trade contractors
- the cost of re-work

These factors are in part a product of the fragmented nature of the construction industry, the increasing complexity of its services, and the creation/operation of “silos” within that structure.

The UK Cabinet Office recognised this, and in collaboration with Her Majesty’s Treasury in 2011 developed the Government Construction Strategy, calling for fundamental changes in the way capital works are procured, and for reductions in construction costs of 15 - 20%.

In 2014 it was reported [5] that the UK Government was on track to meet its goal of AU$40 billion of savings (across all of government) by 2014-15 against a baseline from the previous Government in 2010. The forward goal is to save AU$20 billion for 2017-18 and AU$30-40 billion for 2019-20.

At a similar time, the UK Government established a governance body for its major projects across all departments - the Major Projects Authority. This body provides a layer of assurance to the infrastructure delivery process, with transparency of its performance published annually.

3.0 Key Industry Publications (Australia)

The need for reform of infrastructure delivery is well documented in the following key Australian industry publications:

- Building and Construction Procurement Guide: Project Team Integration and Building Information Modelling (June 2015) - Australian Construction Industry Forum and Australasian Procurement and Construction Council
- Pathway to Productive and Sustainable Infrastructure – Workshop Report (June 2015) Australian Sustainable Built Environment Council
- Australian Infrastructure Audit – (April 2015) - Infrastructure Australia
- Productivity Commission Inquiry Report - Public Infrastructure (Nov 2014) - Australian Government
- The Case for Project Team Integration (March 2014) - Australian Construction Industry Forum and Australasian Procurement and Construction Council

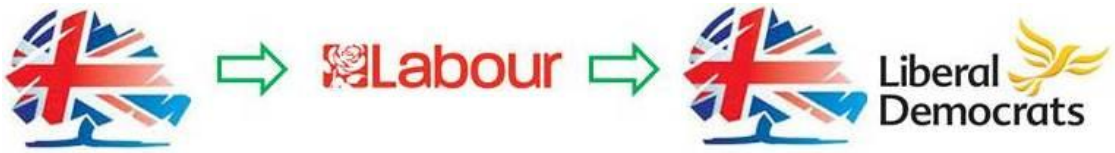
4.0 Government Reform - United Kingdom

The need for efficient infrastructure delivery has been an area of focus for the UK construction industry dating back to 1934 with Alfred Bossom's report "Reaching for the Skies", Simon's report of 1944 and Barnwell's report of 1967.

In more recent times, during the economic recession of the early 1990's the controversial "Latham Report" was commissioned by Sir Michael Latham, an ex-Member of Parliament. This report was commissioned jointly by the UK Government and the construction industry. Unlike preceding reports, the Latham report consulted extensively with the wider construction Industry supply chain, and recommended an understandable action plan with timeframes and resources for implementation.

Since this time, six electoral cycles have passed, with elected parties changing three times. Despite the changes of Government from one elected party to another, the intent to tackle efficiency reform remained a high priority, and the focus on efficient infrastructure delivery has been maintained, seeing the formation of numerous industry forums and submissions of key industry publications as shown in the next section.

Conservative Labour Conservative & Liberal Democrat coalition



4.1 Key Industry Publications (UK)

- **Constructing the Team (1994) – Sir Michael Latham**
    - Clients at the core of construction
    - partnering agreements, with adjudicated dispute resolution
- **Rethinking Construction (1998) – Sir John Egan**
    - LEAN principles: waste reduction
    - value stream mapping and integrated supply chain
- **Modernising Construction (2001) – National Audit Office**
    - Integrate designers with whole supply chain, enhancing buildability inputs into design
    - enabling operational efficiency
- **Accelerating Change (2002) - Strategic Forum for Construction**
    - Sustainable, customer focussed industry, with strong client leadership and integrated teams
    - Discard the use of lowest cost tendering -embrace procurement options with value for money
- **Construction matters (2007) – UK House of Commons Business and Enterprise Committee**
    - Created of the role of Chief Construction Officer to the UK Cabinet
- **Government Construction Strategy (2011) – UK Cabinet Office**
    - Construction Advisor
    - Government Construction Strategy
    - New models of construction procurement
    - Benchmarking
    - Fair payments
    - Digital technology
    - Pipelines of work
    - Operational efficiency
    - Sharing best practice

