Profiling Australian Building Information Modelling (BIM) and policy perspectives for public procurement of infrastructure projects
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This paper is issued as an authored “working paper” and is an excerpt of the work in progress being undertaken by the lead author towards fulfilling a PhD candidature. As a working paper, this document has been subject to a limited peer review. The views expressed in this paper are those of the authors alone and do not represent the views of the University of Melbourne. Any comments on the paper may be sent directly to the lead author, Ilsa Kuiper, via ikuiper@student.unimelb.edu.au.

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Abstract

The narrative surrounding building information modelling (BIM) in Australia includes subtle inferences that appear to tip BIM into digital and data-based discourses. Like international examples, Australian public policy on, referencing or concerning BIM is playing an implicit part in these developments, including in the procurement of public infrastructure projects.

Whilst such directions are illustrative of scaled adaptive processes, including in reconciling how BIM is approached, questions are raised about the inherent intent of BIM and the extent to which the institution of government is or should be involved. Opening the door on wider and more expansive considerations for BIM go well beyond just improving productivity in the construction industry. By implication, the circumstances pose a further and different set of objectives, opportunities and challenges of interest about BIM.

The research literature on “BIM policy”, however, is indeterminant. Whilst descriptions of public examples are evident, there is limited discussion profiling the relative characteristics both about the objective for and of BIM and of the respective issuing or publishing agency or institutional frameworks. How this relates to or converges with (or not) with digital and data narratives, particularly for the purposes of policy development, remains largely unexplored.

To consider the issues at hand, the present working paper presents an overview of Australia policy developments intimating changes to the narrative on BIM. A discussion on “BIM policy” is followed by
a synopsis of Australian policy examples and involved stakeholders. Linkages to data and digital contexts are highlighted, along with a discussion identifying other potential research domains that may be relevant to policy development. Questions are posed for further consideration and potential research.

Key words: public procurement, policy, infrastructure projects, building information modelling, BIM, data
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Introduction

The Australian architecture, engineering and construction (AEC) industry is not immune from developments and discussions concerning building information modelling (BIM), see (Hampson & Shemery, 2018; Kuiper & Holzer, 2013; S. Liu, Xie, Tivendal, & Liu, 2015; Sanchez, Kraatz, & Hampson, 2014). There is, however, limited detailed research profiling the Australian public policy landscape as it concerns or relates to BIM and how it continues to evolve. Links to public procurement policy also remain indeterminant (Kuiper & Duffield, 2018a), despite the recognised role of public procurement policy in driving industrial development, including for innovation promotion (Dawar & Oh, 2017) (pp. 71-74). Arguably, there is scope to discern “the long causal chain that links public demand to policy output and ultimately to system performance” (Hartlapp, 2018). Institutional considerations and design of the ‘rules of the game’ are further critical factors that shape policy outcomes (Baldwin, Chen, & Cole, 2019).

More recently, as relevant stakeholders grapple with what BIM means and how applicable BIM is to the respective operations and dealings, the narrative on BIM in Australia appears to blend with or is being subsumed by other concurrent developments, be it “digital” or data related or orientated. One view is that these directions are part of more nuanced and localised developments, tailored to address immediate needs and perspectives. It is another proposition again to suggest public policy development must further reconcile issues and considerations in circumstances where:

- the science to definitively or comprehensively explain or describe “BIM” does not necessarily exist or is co-evolving with policy, see (Miettinen & Paavola, 2014);
- the questions asked of governments by industry about BIM will invariably differ or be broader in scope, including the ways in which governments respond or intervene;
- solutions may lie in overcoming or addressing the functional indivisibility of complex problems, be it premised between strategic choice or issue characteristics and delivered via sectoral demarcated policy, integrated policy, coordination or otherwise, see (Hartlapp, 2018); or
- for scaled considerations, there may be multiple interpretations of BIM that warrant or require certain approaches, either relative to existing frameworks, structures and institutions or that potentially pre-empt the need for new or adapted types, see (Singh, 2019).

The changing circumstances raise questions about the subject intent of and for public policy, particularly the role of public procurement, and the extent to which BIM is or continues to be a relevant, necessary or contributory factor. The circumstances further highlight whether directions concerning BIM are developed in consideration of the changing context, the option for broader scaled
applications or require strategic formalisation, realignment or integration. The extent to which changes impact or attribute to affecting policy implementation and other downstream considerations is also pertinent. But nor does this detract from policy related research that draws alignment between BIM and innovation or “BIM innovation” (Papadonikolaki, 2017). Rather it further opens the door to consider and link BIM in the context of “innovation policy” research, and other related lines of investigation.

As part of broader PhD research program being undertaken by the lead author, the present working paper seeks to describe key attributes and references to BIM (and like terms) that have been raised in Australian “policy” and relative to public procurement. In doing so, the working paper aims to highlight examples of the breadth, dimensions and variability of the policy narrative on or that references BIM in Australia. Linkages to other narratives, jurisdictions and domains are further identified to illustrate the potential convergence of concepts and draw from other sources for comparison and insight.

The following sections of the present paper comprise an overview of BIM practice examples, references and terminology in Australian public policy materials and documentation. The concept of “BIM policy” is delineated and qualified, not only in terms of BIM but as a public administrative mechanism or instrument. Key policy reports and documentation and involved stakeholders are identified along with linkages that see the convergence between BIM and data orientated developments more generally. Questions are posed for further discussion and potential future research.

**Features of policy and “BIM policy”**

Whilst the research literature comprises examples that connote the role of “BIM policy”, gaps remain. The need for further research not only concerns the intent and definitional issues associated with “BIM policy” terms (Kuiper & Duffield, 2018c), but also policy and BIM based research more generally. Such challenges are further implicated by the fluidity of what constitutes “policy” itself (Althaus, Bridgman, & Davis, 2018) (p. 8) and other distinctions of and about “public policy”. For the latter, it includes policy determinations as a public administrative instrument, typically in response to problems or issues faced by the community and delineated by intended objectives by “government”. Critically,

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3 Substantiating or detailing the BIM and policy landscape however may be the subject of further research.

4 More generally, Dainty, Leiringer, Fernie, and Harty (2017) highlight the need for “policy studies that evaluate and challenge the processes, networks, power relations and outcomes of BIM policy, and justify the technical concerns that it creates”, including for the UK industry towards a “deeper understanding of the BIM mandate”.

5 For example, it is supposed that “the touchstone for any government should be the results it achieves for its citizens: its public impact” (Centre for Public Impact, 2016) (p. 12). However, like the typology of environmental problems, there can be uncertainties, mismatches across sectors, levels, space and time and
affecting change can be part of the role of public policy. However, anticipating the way in which and how policy is interpreted and enacted upon, is another key factor in policy design, and by default, effective governance (Department of the Prime Minister and Cabinet, 2003) (p. 4).

Policy for the public, by the government

The basis for the development of public policy can arise from a range of potential factors, reasons, motivations or persuasions, including that may be derived by rational or via social-interactive models (Capano & Lippi, 2017). Arguably, if not strictly qualified as “policy”, a public position on a matter is policy orientated in nature or reflect a certain statement or signal by the respective publishing organisation, be it definitive or aspirational. What is not always evident is whether the statement or position that set out is an endorsement by the publishing organisation itself, on behalf of the constitute members that the organisation represents or some other entity. Critically for the purposes of this working paper, such perspectives are interpreted as being indicative only and are subject to acceptance, qualification or rejection by the relevant proponents or affected parties. Nor are the perspectives interpreted as reflecting a definitive statement about that which is known, endorsed or conclusive propositions.

Policy development and life cycle factors, like projects, can also entail certain phases and activities, notwithstanding the variability in practice that can occur, require tailoring and respond to changes (Althaus et al., 2018) (pp. 79-80). Notably, the originating or planning considerations for policy, are just as relevant in terms of the delivery and application6. For some cases, developing policy “on the fly”? or concurrently is not new, whether developed organically or iteratively, by direction, or otherwise relies upon political and collaborative support, and/or driven advocacy or self-interest. The choice of and type of choices made for policy instrument can also be relevant (Capano & Lippi, 2017).

the plurality of norms, values and interests that factor for policy orientated considerations (Ingold, Driessen, Runhaar, & Widmer, 2018).

6 For example, the Centre for Public Impact (2016) (p. 11) describe three key tenants of public impact fundamentals through: (i) legitimacy (public confidence, stakeholder engagement and political commitment); (ii) policy (clear objectives, evidence and feasibility); and (iii) action (management, measurement and alignment).

7 For example, decisions that may be made quickly or during emergency situations to accord with the moment, or that otherwise subvert or bypass general policy development protocols or processes.
The extent to which policy is “public”, in the sense of leadership and governance, points to acknowledging the variability within the institution of what constitutes the “government”, including its structures and form. Differences are likely to impact positions taken, whether between:

- centralised, peripheral and decentralised agencies (and the parts therein);
- independent, national or local entities;
- public services sectors, forums and functions, including that are technically or operationally orientated or are temporary or short termed; or
- public, quasi-government and private sector roles (including as delegated, interaction, or lack thereof).

Likewise, seeking and acquiring formal endorsement and authorisation of such, and the processes involved is also relevant, whether as an internal or external practice and if formalised or not. The co-evolution of public developments and disruption relative to certain states of knowledge also carry

8 As a structural property of systemic networks, along with lateral and hierarchical forms relative to the source of decision making authority, including as part of organisations (Alter & Hage, 1993) (p. 77).
9 As part of research into the role of project managers and BIM implementation, Lindblad and Gustavsson (2018) describe the Swedish Transport Administration (STA) as lacking homogeneity and “a complex client with several sub-organisations and departments, making both intra-organizational and inter-organizational change challenging”.