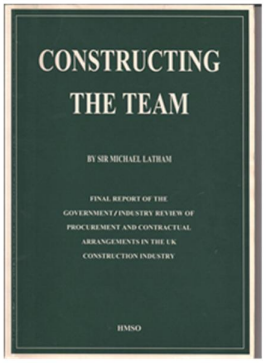
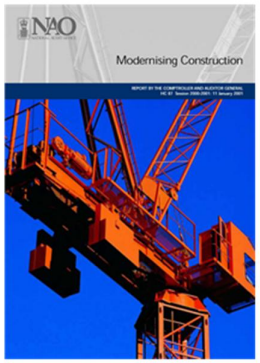
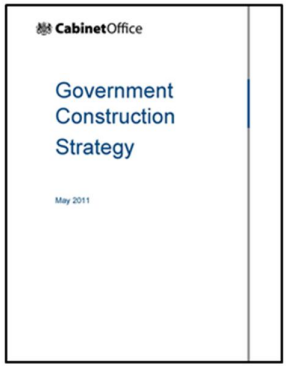
The last publication has been listed in more detail, as this is the basis for the current UK Government's infrastructure delivery framework. As quoted in the Government Construction Strategy:

> *…the UK does not get full value from public sector construction; and that it has failed to exploit the potential for public procurement of construction and infrastructure projects to drive growth.*
>
> *This strategy changes that. It calls for a profound change in the relationship between public authorities and the construction industry to ensure the Government consistently gets a good deal and the country gets the social and economic infrastructure it needs for the long-term. There is a detailed programme of measures Government will take that will reduce costs by up to 20% by the end of this parliament.*

The image below illustrates the progression of influential leaders, forums and publications which directed efficiency reform within the UK construction industry.

International Trends – United Kingdom

Key industry publications

1994 Latham Report (ex-Conservative MP)	1998 Egan Report (ex-CEO Jaguar)	2001 National Audit Office	2007 UK House of Commons	2011 UK Cabinet Office
				
Constructing the Team	**Rethinking Construction**	**Modernising Construction**	**Construction Matters**	**Government Construction Strategy**
Collaborative Contracting	LEAN Principles	Improved Performance	Whole-of-Govt Reform	Whole-of-Govt Reform

Key appointments

Construction Industry Board (CIB) Construction Task Force	Strategic Forum for Construction		Chief Construction Advisor 2009-2012 Paul Morrell (ex-AECOM)	Chief Construction Advisor 2012-2015 Peter Hansford (ex-Nichols)

4.2 Key Government Initiatives (UK)

At the time of forming Government in 2010, the Efficiency Reform Group was established to tackle whole-of-government efficiency challenges. Policy development was focused in three areas: central government efficiency, major project management and government buying. For the purposes of this document, the focus is on major project management, where reform policies were developed and released by the collaborative efforts of the UK Cabinet Office, Her Majesty's Treasury, and the Efficiency Reform Group.

To support all government departments carrying out a major project, the Major Projects Team was established, comprising two entities: the Major Projects Authority and the Construction team. A summary of numerous initiatives under the Major Projects Team is summarised below, and alignment with the Australian construction industry is demonstrated by matching findings/recommendations from recent Australian Government publications.