The tensions between centralised agencies and public service delivery entities and achieving consistency within government are also acknowledged (Althaus et al., 2018) (pp. 147, 161), including the coordination within federated nations (such as the US), see (Alter & Hage, 1993) (pp. 88-89). Conversely, it is another view again to describe the public sector as comprising “production networks”, with speciated niches and multi-organizational relationships, and that drive adaptive efficiencies (Alter & Hage, 1993) (p. 76). Arguably, such examples further contrast with inferences linking public infrastructure project delays and the friction between key Government agencies (amongst other issues), see (State of Western Australia, 2018a) (p. 127, 130).

10 Such implications can directly undermine the challenges for “BIM policies especially when the policy development effort is not coordinated centrally” and despite “the risk of implementation gap in the BIM diffusion process; the risk of duplication of efforts and the generation of overlapping deliverables, and the risk of limited engagement by some stakeholders” (Kassem & Succar, 2017). Appreciably, the expectation of central coordination may point to a broader picture for institutional reform to overcome the practical inconsistencies in relation to BIM. Although it reflects a different scope for change to that which may be required for the adoption of BIM in isolation.

Likewise achieving “harmonisation” or “whole of government” approaches may be a matter of degrees and does not preclude seeking a basis or level in which achieves collective buy-in and acceptance (including in terms of time, adaptability) including via administrative coordination, see (Hartlapp, 2018). Whether these examples could (or should) be measured, including as a function of governments, may be attributable to determining the line between accountability and transparency but also surveillance.

In this sense, there is scope to acknowledge the role and limitations of policy, as attributing to the management of problems rather than solving “wicked, intractable problems” (Althaus et al., 2018) (p. 68). For example, a feasibility study/cost comparison between institutional changes to assure harmonisation/centralisation and compliance, and the identified risks from disparate applications of BIM may be instructive. It may further contrast with current circumstances that accommodate misalignment and differences. This includes those instances and example that involve translation and interpretative processes and services, and which have resulted in discrete markets and distinct knowledge domains or disciplines and functions.
inherent risk. Bounding the expanse and relevance of issues and considerations, including disassociating the “noise” or hype, only further implicate the decision-making process.

Public sector commitment to policy positions can also present a wider administrative scope. Activities may involve developing capability to engage and make decisions in and about the topic, compliance checking\(^{11}\) and “enforcement”. Scope (and gaps) to ensure the enforcer is enforcing are also relevant, including the type of entity available, funded and tasked with this objective. Regardless if these are determined as another measure of diffusion, the resolution or balancing between the associated costs and benefits may be telling or persuasive, particularly where public funding is concerned. It is another matter again to suppose there are or should be certain qualifications about the role and reach of “governments” as a base of power. But it also manifests in terms of expectations for the individual, including in terms of accountability and responsibility (see (Drahos & Krygier, 2017) (pp. 14-15)) and self-regulation. To this extent, research about “improved problem-solving by actor networks without policy intervention” has also been identified in terms of technological innovation systems (Frishammar, Söderholm, Hellsmark, & Mossberg, 2018).

**Policy – a mechanism for intervention and affecting change on and about BIM?** Industry-based promotion for wide spread adoption of BIM, particularly via public procurement and government involvement, is readily espoused in the public realm\(^{12}\). In identifying the implications of BIM adoption in construction for “governments” in Australia, Furneaux and Kivits (2008) note “…the matter of risk needs to be addressed at a policy level and at a contractual level – particularly in procurement, although there may be a need to address this at a regulatory level if the scope of adoption became quite extensive”. BIM adoption is a repeatedly identified topic in the research literature (Santos, Costa, & Grilo, 2017) and is the subject of specific research, including discerned as “BIM diffusion” (Kassem & Succar, 2017). Whilst intentions and expectations can diverge between industry and the public sector (Sanchez et al., 2014) (p. 12), the discourse surrounding BIM also does not appear to be limited to “BIM adoption” in isolation\(^{13}\).

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\(^{11}\) Compliance checking may also involve developing the basis or benchmarks to be achieved/avoided for this type of activity, along with further data collection and capture. By way of examples, refer to the discussion on BIM Assessment Methods by Azzouz, Hill, and Papadonikolaki (2018) and the BIM adoption impact map by Gurevich, Sacks, and Shrestha (2017).

\(^{12}\) For example, procurement is an identified issue in the context of BIM, including from Australia and Europe perspectives, see (buildingSMART Australasia, 2012; EU BIM Task Group, 2017).

\(^{13}\) For example, the need to look beyond BIM adoption has been raised in terms of evaluating BIM maturity (Azzouz et al., 2018).
The policy domain is also a targeted subject of research initiatives and programs that reference or relate to BIM (and other associated narratives), notwithstanding research responses that establish connections to “public procurement” in part. However, addressing how BIM, its adoption along with other associated directions, is promulgated via public procurement and this type of policy is less evident.

Further, Yang and Chou (2018) note the lack of research exploring the underlying rationale behind BIM implementation and intervention by “the government”. One view includes the intent to capture potential improvements, benefits and opportunities. It is another matter again to reconcile

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14 See for example the policy related topics of research proposed by Centre for Smart Infrastructure and Construction, IfM Education and Consulting Services, and University of Cambridge (2017) (pp. 13-14) that concern: rights and justice; privacy, trust, ethics; law and legal requirements; data-driven policy; smart governance and standards; and GIS in public decision frameworks.

15 The PhD research being undertaken by the lead author is one pending reference, albeit conceptually based, that is aiming to consider policy development to address BIM in the context of public procurement as an overarching, broad scaled concept (Kuiper & Duffield, 2018a). Other research literature includes examples referencing BIM as part of the need to reform construction public procurement, including in Ireland (McAuley, Hore, & West, 2012). Other examples include high level or general overviews of government policy and mandates in reference to BIM (see by Holzer (2015)) or that focus on discrete issues or elements of public procurement, whether for:

- use of BIM as part of public tendering processes (Bolpagni, 2013), as well as e-procurement (Costa & Grilo, 2015) in conjunction with other technological tools for construction procurement (see (Ibem & Laryea, 2014)) and non-BIM context comparisons (Y. Ren, Skibniewski, & Jiang, 2012);
- use of BIM by public sector agencies of different jurisdictions (buildingSMART Australasia, 2012) (pp. 31-36), (Sanchez et al., 2014) (p. 9), (EU BIM Task Group, 2017) (see case study references); and
- development of a partnering framework to support integrated project methods or approaches (Porwal & Hewage, 2013).

These examples further contrast to other references that concern BIM and project procurement related issues, including contracts, more generally, see (Kuiper & Holzer, 2013; Olatunji, 2014), as tools of procurement and commercial or economic efficacy. Although misconceptions about the role of contracts may also be evident. Further research is required to determine the exact relationship between contractual references to BIM and effective BIM adoption, or whether “BIM contracts” exist (in contrast to contract documentation that references or addresses BIM). Other potential considerations include: ascertaining whether procurers, who use contracts, see BIM as an inherent risk concern or requirement that warrants elevated attention for contractual inclusion and potential recourse or protection (or not); transaction cost factors; organisational knowledge and capability (i.e. awareness, capability); or strategic procurement factors.

16 The contrast between industry and research examples may be insightful. For example, the European Construction Sector Observatory (2019) provides a high-level summary of “the drivers, opportunities, and challenges around its implementation, and draws recommendations for EU policy makers and other relevant actors on how to support and foster the adoption of BIM by the construction industry”.

17 In terms of policy, Goodin, Rein, and Moran (2013) (p. 904) note of constraints of policy choice relative to “problems looking for solutions; solutions looking for problems; and people looking for things to do”.

18 For example the vision for a national standard by Australasia BIM Advisory Board (2018b) (p. 5) states: "Government organisations can provide leadership to encourage the untapped opportunity for savings and benefits of digital design and construction, and in turn, provide better public services and better value for public expenditure. The vision is to build a BIM process consistency framework, together with the private sector, that sets the national standard."
the application or support of and for BIM for the purposes of overcoming and resolving existing problems faced in the community. The extent to which public policy on BIM has demonstrable or justified grounds or scrutiny, including through a business case or other processes or evidence, may depend on the requirements of the respective jurisdictions and public departments\textsuperscript{19}. Determining the rational for applying public procurement as an innovation tool (Elder & Georghiou, 2007) is also applicable, whether as a response to encourage local demand, to address certain failures, be it market or system related\textsuperscript{20}, or improve government services. Few people question whether or why BIM based policy related intentions and objectives are not achieved (nor question the originating or related objective or ultimate aim\textsuperscript{21}). It is rarer again to determine those circumstances in which BIM policy would result in problematic outcomes\textsuperscript{22}, despite this risk for policy design and implementation being acknowledged more generally (Althaus et al., 2018) (p. 179).

\textsuperscript{19} Anecdotally, there is the suggestion that a government business case has been developed for the implementation of BIM in Scotland. However, the development of this sort of business case is not necessarily duplicated across the home nations of the UK.

\textsuperscript{20} Baptista, Pereira, Moreira, and De Matos (2019) (in reference to (Weber & Rohracher, 2012)) describe “structural system failures (e.g., infrastructural, institutional, interaction or network, and capabilities failures) and transformational system failures (directionality, demand articulation, policy coordination and reflexivity failures”.

\textsuperscript{21} There are several anecdotal examples in which the starting premise for BIM by Australian owner clients was to “give it a go”. Approaches by public sector agencies, however, may demand a certain rigour in analysis and business case robustness, and be subject to the respective procurement regimes and considerations, see for example (Wedutenko & Smith, 2019). It further applies to those instances that result in the call for institutional adaptation and improvement (State of Western Australia, 2018b) (pp. 9-10). Similarly, for infrastructure projects, infrastructure decision-making principle 5 states:

\begin{quote}
Governments should undertake detailed analysis of a potential project through a full business case and should not announce a preferred option or cost profile before undertaking detailed analysis involving multiple options. Business cases should include rigorous examination of the potential project’s benefits relative to its costs, show the project to be resilient to change under a range of future scenarios, and show the split between public and private benefits (Infrastructure Australia, 2018) (p. 2).
\end{quote}

It further differs to contemplating BIM in terms of the “management and maintenance of private 3D digital data being the responsibility of the private sector” and the likely “need for amendments to legislation and regulation and development of standards covering both the move to a 3D Digital Cadastre …and integration of 3D data more broadly” (ACIL Allen Consulting Group, 2018) (p. 15). This may be especially pertinent when government is “a major stakeholder in the development” of such a system, as a major user and “supplier of (and/or responsible authority for) may public data sets” (ACIL Allen Consulting Group, 2018) (p. 15), which in part are sourced from the private sector.

\textsuperscript{22} For example, Aksenova, Kiviniemi, Kocaturk, and Lejeune (2018) intimate that national approaches to BIM have not resulted in systemic changes in business practices and new business developments for the Finnish AEC industry, due to: (i) technology push rather than market pull; (ii) diminished market diversity through the mechanism of public funding; (iii) high levels of idea diffusion verses established competencies; (iv) lack of government-driven mandates encouraging industry for systemic changes; (v) mismatch between business model of software market versus BIM-driven innovation model; (vi) traditional division of labour versus the need for new contractual models; (vii) lack of business development and leadership competencies in education and practice.
Appreciably, the governmental motivation or position on BIM differs from acknowledging the role of government for BIM adoption (S. Liu et al., 2015; Wong, Wong, & Nadeem, 2011) and the government’s influence on BIM implementation, via key strategies and policies (Atkinson, Amoako-Attah, & B-Jahromi, 2014; Guerrero & Lindblad, 2018). What is not always clear is whether certain distinctions and limitations apply within the institution of “government”23, including that reconcile intervention by government as an economic rationale or otherwise direct or influence events (Drahos & Krygier, 2017) (p. 17).

Determining what is left to the market or otherwise requires action by a government24, is further distinct to and contrasts with “top-down”, “middle-out” and “bottom-up” diffusion dynamics (Kassem & Succar, 2017). Further research examples point to the self-perpetuating drives behind the “diffusion” of BIM, including as an “innovation”, whether attributed to internal and external factors, or rather a mix (Gholizadeh, Esmaeili, & Goodrum, 2018), or isomorphic pressures (Cao, Li, & Wang, 2014). Whether such examples amount to a form of tailoring, including by and as part of the inherent function of organisations, projects and industry adapting to changing circumstances (Papadonikolaki, 2017), and as subject to unique contextual factors, is also relevant. By implication, references to BIM based examples from different jurisdictions and organisations can assist but addressing local or localised needs may be necessary for application.

Framing BIM for policy, policy frames of BIM

Approaches to BIM adoption from policy25 perspectives are connoted as passive, active and/or assertive actions, including that vary across jurisdictions and which is dominated by passive policy approaches (Kassem & Succar, 2017). Akin to institutional considerations (Papadonikolaki, 2017), government led examples are identified, along with industry-driven approaches (with government

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23 The public institution of “the government” comprises a myriad of components and parts that can be distinguished in terms of authority, scope, services, capability and responsibility, and therefore may have certain degrees of relativity to “BIM”, including beyond just the adoption or implementation of BIM. Also see discussion by Sanchez et al. (2014) (pp. 15-16) highlighting the institutional distinctions and structural limitations of Australian and Swedish government entities. Further distinctions may be discerned from the authoritative basis of and disassociations within such institutions in, see (Kuiper & Duffield, 2018a). However, it is another matter again to develop rules that aim to mitigate implications (either at local, regional or national scales) arising from a misalignment, be it approaches, direction, standards or language based. As noted by Barns, Cosgrave, Acuto, and Mcneill (2017) “[t]he politics of the digital city are structure round a highly differentiated governance landscape”.

24 Whether such approaches are culturally deterministic may be further considerations. For example, Child, Faulkner, and Tallman (2005) (p. 5) discuss the impacts and influences on economic approaches, directions and implications arising from cultural and historical perspectives.

25 Deciphering what constitutes “policy” may also be relevant, see (Kuiper & Duffield, 2018c).
support) and as a mixture\(^26\) (Yang et al 2018). Supplier-led and client-led innovations are further strategies (Guerrero & Lindblad, 2018) that accord with these approaches.

Practice and approach types may be alternatively and further qualified, whether examples are determined:

- from strategic or aspirational perspectives (i.e. (Cabinet Office, 2011; Office of Projects Victoria, 2019)\(^27\)), including as a general encouragement of use (European Parliament and of the Council, 2014)\(^28\) (see (Charef, Emmitt, Alaka, & Foucha, 2019));
- via roadmaps or models, as denoted in standards (The British Standards Institution, 2013) (p. vii), (BIM Industry Working Group, 2011) (p. 16), (Sacks, Eastman, Lee, & Teicholz, 2018) (pp. 332-335);
- or acknowledged for incremental and piecemeal change (i.e. (Yang & Chou, 2018), (Sanchez et al., 2014) (p. 20), (State of Queensland, 2018) (p. 4));
- via centralised agency guidance and policy notes, including that are public procurement related, whether overtly or directly referenced\(^29\), or part of or for project programs or

\(^{26}\) Yang and Chou (2018) give the examples of the Singaporean Government as a government lead approach, which comprises “a series of policies...to lead the industry involved in BIM applications”; and in the United States as industry approach, where “the government has taken limited actions in promoting BIM applications, but the BIM-related activities in the industry are active and BIM implementation is high”.

Further research and empirical evidence may be required to examine the basis for these classifications, including whether these are discerned by materials that are available in the public realm and otherwise reflect particular governing and cultural dispositions of the presiding institutions.

\(^{27}\) As part the UK Government Construction Strategy, the “Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016. A staged plan will be published with mandated milestones showing measurable progress at the end of each year” (Cabinet Office, 2011) (p. 14).

\(^{28}\) Arguably, the EU directive is “BIM-like”, encouraging member states to consider its application rather than dictating requirements and terms. Article 22 Rules applicable to communication, paragraph 4. states: “For public works contracts and design contests, Member States may require the use of specific electronic tools, such as of building information electronic modelling tools or similar. In such cases the contracting authorities shall offer alternative means of access, as provided for in paragraph 5, until such time as those tools become generally available within the meaning of the second sentence of the first subparagraph of paragraph 1” (with emphasis).

\(^{29}\) Examples include by Ministry of Business Innovation and Employment a BIM Guide for “planning construction procurement” and in conjunction with supporting materials such as the BIM Handbook and guide series) and by the Scottish Government (2017). Also see the BIM adoption position paper (Government Contracts Committee for Construction, 2017) as part of the Department of Public Expenditure and Reform in Ireland.
portfolios (including pilot projects), and that encompass consideration into other built environment lifecycle phases, including asset management\(^{30}\);

- via collaborative efforts, in conjunction with or between public and private sectors, including at international or inter regional scale and in association with certain industry sectors (see (Australasia BIM Advisory Board, 2018b; CEDR Task Group S3 Information, 2017; EU BIM Task Group, 2017));

- by or for discrete organisations (i.e. see (Wong et al., 2011)) and across the public sector agencies (Gurevich et al., 2017), including that focus on planning, operations and procurement (generally pertaining to built environments) (Queensland Government, 2017) (pp. 24-26), or that have arisen out of public procurement processes, either as contractor performance concerns (State of Western Australia, 2018a) (p.157) or formal disputes, see (BAM PPP PGGM Infrastructure Cooperatie U.a. v National Treasury Management Agency & anor 2016);

- relative to public client project managers, particularly translating organisational directives for BIM based procurement applications, such as setting demands and requirements (Lindblad & Gustavsson, 2018), or the acknowledged lack of project activity skilled resources within public agencies (Aksenova et al., 2018) or direct BIM related experience (PricewaterhouseCoopers, 2014) (p. 32); or

- part of a combination of the above circumstances and approaches (Sacks et al., 2018) (p. 325) that make direct cross reference to each other\(^{31}\) or that make up “a range of policy instruments” to address concerns about BIM (Furneaux & Kivits, 2008) (p. 29), arguably either directly and indirectly.

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\(^{30}\) The State of Queensland (2018) (p. 1) set the scope for BIM Principles to “apply to those who are involved in any part of the lifecycle of new major construction assets, including the planning, procurement, design, contract management, construction, operation or maintenance of the assets”. Although the relevance and value of BIM for property propositions and corporate real estate management has been raised more generally (Wilkinson & Jupp, 2016). More broadly, ACIL Allen Consulting Group (2018) (p. 14) further suppose that data of 3D modelled systems “will be accessed by property developers, owners and investors, financiers, insurers, asset and facility managers, lessees and real estate agents, as well as major architectural, engineering and consulting firms, and building contractors across jurisdictions”.