Relevance of UK Government Efficiency Reform to Australian Objectives

	Initiative	Productivity Commission Recommendations (ID number)	Infrastructure Australia Findings (ID number)
UK Government - Efficiency Reform Initiatives	Implementation of whole-of government reform	7.1, 7.3, 16.1, 16.2	16, 17, 18, 19, 20, 21, 22, 23, 24, 25
	Consistent governance, review and audit	7.1	16, 18, 22, 23
	Transparency of performance reporting	7.1	18, 20
	Intelligent client	7.1	
	Data benchmarking	7.1, 7.2, 9.1, 9.2,10.1, 14.1	4, 20
	Building Information Modelling (BIM)	12.5	34
	Procurement process	6.1, 7.1, 12.4	33
	Reduce procurement costs	12.3	
	Collaborative contracting	12.4	
	Risk allocation/management	7.1	
	Greater investment in pre-construction	12.1, 12.2	
	Contesting specifications	12.6	
	Understand site risks	12.9	
	Pipeline of projects		32, 33
	Engaging small business	12.8	
	Asset management		46, 47, 81
	Sustainability/environment		24, 40, 41, 42, 43, 44, 45
	Co-ordination and leadership		
	Efficiency and elimination of waste		
	Client Relationship Management		
	Supplier Relationship Management		
	Sharing best practice		
AU Govt Findings	Long-term infrastructure planning		19, 21, 25
	Social impact and land-use planning	9.1	16, 17, 35, 50
	Community outcomes clearly defined	7.1	17, 35, 50
	Project selection	2.3, 6.1, 9.1	11, 12, 18
	Recognition of social/economical value-add		9
	Cost-benefit analysis	2.3	18, 20
	Funding/Finance	4.1, 5.1, 6.1, 7.1, 8.1, 8.2	26, 27, 28, 29, 30, 31

Note: Shaded areas show gaps in coverage

4.2.1 Major Project Management

To support all government departments carrying out major projects, the Major Projects Team was established, comprising two entities: the Major Projects Authority and the Construction team

4.2.1.1 Major Projects Authority (MPA)

The Major Project Authority is responsible for the effective and efficient delivery of major projects across all government departments. It manages the portfolio of projects and programmes, providing transparent reporting to government and the public. It also approves integrated assurance and approval plans, and conducts reviews during the project or programme, providing specialist expertise where necessary.

An important role of the MPA is to build the skills of major project leaders. To achieve this, the Major Projects Leadership Academy was developed, run in partnership with the Oxford Business School and Deloitte. The requirement will be that no major project will be led by someone without completing the academy programme. This strengthens the in-house skills of the public service, supporting the efficient delivery of complex projects, and developing the public sector as an intelligent client.

Relevance to Australia:

The formation of the MPA is consistent with the following findings/recommendations of the Productivity Commission Inquiry Report and the Australian Infrastructure Audit Report, as shown in the table below.

Initiative	Productivity Commission Recommendations	Infrastructure Australia Findings
Implementation of whole-of government reform	7.1, 7.3, 16.1, 16 2	16, 17, 18, 19, 20, 21, 22, 23, 24, 25
Consistent governance, review and audit	7.1	16, 18, 22, 23
Transparency of performance reporting	7.1	18, 20
Intelligent client	7.1	
Data benchmarking	7.1, 7 2, 9.1, 9.2,10.1, 14.1	4, 20

4.2.1.2 Construction

Key to the effectiveness of the Construction group is the action list proposed by the Government Construction Strategy. Changing procurement behaviours, removing inefficiency and improving strategic collaboration with the supply chain are central themes of the implementation plan.

a) Cost benchmarking

b) Co-ordination and leadership

c) Forward programme and data

d) Governance and client skills

e) Value for money, standards and benchmarking

f) Efficiency and elimination of waste

g) Building Information Modelling (“BIM”)

h) Alignment of design/ construction with operation and asset management

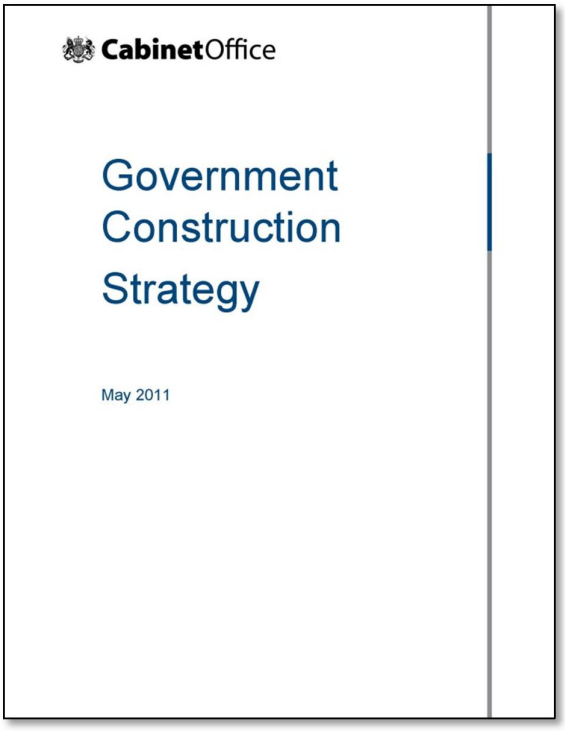
i) Supplier Relationship Management

j) Competitiveness and reducing duplication (whole public sector)

k) New Procurement Models

l) Client Relationship Management

m) Implementation of existing and emerging Government policy in relation to sustainability



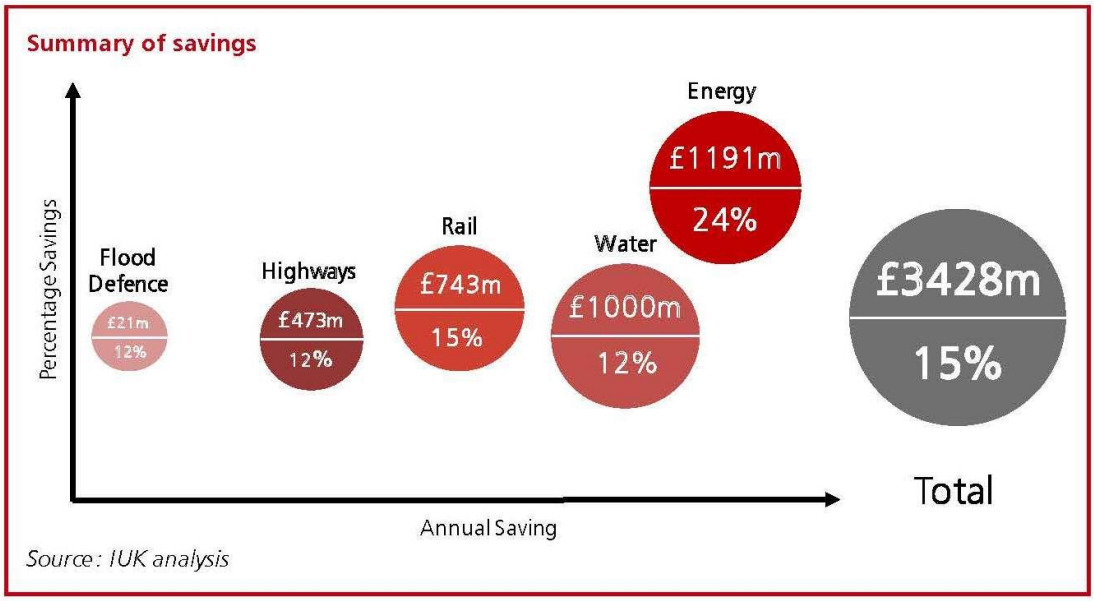
As part of the strategy, trial projects are being delivered to test various methodologies proposed in the action plan. Some of these methodologies include:

- lean procurement processes generally;
- applying a cost-targeted, integrated approach to procurement;
- aggregating demand across Government, generating economies of scale – for example through the centralised procurement of common components, as appropriate;
- use of whole life, outcome based specifications that remove unnecessary prescription and encourage supply chain innovation;
- integrated project insurance;
- the phased introduction of Building Information Modelling; and
- post-handover operation of built assets

The progress of these activities is regularly monitored with performance reported to the Cabinet Office with the assistance of the appointed Chief Construction Advisor.

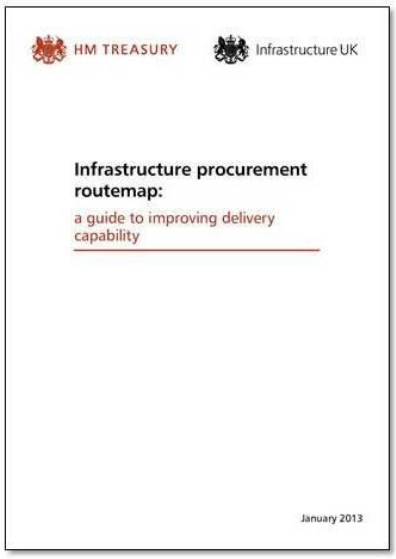
The Chief Construction Advisor is typically filled by a respected private industry leader, ensuring that strategies work with policy and to carry out reforms in both the infrastructure and construction industries.