\(^{31}\) For example, the UK Government Construction Strategy is referenced by Joint Select Committee on Government Procurement (2017) (pp. 94, 100) as a complementary policy/initiative for specific areas of procurement (i.e. large building and construction procurement).
The administrative and social frameworks behind the structures and public entities possibly further exemplify the effect or role of singular policies within or part of regulatory networks or governance (Drahos & Krygier, 2017) (p. 15). The net result includes structures that constitute or frame a set of collective, multi-sourced or over-arching directions\(^{32}\) and “rules”. Whilst seeking broad cooperation from many effective independent actors to accomplish their goals, the element of command is perceived as lacking or abandoned, resulting in effective steering scope of statecraft instead (Goodin et al., 2013) (pp. 894-896).

Arguably, such networks are reflective of formalised parts (rather than the whole) and may not necessarily be attuned to the network to be consistent, complimentary or non-repetitive\(^{33}\). Further research is likely to determine the extent to which the listed basis and mechanisms above accord, align or are implicated with intended approaches (or not). Examples may include deciphering relationships or relativity, whether:

- generally, as part of government strategy frameworks or resource management frameworks (see Figure 1, (i) & (ii) below), or hierarchies;
- specific jurisdiction based policy hierarchies\(^{34}\) or part of policy landscapes, including relative to digital government, see (digital.NSW, 2018); or
- that are project and/or organisational related\(^{35}\), including supporting documentation (Figure 1, (iii) below).

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\(^{32}\) See for example the discussion by Staples and Dalrymple (2016) on the alignment (or lack thereof) of government strategies in the construction industry and public procurement. By way of extension of these examples, the legal hierarchy by Transport for NSW (2018) (p. 6) further highlights the linkages from organisational asset policy and its digital engineering framework, through to the inter-organisational engagement via the tender and contract documentation.

\(^{33}\) See for example the findings and recommendations concerning the public sector procurement framework in Western Australia (State of Western Australia, 2018b) (pp. 112-113, Appendix H).

\(^{34}\) For example, Vaux (2019) (slide 42) provides an overview of current NSW initiatives that address future transport (NSW Government, 2018c), public infrastructure (Infrastructure NSW, 2018) and more broadly (NSW Government, 2017) in the context of digital engineering.

\(^{35}\) For other examples, refer:
- relative policy levels, be it state BIM policy, agency or program level policy or specific project/asset policy (Australasia BIM Advisory Board, 2018b) (p. 14);
- to discussion on the hierarchy of public governance frameworks, as it pertains to project control and support (Volden & Andersen, 2018); and
- the recommended BIM governance model, along with an integrated approaches to asset and supply chain management and lean construction, for consideration by public sector agencies in Western Australia (PricewaterhouseCoopers, 2014) (pp. 7, 45).
Figure 1 Framework examples, extracts of (i) government strategy framework by Stables and Dalrymple (2016), (ii) the resource management framework set out in the Commonwealth Procurement Rules (Department of Finance, 2017) (p. 8) and (iii) the Digital Engineering suite of supporting document (Transport for NSW, 2018) (p. 6)

Whether approaches could be qualified in terms of the degree of state regulation (Papadonikolaki, 2017) or being determinative of other systemic framework distinctions (such as culture, civil/common law) may also be pertinent.

However, merely having a policy or a position, or being aware of BIM, is a very different proposition about whether “BIM” is actually adopted and implemented (Yang & Chou, 2018), including how this is demonstrated (Dainty et al., 2017). Affecting organisational imperatives, for a “client to act as an innovation champion on BIM”, can be problematic to achieve, particularly if conflicts arise between policies, guidance and work practices (Guerrero & Lindblad, 2018). Like some perspectives about “BIM mandates” reiterate, whilst the intent can be “right”, the implementation may not be “perfect” (National Building Specification, 2018) (pp. 17-18). The approach may set “the industry on the right path with BIM”, but for some maintaining momentum is considered a further measure of “success” (National Building Specification, 2019) (p. 23). Such outcomes are also despite policy implementation being an acknowledged challenge generally (Althaus et al., 2018) (p. 185) and as a field in research (Baldwin et al., 2019).
A word on mandates

Conversely, the examples identified above raise the prospect of qualified interpretations of a “mandate”, as a form or type of policy or policy instrument. Whilst analysing the use of mandates is evident in other contexts, the profiling of “BIM mandates” is relatively limited. “BIM mandates” are acknowledged in the research literature but few examples profile the characteristic distinctions about these types of rules or mechanisms. Differences, for example, that concern government mandates, mandates that are enforceable by law, incentivized, or that otherwise are illustrative of expected or self-perpetuated practice, standards or norms. The latter of which may also be founded in political, reputational or commercial or competition grounds and further apply to circumstances in which the mandate is not followed.

In the case of some policies on BIM, the effect of “mandate” can have other possible interpretative connotations. One example is where such policy is viewed as an imposition on industry (Dainty et al., 2017).

36 For example, refer to the review by Circo (2008) considering mandates for promoting green building developments in the US. The author profiles and considers whether government intervention is appropriate, the use of mandates or incentives (or both), and the effective level of government for application (from international to local perspectives).

37 Yang and Chou (2018) briefly discusses literature based considerations of a “BIM mandate”, including in reference to (Cheng & Lu, 2015). As noted above, Dainty et al. (2017) also calls for further critical research into the matter.

38 Althaus et al. (2018) (p. 185) note the use of mandates by governments “to support the delivery of certain policies on the grounds of represented authority” and, in reference to (Constitution Commission, 2002), the inferences from the concept of the mandate for Australian contexts that:

- Government has the right and duty to organise and operate the machinery of government effectively, accountably, and subject to the supervision of Parliament;
- A Government has the right and the duty to govern, although not to do whatever it likes;
- A Government has the right and duty to implement its specifically outlined initiatives and the broad directions of its election policy, subject to Parliamentary supervision of detail;
- Electors are entitled to expect that a Government will honour and implement its promises.

39 Examples include via statutory compliance or contractual regimes. For the latter, examples of research literature based profile of contractual risk and standard form contract documentation referencing or addressing BIM based projects, see (Arshad, Thalheem, Nasir, & Malik, 2019). Perspectives from legal professionals and academics are likely to offer further insights (by way of examples see (Circo, 2014; "CMS Guide to Building Information Modelling (BIM)," 2017; Jensen, 2018)). The practice of contract administration and management is also relevant and necessary factor, including in the public sector, see (State of Western Australia, 2018b) (p. 107).

Other forms are noted by Sacks et al. (2018) (pp. 324-325), who highlight the role of “construction owners” mandating BIM, via memorandums or public notices.

40 Understanding the authoritative basis of a “mandate”, including its intent and effect, and the consequences of non-compliance (if any) are relevant (see (R. Davies & Harty, 2012)), including whether some circumstances result in an unenforceable mandate. There can be significant differences in the types of activities that “must” or “shall” be undertaken or carried out, as compared to those that “may” be required or are encouraged or recommended. Alternative approaches may be considered, as industry representatives have further questioned the effectiveness of a BIM mandate, noting some preferences for “more carrots than sticks” (Aksenova et al., 2018). Further, approaches may be distinguished from different groups. Yang and Chou
2017), arising in circumstances where requirements are tantamount to prescribing literally how work is to be undertaken. Whether public endorsement or positions like this amount to inadvertent risks and liability, particularly if the bounds of capability and authority are crossed or professional advice is not sought or ignored, is likely to depend on the factual context. Conversely, determining whether the lack of capacity of another parties to engage in a certain way or actively inhibits development or progress presents another perspective.

Relevantly, it brings to light certain responsibilities to ensure the intent, definitions and any requirements are clearly qualified and stipulated. Pre-empting the interpretation, adoption and acceptance by people are further considerations, including the relative cognitive functions. This includes for industry “knowing what to do to comply” with a BIM mandate (National Building Specification, 2019) (p. 24). The need to demonstrate the effective use of BIM before mandating has also been raised (Sanchez et al., 2014) (p. 17).

Alter and Hage (1993) (p. 78) note the relevance of common cognitive structures as necessary antecedent of interorganisational network development, “the degree to which it is articulated or to which an explicit consensus exist can vary widely”.

(2018) observe that whilst the Taiwanese public construction agency did not have a clear BIM mandate, there are other agencies that support the promotion of BIM.

There is a distinct lack of research discussion about the practical and social implications of legal mandates about BIM, including if this is collectively and politically driven, requires hard wiring into law, alternative options, or is subject to economic analysis or technological adaptation or changing perspectives. The extent to which the institution of government is (or should be/not be) charged with setting or formalising certain data structures or engineering information is another avenue for consideration (Kuiper & Duffield, 2018a).

Capano and Lippi (2017) note the increased conditional and situational factors that can lead policy decision makers to adopt certain instruments, regardless of whether it be capable of resolving the problem in question. In the current backdrop of potential transparency, including via social media, strategies relying upon self-perpetuation or strategic misrepresentation can be at risk of attracting negative exposure. Whether these further amount to contributory factors undermining the tenants of trust, belief, faith or credibility, particularly of public institutions (be it governmental, financial or religious affiliations), may be subject to further research.

A further element of non-adherence may relate to equivalent examples, including in respect of government and public procurement procedures and requirements, cabinet protocols and expected standards, see (State of Western Australia, 2018b) (p. 14).

For example, that may accord with recommended approaches, including that are evidence-based (The British Standards Institution, 2015) (paragraphs 4.2, 4.6.1).

For example, implications have been raised for potential future circumstances where BIM becomes “a core design, construction and FM process tool then not using it may be regarded as professionally negligent” (PricewaterhouseCoopers, 2014) (p. 44). Arguably, however, such matters are subject to legal determination and factual context, including that concern professional duties (to act with reasonable care and skill) and insurance. A further example includes software vendor liability disclaimers, see (Alwash, Love, & Olatunji, 2017). It is another matter again to demonstrate that a party has engaged in misleading and deceptive conduct by inflating their BIM capabilities, related claims (i.e. BIM reduces human errors, see (Love, Edwards, & Han, 2011)) or promoting software as the only answer when leading up to a commercial arrangement. Holding a public entity to account for decisions made is also feasible albeit subject to public administration law regimes.
Predicated on the mixed interpretations of BIM (Kuiper & Duffield, 2018b, 2018c) and without certain qualification, a BIM mandate can also be viewed as offending or infringing existing public procurement policy approaches. Responses by the Australian Government intimate as much when stating:

“The Australian Government supports the use of modelling technology, as it is likely to drive down costs and provide detailed information for whole-of-life infrastructure. The Government notes some Commonwealth and state agencies are already using BIM for a variety of projects including social infrastructure, defence and land transport; and sees the move to a technology-based design system being required in the medium future. The Government does not, however, endorse any specific technology in procurement activities and considers that individual government agencies are best-placed to consider the benefits of using of such technology”. (with emphasis) (Commonwealth of Australia, 2014) (p. 15),

and

“...the Government does not endorse any specific technology and the promotion of these products is best undertaken by the market, which is best placed to demonstrate their value. Agencies that deliver infrastructure projects are best placed to assess the extent to which these technologies can provide value for money for particular projects” (Australian Government, 2017) (pp. 10-11). Also see (Commonwealth of Australia, 2016) (p. 64).

The above quotes also emphasise the relevance of technology as an organisational based function and responsibility rather than premeditated expectation for Big Procurement (i.e. overarching public procurement frameworks around expenditure of public funds, public tendering processes, see (Kuiper & Duffield, 2018a)). It further sits aside from other examples referencing BIM in this context, whether:

- generally. Examples include considering BIM as part of; an industry-based objective, “along with related digital technologies and processes”, for the wide spread industry adoption of BIM (buildingSMART Australasia, 2012) (p. 4); a construction sector based objective (State of Victoria, 2016) (p.9); or the need “to establish BIM as a procurement standard” (House of Representatives Standing Committee on Infrastructure Transport and Cities, 2016)(p. xiv)); or
- more specifically, including as it concerns infrastructure: as an example technology to improve infrastructure delivery and lower costs, recommended for mandatory application for the “design of large-scale complex infrastructure projects” (Infrastructure Australia, 2016) (p.

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46 The vision for Victoria, includes emphasised focus on digital technologies for construction with the preemptive expectation for industry growth is that “the largest scale impact is likely to be realised through effective implementation of BIM with the support of digital technology” (State of Victoria, 2016) (p. 9).
169) or part of developing national approach concerning the use of BIM in the delivery of major projects (Transport and Infrastructure Council) (p. 7).

Further, the intent or objective for a mandate content may also require consideration. For example, there may be scope to emphasise coordination, as a method or process rather than an outcome, and that occurs at all hierarchical levels via a wide range of methods, including for relative administrative coordination and operations integration (Alter & Hage, 1993) (pp. 90-91).

Tensions (systems friction)
Another perspective for policy development concerns the extent to which policy and other approaches are premised upon addressing problems and issues faced in the community. One stance is to pre-empt the potential for such problems or remedy issues retrospectively as problems arise. Appreciably, the BIM adoption drive may fall into the former category, with the future benefit of widespread use of BIM based on collective know-how and interaction. Arguably, the latter may yet emerge. For policy considerations or government intervention, it may also warrant determining the relevant impact and implications of problems experienced, including the relative scale, type of manifestation (i.e. economic), effected parties or sectors etc. But it may also play out in terms of social norms, the law, or moral and ethical standing. However, nor do these factors negate considering how BIM related matters are and can be addressed under existing frameworks and “rules”.

One simplified example includes recognising the knowledge gaps, such as the lack of universal definition of BIM (State of Victoria, 2016) (p. 18) and notwithstanding the range of example definitions and approaches deciphering what BIM is, see (Kuiper & Duffield, 2018b)47. However, other examples point to issues that have arisen from commercial dealings, be it about consumer or trade practices related matters including:

- the impacts of perceived oversold promises about BIM (as a software system) for organisations (Merschbrock & Nordahl-Rolfsen, 2015);
- the “feeling that software companies are selling BIM to unfamiliar owners as the answer to all project problems”, along with the claim of oversold services by consultants and designers that “often don’t provide the solution promised”, and criticisms and limitations of non-adopters (PricewaterhouseCoopers, 2014) (pp. 6, 29); or
- the risk of software vendor liability disclaimers (Alwash et al., 2017).

47 A further recent example is by European Construction Sector Observatory (2019) (pp. 5-6) arguably blending a range of conceptualisations by reference to “2D BIM (drawing)” along with “3D BIM (includes information sharing and the creation of graphical and non-graphical information), 4D BIM (includes time management); 5D BIM (includes cost analysis), 6D BIM (includes sustainability assessment) and finally 7D BIM (management phase of what has been achieved)”.
Inferences of inequality, whether split along the “digital divide” or that arise from “technocratic optimism” (Dainty et al., 2017), and misinformation about BIM reducing human errors in design (Love et al., 2011), from research are also relevant. Appreciably, such examples also differ from steps taken in direct response to the tensions experienced by industry members, including public sector agencies. Courses of action in respect of doubts about industry BIM capabilities (including the lack thereof), include seeking determinations about capabilities in particular jurisdictions (see (Brewer, Gajendram, & Le Goff, 2012)) or flagging issues and concerns that arose during the course of project delivery, as part of audit or review processes, see (State of Western Australia, 2018b) (p. 157).

Recourse to the law is another source of identified tensions in practice, particularly from reported cases. This includes those disputes that have arisen from or refer to BIM practices and where public agencies are involved (as the procuring entity), including that concern:

- public procurement probity related issues arising from the request, use, uploading and tender submission of BIM models/files (BAM PPP PGGM Infrastructure Coöperatie U.a. v National Treasury Management Agency & anor 2016). By contrast, also see the Dutch case between private parties concerning reliance on BIM models during the tender process (Court of The Hague, 27-09-2017 / C / 09/503755 / HA ZA 16-80, 2017) [4.31-4.34]; and
- refusal motions (as part of a larger litigation concerning a C$3B rail stations and tunnel project in Toronto) in which the defendant party was denied access to “the BIM” (which is described as “a computer visualization tool”) due to its refusal to pay access fees requested by the plaintiff, and the subsequent access arrangement made to access BIM “on terms to be agreed upon between counsel without prejudice” to the defendant’s rights “to move on the outstanding refusals in the future, if necessary” (Walsh Construction Company Canada v. Toronto Transit Commission, 2019) [92].

By way of further contrast, “BIM implementation records” have been qualified for exemption under the freedom of information and protection of privacy legislation as determined by the Ontario Information and Privacy Commissioner, noting that “disclosure would allow competitors familiar with the software to accurately determine the third party’s underlying information” and that “disclosure could reasonably be expected to prejudice significantly the competitive position of the affected party” (Ryerson University (Re), 2014) [55]-[56].

Appreciably, these cases reflect a very small minority of examples, particularly in contrast to the breadth of dispute and unreported legal cases, including that are subject to other dispute resolution options or processes. Given the jurisdiction boundaries, the merit, weight or relevance of such cases, are further factors for consideration. Relevantly, the legal issues that concern or that relate to BIM are
not limited to contracts and contractual law (Alwash et al., 2017) but can be subject to legislative frameworks or regimes (or potential future ones, see (Kuiper & Duffield, 2015)) and relative to industry practice.

Further research, however, is required to determine whether disputes or points of friction could be categorised relative to the respective informational transactions and rule reference. Of note, is whether the distinguishing differences arise in terms of the respective types of systems described within or as BIM, whether as a technological tool or software program, modelling related or as data (Kuiper & Duffield, 2018d). By extension, linking these characteristics, as well as relative to the other associated systems or dynamics, in respective of other identified legal issues may also be telling. Whether these are the basis for pre-empting misalignment or the emergence of likely disputes, including in reference to existing legal frameworks, is a whole new and untested paradigm. Although it is one that, if realised, arguably tips into the dark side of BIM, bringing into question the elements of control and surveillance (R. Davies & Harty, 2012).