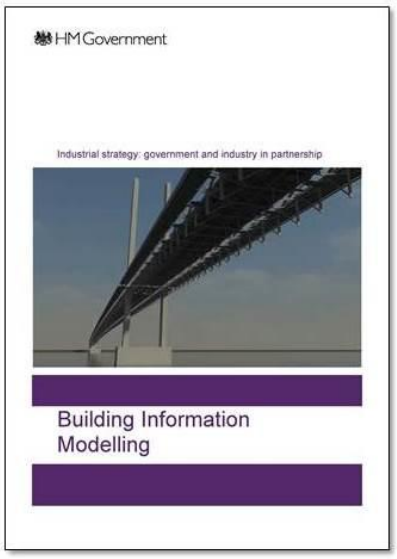
The July 2014 Infrastructure cost review showed an annual cost saving of 15%, equivalent to approximately AU$7.0 billion.



Source: Infrastructure Cost Review: Measuring and Improving Delivery, HM Treasury, July 2014

Example outputs from the Government Construction Strategy:





Relevance to Australia:

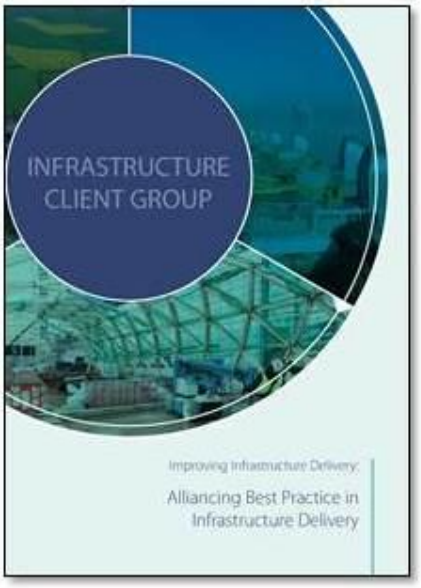
The intent of the Government Construction Strategy is consistent with the following findings/recommendations of the Productivity Commission Inquiry Report and the Australian Infrastructure Audit Report, as shown in the table below.

	Initiative	Productivity Commission Recommendations	Infrastructure Australia Findings
UK Government - Efficiency Reform Initiatives	Implementation of whole-of government reform	7.1, 7 3, 16.1, 16.2	16, 17, 18, 19, 20, 21, 22, 23, 24, 25
	Consistent governance, review and audit	7.1	16, 18, 22, 23
	Transparency of performance reporting	7.1	18, 20
	Intelligent client	7.1	
	Data benchmarking	7.1, 7.2, 9.1, 9.2,10.1, 14.1	4, 20
	Building Information Modelling (BIM)	12 5	34
	Procurement process	6.1, 7.1, 12.4	33
	Reduce procurement costs	12 3	
	Collaborative contracting	12.4	
	Risk allocation/management	7.1	
	Greater investment in pre-construction	12.1, 12.2	
	Contesting specifications	12.6	
	Understand site risks	12 9	
	Pipeline of projects		32, 33
	Engaging small business	12 8	
	Asset management		46, 47, 81
	Sustainability/environment		24, 40, 41, 42, 43, 44, 45
	Co-ordina ion and leadership		
	Efficiency and elimination of waste		
	Client Rela ionship Management		
	Supplier Relationship Management		
	Sharing best practice		

5.0 Industry response

In relation to collaboration in the supply chain, BS11000 was developed to enable organisations of any size and from any sector to improve efficiency and partnership working; particularly those within or managing a supply chain.

British Standard BS11000 Collaborative Business Relationships



Infrastructure Client Group Alliancing Best Practice in Infrastructure Delivery

Guidance information was developed to prepare the UK construction industry for new forms of contract such as alliancing. UK procurement policy was heavily influenced by Australian experiences in early contractor involvement and alliance contracting.