**Perspectives on BIM in Australia**

Research into Australian perspectives on BIM and public procurement policy is relatively rare, despite examples profiling relevant issues in part, see (Sanchez et al., 2014) (p. 15). It is rarer again to distinguish examples that question the presumption of BIM, particularly from a public governance perspective. The circumstance is despite prolonged efforts by industry advocates repeating calls for government and collective action (buildingSMART Australasia, 2012) (p. 2) and more recent developments that exemplify BIM policy in the Australian AEC industry. For the latter, examples include the raft of public materials and actions emanating from government related entities and representatives.
The application of BIM in Australia, some examples

Despite the claimed potential of “BIM” for the Australian industry (Allen Consulting Group, 2010), there are limited academic examples that comprehensively profile the BIM landscape directly. The research literature does offer insights of BIM uptake and use in Australia for some cases albeit that comprise certain qualifications or limitations:

- by construction small to medium enterprises (SMEs), particularly given the “lack of solid evidence of concomitant financial benefits” and lack of resources and knowledge on BIM (Hosseini et al., 2016), and lack of awareness and biased negative perspectives (in South Australia) (Rodgers, Hosseini, Chileshe, & Rameezdeen, 2015);
- for road infrastructure projects (H. Y. Chong, Lopez, Wang, Wang, & Zhao, 2016) and road agency programs (Hampson & Shemery, 2018);
- for civil engineering applications of a bus station redevelopment in Western Australia (A. Whyte & Donaldson, 2015);
- for public building applications, including:
  - in Queensland as part of incremental organisational adoption processes of digital modelling technologies and processes and as part of integrated project delivery (IPD) considerations (Kraatz, Sanchez, & Hampson, 2014);
  - hospital projects in Western Australia (PricewaterhouseCoopers, 2014) (including in recognition of positive and negative experiences by project participants (PricewaterhouseCoopers, 2014) (pp. 7, 40)) and South Australia (Mignone, Hosseini, Chileshe, & Arashpour, 2016); and
  - in New South Wales (NSW) for the Sydney Opera House as part of its facilities management program (Ballesty, 2006);

By way of State based examples, see by or reference to:

- Alabdulqader, Panuwatwanich, and Doh (2013) profiling BIM use across 25 AEC companies in the State of Queensland;
- Newton and Chileshe (2012) detailing South Australian industry perspectives of and about BIM; and

BIM use in respect of SMEs is also profiled in the research, in the UK (Ayinla & Adamu, 2018; Dainty et al., 2017; Loveday, Kouider, & Scott, 2016; National Building Specification, 2018) and Sweden (Bosch-Sijtsema, Isaksson, Lennartsson, & Linderoth, 2017). Identified limitations concern the range and types of BIM applications or functions and lack of normative pressure and client demand (Bosch-Sijtsema et al., 2017) and the “digital divide” (Ayinla & Adamu, 2018; Dainty et al., 2017). The impact on SMEs was also identified as part of a roundtable discussion in Ireland (McAuley et al., 2012).

Costin, Adilfar, Hu, and Chen (2018) highlight the increasing interest and attention of BIM for transport infrastructure related applications in the research literature, with focus on roads, highways and bridges.
with respect to related disciplines, such as quantity surveying (Aibinu & Venkatesh, 2014) and architecture in Queensland (Association of Consulting Architects Qld/NT & Australian Institute of Architects Qld BIM Taskforce, 2018), including in contrast between disciplines (Gu & London, 2010); or
• to address certain issues, including information asymmetry in project dealings from Australian perspectives (Forsythe, Sankaran, & Biesenthal, 2015).

K. Davies, McMeel, and Wilkinson (2017) go further to identify hybrid practices of BIM in Australia and New Zealand, albeit in recognition of the challenges in qualifying what constitutes a “BIM project”51. Likewise, the same challenge applies when considering AEC industry examples, which are not necessarily, nor independently, benchmarked or qualified in terms of BIM.

Appreciably, the application or reference to BIM in Australia is not limited to the research literature and further research is required to distinguish this scope. In view of industry examples, the breadth of public/government research could extend between national and local council perspectives (see Annexure A). More generally, others observe that the “BIM implementation strategy of Australia is mainly influenced and driven by the pioneering UK efforts” (Borrmann, König, Koch, & Beetz, 2018) (p. 20). As such it is a recognised approach, for off-the-shelf ideas and borrowing from other jurisdictions (Goodin et al., 2013) (p. 904).

Public stakeholders and BIM
Taking a broad interpretation of “policy”, there are several Australian examples in the public domain that reference or concern BIM, either directly or as subsumed or incorporated into other related initiatives. Despite aspirations for harmonised approaches to BIM or BIM consistency (Australasia BIM Advisory Board, 2018b) (p. 4) in Australia and the identified role of government, the public narrative on BIM is diversified.

Directions and approaches in Australia are illustrated by an array of documentation, forums or organisations52 (refer to examples set out in Annexure A). To this extent, how policy has led, responded or is responding to BIM appears to be mixed, whether that accord with “BIM4Government”

51 Of note is whether approaches, like BIM Assessment Methods (see (Azzouz et al., 2018)), would apply for Australian cases.
52 Repeated public sector involvement examples stem primarily from the national and eastern states of NSW, Queensland and Victoria, although discrete industry examples are also evident (i.e. from Western Australia on behalf of public sector entities (PricewaterhouseCoopers, 2014); from South Australia (for building applications, see (Government of South Australia & Department of Planning Transport and Infrastructure, 2017)); and in Tasmania, for sector educators (Brewer, Gajendran, & Le Goff, 2012)). Notably, there are also several key individuals that have contributed to multiple reports and developments, and present regularly (both in private and public capacities).
propositions or in alignment with like or associated developments. Similarly, references used and
directions taken are arguably contextual, whether discerned in terms of location, jurisdiction,
organisations and influenced by certain interactions and collaborative efforts.

In terms of policy, further research is required to determine if the example directions point to more
collective perspectives. This includes whether such perspectives amount to or illustrative of:

- building consensus or legitimacy (Centre for Public Impact, 2016) (pp. 18-21);
- demonstrating action or part of the journey of self-discovery (Goodin et al., 2013) (p. 902); or
- on-going attempts and collaboration to “figure it out” or “figure out it”, see (Capano & Lippi, 2017).

Interpreting BIM – Australian public sector examples
One distinguishing feature exemplifying the changing approaches to BIM in Australia, is how
governments and public sector agencies have elected to interpret and address BIM. Australian
examples appear to pitch to the on-going narrative shift or adaptation that considers the context
associated with BIM rather than strictly focusing on BIM in isolation. By implication, the intended
reference of BIM is blurred, particularly where BIM is subsumed, as part of other data and digital
developments, rather than as the entire or subject intent. Arguably, further research is required to
determine the extent to which these developments are similar to, align or differ from international
examples, including whether between Australian definitions of “digital engineering” and:

- UK interpretations of “BIM”, as a broadly defined concept encompassing process, technology
  and collaboration elements; and
- “digitalisation” based developments intended for the European construction sector
  (European Construction Sector Observatory, 2019) (p. 3).

In some cases, public policy interpretations of BIM in Australia reflect existing approaches that denote
BIM as “digital representation of physical and function characteristics of a building or piece of physical
infrastructure” (State of Queensland, 2017) (p. 3). However, one major distinction includes the
reference to “digital engineering”, of which BIM is a part but further comprises non-BIM elements for
the planning to operations of projects and assets (Transport for NSW, 2018) (p. 4)\(^{53}\). Stemming from
the promotion and development by Transport for NSW, “digital engineering” is defined as “a
collaborative way of working using digital processes, to enable more productive methods of planning,

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\(^{53}\) In contrast, other examples note life cycle linkages in part including, between BIM and virtual design and
construction (VDC) (Sanchez et al., 2014) (p. 17).
“designing, constructing, operating and maintaining...assets” (Transport for NSW, 2018) (p. 4). “Digital engineering” has also been referenced in Federal and other State policy orientated documents in Australia (see (National Digital Engineering Working Group, 2016; Office of Projects Victoria, 2019)) and as part of ongoing cross promotional events and collaboration (see Figure 2).

Whilst “digital engineering” is applied generally in the research literature (see (Golizadeh, Hon, Drogemuller, & Hosseini, 2018)), research examples premised upon these initiatives are also evident, particularly where industry is involved, see (Hampson & Shemery, 2018) (p. iii). Despite the lack of direct research that targets policy development in these terms, industry examples point to the

54 Arguably, this definition of digital engineering accords with expansive interpretations of “BIM” (Kuiper & Duffield, 2018b), despite some references intimating digital engineering and BIM are one in the same, see (Infrastructure NSW, 2018) (p. 218).

55 More recently, public sector examples from Victoria see the broadening or convergence of policy developments from various agencies that tap into digital technologies in the construction sector (see (State of Victoria, 2016)) and digital asset and engineering, see (Office of Projects Victoria, 2019). Whilst reference to public procurement is evident from both sources of strategy, a comparison including how these strategies collectively contribute or integrate may be subject to further research.

56 Determining the distinction between industry and research developments may be subject to further research, including whether differences are reflective or attributable to research publishing processes or industry led conceptualisations.
potential alignment of policy frameworks, analogous challenges and the types of policy risks that may be involved.\footnote{Vaux (2017) (slide 20) observes the emerging risk for digital engineering concerns developments that: occur independently; grow in an ad-hoc and uncontrolled way; lack direction from both the public or private sectors; and are similar to those experienced with geographical information systems (GIS). For the latter, see (Open Geospatial Consortium, 2015). Also refer to footnote 34 above.}

**Potential policy directions for BIM (and other aligned narratives)**

Appreciably, the relevance of BIM in Australia is not limited to the construction sector, nor built environment assets and lifecycles, with BIM applications raised in other domains, sectors and public functions.\footnote{Relative to spatial data (Smart, 2017) (pp. 21-22, 28-29), BIM examples include infrastructure and asset management as well as land and property administration. However, as data there are arguably potential extension to BIM applications in terms of utilities, smart cities, local government, emergency services, insurance, planning and logistics considerations. For the built environment, disciplines "such as the visual arts, architecture, engineering, urban planning, real estate, history, interior design, industrial design, geography, environmental studies, law and sociology" are relevant, and may draw from a collection of systems to affect “built environment information modelling” (BelIM) (Tah, Oti, & Abanda, 2017). Also see research examples profiling the application of BIM and land administration research, particularly for the State of Victoria (Atazadeh, Kalantari, Rajabifard, & Ho, 2017).} The extent to which BIM, particularly as BIM data, is part of a broader narrative or “wider public” interest (see (Hartlapp, 2018)) that concerns data more generally is less formulated and remains inconclusive from policy perspectives. Further research may involve categorising the types of instrumentality (as specialized/generic\footnote{Further comparisons and contrast may lie between evolutionary economic perspectives of generic and operational policy, and orders of generic policy (Dopfer & Potts, 2008) (pp. 94-95).}) and legitimacy (internal/external) (Capano & Lippi, 2017). For the former, this may include distinguishing policy and approaches addressing or referencing BIM specifically or under other narratives (be it data, big data, smart infrastructure or smart cities).

In reconciling data and digital orientated approaches that encompass BIM considerations and public policy, the following sections identify two potential issues for consideration. The first looks at the data propositions of BIM and how this relates to policy and public procurement broadly defined (Kuiper & Duffield, 2018a). The second identifies other potential research domains that link policy and public procurement, and that may be relevant to the discussion on BIM, both in terms of innovation and data.
Digital/data policy, public procurement and BIM

BIM data and beyond

A number of Australian industry examples proffer a more expansive, social or community-based context and scope inferences about built environment related data relative to BIM, whether:

- as part of or relative to spatial and 3D contexts (ACIL Allen Consulting Group, 2017; Plume, Simpson, Owen, & Hobson, 2015; Smart, 2017);
- in consideration of 3D digital cadastre implementation and integration to accord with digital built environment developments (with options for BIM and digital engineering) and that accord with national to local government policy issues (ACIL Allen Consulting Group, 2018) (pp. 1, 3, 14);
- raised in context of cities development governance, including for technology (including BIM) supported urban regeneration (House of Representatives Standing Committee on Infrastructure, 2018) (pp. 283-285); or
- considered generally part of strategic government directions and imperatives more generally, be it for example:
  - digital assets (including as including reference to digital engineering and BIM, see (Office of Projects Victoria, 2019)) or “smarter infrastructure” (Advance Queensland & Queensland Government, 2018); and
  - following recommendations concerning state based foundational spatial data frameworks upgrade and development, including business case preparation (from map to model basis) (Infrastructure NSW, 2018) (pp. 79-80).

What is not always evident is the extent to which BIM, arguably as models derived from BIM or BIM data, is intended to constitute or form other classifications or contributions. This includes whether:

- as “infrastructure related data” (House of Representatives Standing Committee on Infrastructure Transport and Cities, 2016) (p. xiii);
- fulfilling or contributing to “a need for more detailed information on infrastructure performance” (Infrastructure Australia, 2015) (p. 7)\(^6\); or
- identifying best practice in infrastructure sector (Infrastructure Australia, 2016) (p. 162); or

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\(^6\) Also refer to (Infrastructure and Projects Authority, 2017) (p. 9) which describes a UK approach to transforming infrastructure performance by focusing on benchmarking for better performance, alignment and integration, procurement for growth and smarter infrastructure.
• making “better use of existing infrastructure through technology and data” (Infrastructure Australia, 2018) (p. 1).

Notably, research examples offering expansive perspectives of data and systems in reference to BIM, can be:

• conceptual, concerning the role of data for knowledge of or about built environment (Starkey & Garvin, 2013), or frameworks for broad scaled built environment data management (Haines, 2014);

• practically orientated, albeit for discrete, conceptual applications, including linking geospatial information science and BIM domains for modelling cities and landscapes in 3D (with CityGML) (Ohori, Biljecki, Kumary, Ledoux, & Stoter, 2018); for utility resources demand analysis of digital city models (Gilbert, Barr, James, Morley, & Ji, 2018), applying GIS-BIM for land administration purposes (Atazadeh, Kalantari, Rajabifard, Ho, & Ngo, 2017; Atazadeh, Rajabifard, & Kalantari, 2017)61; and

• otherwise branded under or linked to other conceptualised terms, such as:
  o “big data”, including as part of projects (J. Whyte, Stasis, & Lindkvist, 2016); maintaining highways (Aziz, Riaz, & Arslan, 2017); integrated projects systems (Boton, Halin, Kubicki, & Forgues, 2015); construction management research (Sørensen, Olsson, & Landmark, 2016); as part of data analytics (Correa, 2015); for the development of regulations (Hjelseth, 2016); or energy management (Khan & Hornbæk, 2011) for example;
  o “Industry 4.0” references (De Lange et al., 2017; Papadonikolaki, Leon, & Mahamadu, 2018), or “digital revolution” (Charef et al., 2019);
  o blockchain, including for construction management (Turk & Klinč, 2017); and
  o cyber-physical systems (CPS) (Correa, 2018), linking sensors within physical context and tied to systems architecture for real time analysis and decision making62.

61 By association, BIM may form part of the technological and data implications that arise as part of potential broader reforms for land administration developments (Wallace et al., 2010) and notwithstanding the types of legal frameworks required to enable data use for such developments (Kuiper & Duffield, 2015). Whether BIM could be applied for the purposes of registering intellectual property (as certain types of representable forms) and administering such systems, however, is a different matter.

62 Examples such as these appear to accord with manufacturing related “cyber-physical systems” that “are intended to establish an interconnection between the physical world and the cyber-space” (Müller, Maier, Veile, & Voigt, 2017) (in reference to (He & Xu, 2015; Lee, Bagheri, & Kao, 2015; L. Ren et al., 2015)). Although the reference by Müller et al. (2017) of cyber-physical systems offering “mechanisms for human-to-human, human-to-object and object-to-object interactions along the entire value-added chain” in reference to (Wan, Yan, Suo, & Li, 2011), also reflects interaction descriptors for informational transactions (Kuiper & Duffield, 2018d).
BIM data policy development linkages?

The merging or convergence of BIM and data possibly also accords with other policy linked terms, conceptualisations and approaches, particularly those from the UK, including as:

- Digital Built Britain ("Digital Built Britain - Level 3 Building Information Modelling - Strategic Plan," 2015) and “digital twin” (J. Whyte, K. & Hartmann, 2017);63
- smart infrastructure and construction (including for “infrastructure to respond intelligently to changes in its environment with the ability to influence and direct its own delivery, use, maintenance and support” (Mair & Yatteau, 2016) (p. 3)), or “intelligent assets” (relative to “building information management”) (McFarlane et al., 2017) (p. 5); and
- a basis for planning decisions and to improve planning systems via “City Information Modelling”64 (Burgess & Quinio, 2018) (p. 19).

Such examples may align in part with calls for a shift in research from BIM adoption to the functionality of BIM in its integrated form (Hosseini, Pärn, Edwards, Papadonikolaki, & Oraee, 2018) (in reference to (H.-Y. Chong, Fan, Sutrisna, Hsieh, & Tsai, 2017; Gholizadeh et al., 2018)65, including at scale. This also follows other examples from industry and research. For example, the Office of Projects Victoria (2019) (p. 17) note, in view of the National Digital Engineering Policy Principles (National Digital Engineering Working Group, 2016), that governments “will work to ensure DE approaches complement existing project design and developments systems and interface with ...GIS”. Another digital solution may include or foster structures that focus on enabling data access. Such approaches include for collective, jurisdiction based database development in consideration of “Building Information Management” and “data procurement frameworks” (amongst others) to improve product compliance and enforcement systems for the building and construction industry across

63 By way of further cross over example, the Transport for NSW (2018) (p. 4) includes reference to core “DE Framework Objectives” in developing capabilities including a “digital twin” that “supports the creation of a ‘digital asset’ that enables us to visualise and manage critical data to gain new insights”.
64 It is acknowledged for the UK there is “no mention of BIM at a national planning policy level, and there is a lack of awareness and engagement with BIM at the local level” (Burgess & Quinio, 2018) (p. 19).
65 Of note, Gholizadeh et al. (2018) identify 14 BIM functions from the research literature, including: 3D visualisation; clash detection; facility space planning and logistics; code validation; constructability and structural analysis costs estimation and quantity take-off; scheduling animation; energy analysis; shop-drawing process; material tracking, delivery and management; stakeholder engagement, project turnover and close out; and facilities management. Whether these represent part of the limitations dictated by the relative data structures enabled by BIM warrants further analysis. Arguably, however, the listed functions are still able to be undertaken without BIM.

In contrast, Papadonikolaki et al. (2018) profile BIM software function applications across life cycle considerations. The authors not only highlighted the fragmented capability particularly as it concerned industry foundation class (IFC) based transactions (import/export) relative to the respective phases, but further posit limitations between standards and BIM software-based solution offerings. Although distinctions may arise if applying broader interpretations of “BIM”.

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Australia (Shergold & Weir, 2018) (p. 28). Other examples highlight the premise in terms of digital 3D cadastres, including in recognition of private sector concerns regarding 3D model control beyond the legitimate needs of government under existing law and the governance and legislative structures required to affect such a system (ACIL Allen Consulting Group, 2018) (pp. 14, 32-33). Whether examples would ever amount to network wide alignment or integration, including for the purposes of infrastructure funding such as intimated for the water sector in Canada (Zeb, 2014), remains to be seen.