6.0 The convergence of Integrated Project Delivery, LEAN Construction and BIM

The observations of recent international trends might be described as a convergence of Integrated Project Delivery (IPD), LEAN construction and BIM. This is described in the recent ACIF/APCC publication "Building and Construction Procurement Guide: Project Team Integration and Building Information Modelling", as previously mentioned[6].

A brief description of each element is provided below.

6.1 Integrated Project Delivery

As quoted from the ACIF/APCC publication[6]:

Project Team Integration (PTI) refers to the process and level of integration, cooperation and collaboration of the stakeholders in a construction project. The level of integration is substantially up to the Principal/ Client. PTI is a process to facilitate integration and encourage collaborative behaviour and harness the talents and insights of all participants, as well as to reduce waste and optimise project outcomes through all phases of design, fabrication, construction, project handover and facilities management. PTI principles can be applied to a variety of contractual arrangements. Some forms of collaborative contract include Early Contractor Involvement (ECI) and Alliancing.

6.2 Lean Construction

As per Diekmann et al (2004)[2] Lean construction is the continuous process of eliminating waste, meeting or exceeding all customer requirements, focusing on the entire value stream and pursuing perfection in the execution of a constructed project.

Benefits include improved value creation, improved efficiency, and increased profitability of the supply chain, creating a more competitive construction industry, improved safety, better integration, increased reliability and lower costs.

According to a study[7] by Engineers Australia (2012) recommended practices for Lean construction include: Target Value Design, Last Planner System, Pull Planning, Information Centre meetings, 5-S and Visual Management, Standardised Work, and Continuous Improvement.

In Australia, the promotion of Lean principles in the construction industry is a key objective of the Lean Construction Institute Australasia. Website: http://www.lcia.org.au/

6.3 Building Information Modelling

In the USA, the National Building Information Model Standard Project Committee defines BIM as:

Building Information Modelling is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition.

It is a management and information tool, which to be fully utilised and effective, requires cooperation and collaboration of all stakeholders. This higher level of collaboration is best achieved with an integrated project delivery model.

"BIM is a term used to describe a myriad of computer software applications that can be utilised by design and construction professionals and increasingly facilities managers alike to plan, layout, estimate, detail and fabricate various components of a building".[8]

The intentional structuring of project data using BIM allows Lean principles to be embedded:

- Standardisation of design leads to standardisation of work
- Reliable information flow maximises production rates
- Effective change management minimises interruptions to work flow and re-work
- Optimising design enables efficient construction cycles

7.0 Conclusions

The efficient delivery of infrastructure in Australia has been the topic of several recent inquiries and audit reports. Recommendations and findings of these reports have been compared to UK Government initiatives as part of their Government Construction Strategy, to highlight areas of overlap. Policy reform in the UK has targeted a saving of 15-20% in the delivery of major projects, which to date has generally been achieved.

While the private sector will pursue cost-saving initiatives such as Lean and BIM for their own profitability, the extent and speed of uptake can be maximised by client-led policy changes, as is the case in the UK. The primary "instrument" to effect these changes is the procurement strategy, however this needs to be supported by a wider strategy of "how to do business more efficiently".

In the UK, the Government has addressed this on multiple fronts, including:

a) New Procurement Models - integrated project insurance; long-term frameworks and collaborative contracts

b) Efficiency and elimination of waste – discarding processes and activities that add no value

c) BIM – enabling the efficient flow of higher-quality data to improve decision-making

d) Governance and client skills – training for new collaborative forms of contract

e) Supplier Relationship Management – to sustain long-term supply chain engagement

f) Cost benchmarking – to enable consistent, tight control

All of these elements are interrelated and co-dependent. The government recognised that to effect the change in strategic direction, support would be needed from expertise in the private sector. For this reason, the implementation was planned by various public/private sector working groups, steered by government parliamentary committees.

It is recommended that a similar approach be taken in Australia, perhaps with Infrastructure Australia acting as an independent entity which facilitates the public/private partnership to develop the policy reforms.

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