However, the relationship of BIM in the context of “data for the public good” has already been raised in the UK ("Government response to data for the public good," 2018; National Infrastructure Commission, 2017), promulgating in further developments and relationships, such as:

- tasking the Centre for Digital Built Britain with “the establishment of a digital framework for infrastructure data, drawing together key organisations and existing initiatives both large scale (BIM) and smaller scale”, see Recommendation 1 ("Government response to data for the public good," 2018);
- the Transforming Infrastructure Performance initiative, see (Infrastructure and Projects Authority, 2017); and
- following the development of the Geospatial Commission (an expert committee tasked in setting UK’s geospatial strategy and promoting the best use of geospatial data) (Geospatial Commission, 2019).

Along this vein, contemplating public policy in relation to other types of digital data structures or data conceptualisations is far from new (despite being arguably directly relevant to the consideration of BIM) but also part of the on-going research and development, whether as:

- spatial data infrastructure (SDI) programs directing policy focussing on access to information, pricing and promoting cooperation (Rajabifard & Coleman, 2012) (pp. 11-12) and past examples of “government digital cartographic data policy” to address the production, distribution and dissemination of data in considerations of copyright issues and drives for “open data sharing” (Clarke & Mulcahy, 1994);

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66 Also see the inter-jurisdictional engagement towards achieving this as part of the Building Confidence Report Implementation Plan (Building Minister’s Forum, 2019) (p. 6).
• Big Data, including:
  o along with artificial intelligence (AI) for the better use of “citizen data” in delivering and tailoring public services and despite gaps with related public policy research (Pencheva, Esteve, & Mikhaylov, in press);
  o policy implications in response to privacy, data quality, access, curation, preservation and use, including as part of “data infrastructure” developments (from Korean perspectives) (Shin & Choi, 2015); and

• data access and availability, particularly as a macroeconomic distinction or basis and notwithstanding the frameworks, institutions or entities that may be required to address data stewardship and responsibilities (Productivity Commission, 2017) (pp. 307-340).

Research establishing a definitive connection between the role of data as attributing to sustainability objectives, or as connoting another stream or intent of sustainability around data (i.e. “digital sustainability”), may also fall within this gambit. For the latter, it poses a direct link to data management and governance, inevitably opening the door to more systemic issues. For policy development and frameworks, data governance considerations are likely to encompass internal views and perspectives, and external transactions, whether between organisations or other bounded forms or systems. It also arguably links into discussions on the circular integration of processes, industries, and economies (Walmsley, Ong, Klemeš, Tan, & Varbanov, 2019).

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67 By way of contrast, Tambuwala, Bennett, Rajabifard, Wallace, and Williamson (2011) highlight the gaps in macroeconomic policies in relation to the role of government land information in Australia, particularly given the lack of national constitutional authority over land administration and differing property valuation approaches and state taxation. The authors further point out that the circumstances are notwithstanding the ties between national wealth and land (including setting interest rates) and that contrast with other international directions. Developments with land administration systems, including in respect of electronic lodgement network operators and systems limitations in some jurisdictions (see (Standing Committee on the Environment and Planning, 2018)), are further factors for consideration.

68 By way of examples, refer to the discussion by Roberts, Pärn, Edwards, and Aigbavboa (2018) in terms of sustainability and digital asset management, and Y. Liu, Van Nederveen, and Hertogh (2016) who explore the relationship between BIM and sustainability in transport infrastructure from the perspective of government. The Sydney Cross Dependency Initiative (XDI) is another industry example that draws upon infrastructure data to develop a “tool that will be able to identify cross-dependent climate change impacts in water, electricity, transport, telecommunications, and built environment infrastructures” towards enabling city resilience to climate change (Office of Environment and Heritage, AdaptInfrastructure, & XDI Cross Dependency Initiative).
It is another question again if certain data structures (as enabled by a program/technology and depicting built environment representations) are mandated or advocated, whether:

- formally recognised and temporally contextualised⁶⁹;
- distinguished as demand or supply related function, including sourced via and by procurers on behalf of the public (as part of data stewardship?) or the betterment of the community;
- as an additional or further basis for and output from and/or by the construction industry⁷⁰, including as a resource for downstream use and application (Kuiper & Duffield, 2018a, 2018d); or
- highlighting the tension or blurring between objectives for consistency and change.

Again, the extent to which policy is developed to consider or address BIM in terms of the applications and implications of certain data structures is not apparent in the research literature. In such instances, questioning and justifying why such forms are better or necessary, or what can be availed, are likely to be relevant, including that may differ for more expansive applications.

Potential approaches to BIM, drawing from other policy related research

In looking beyond the BIM related policy discussion in the literature, the following section sets out a general overview of innovation and data orientated policy research that may be relevant for BIM based policy research. Other possible approaches are also identified.

Under the guise of innovation policy?

Research on innovation and public procurement policy is another potential avenue for reference and examination relative to BIM. Despite limitations in the research literature of public procurement as a policy tool (Grandia & Meehan, 2017), arguably the topic of BIM reflects a discrete case study, as a type of innovation or comprising innovative dimensions⁷¹. The extent to which approaches concerning

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⁶⁹ One contrasting example is the formal acceptance and recognition of certain languages by nation states and notwithstanding changes that occur, either used as part of the everyday vernacular or collectively adopted. There may be scope to determine or measure the relevance of and for BIM data or digital 3D data, as a preferred or dominant basis. Appreciably, such perspectives may also be premised upon what constitutes BIM and non-BIM, and how this is or can be reconciled with adopted approaches, including those that may be unsubstantiated, unilateral or blended interpretations.

⁷⁰ Arguably, such outputs do accord with the expectations of a construction meso-system responsible for the production and management of services rendered to end users and the community by the built environment structures and lifecycles, and that sit beyond narrow views of construction industry outputs as just “building” or the “act of building”(Carassus, 2001). Differences lie in the production of virtual or digital structures. Such perspectives also potentially shift or expand the role of the AEC industry, as the source or manufacturers of data (or certain types or structures of data). Appreciably, it may see the entry for data and technologically orientated players and developments, possibly intimating further levels of labour division or diversification/fragmentation in the AEC industry.

⁷¹ In Australia, BIM is also acknowledged under the auspices of “digital innovation” for data-driven urban management (AlphaBeta Advisors, 2018) (p. 22).
BIM accord with Elder and Georghiou (2007) policy discussion may be informative, particularly of “innovation systems” that:

- emphasise the “significance of having a large and differentiated group of innovation actors and an enabling framework for learning-orientated interactions between them”;
- call upon policy aimed at optimising the interaction of components of the system (in reference to (Arnold, Kuhlman, & van der Meulen, 2001)) and act “upon a large variety of actors and linkages”; and
- encompass “demand for innovations” considerations\(^\text{72}\).

Implementation considerations may follow issues identified by Elder and Georghiou (2007) (amongst others) for the placement of a complex implementation framework that concern:

- changing rationales and comprehensive inter-departmental strategies;
- linking up with private demand;
- coping with complexity and procurement discourse (aligning public need and supplier capacities); and
- activating and enabling the procurement chain.

Reconciling the types of potential policy mechanisms and tools for consideration and application may also be relevant, see Figure 3.

\(^{72}\text{For example, Mair and Yatteau (2016) (p. 7) highlight the role government procurement processes and supply chain management plays in enabling innovation adoption, including to focus on longer term asset performance, whole of life approaches to value, reconciling differences between the infrastructure procurers and operators, seeking outcome based specifications, and reconciling the rigidity and complexity of procurement frameworks (including to avoid inhibiting SME contribution).}\)
However, other innovation policy-based issues and references may be drawn upon for consideration, discussion and analysis, including:

- the development of policy learning and coordination for “policy coherence and consistency across fields and levels, as well as the necessity of reflexivity in and associated adjustments of policy processes” (Grillitsch, Hansen, Coenen, Miörner, & Moodysson, 2019) to leverage system transitioning (Schot & Steinmueller, 2018);
- “public procurement innovation” (PPI) (Li & Georghiou, 2016);
- contrasting product based public procurement approaches with other supply/demand mechanisms and options (Aschhoff & Sofka, 2009);
- innovation policy mixes concepts and evaluation, via various governance modes (Magro & Wilson, 2018);
- technological innovation systems research, which notably identifies issues including “a lack of collaboration among key actors, institutional battles with rival technologies, an absence of diversity in the actor base, lack of skills and capabilities, and the absence of appropriate policy interventions” (Frishammar et al., 2018);
- “urban innovation” realised smart city developments, including that incorporate consideration of technology, organisation (enterprise architecture, cross-organisation,

73 Governance modes include or relate to approaches by single government and for discrete beneficiaries, through to examples with multiple governments, policy-makers and stakeholders and that comprise a variety of interests.
leadership), policy (integration, branding and demand focused) and context (physical, environment, interactions) dimensions (Nam & Pardo, 2011); and

- in recognition of localised circumstances and approaches to innovation, including for Australian built environment procurement practices and identified impediments to innovation (Miller, Furneaux, Davis, Love, & O’Donnell, 2009).

Appreciably, the discussion above points to considering whether there are in fact a range of objective outcomes that could be pursued in respect of BIM, from “do nothing” through to evoking comprehensive and systemic change of industries, sectors or community thinking. It further raises questions about “how far to go?” and what realistically or feasibly can be achieved. Directions, particularly for scaled perspectives and developments as demonstrating social relativity and change, may also point to “social innovation” and public policy research, despite conceptual gaps of the former (Baptista et al., 2019).

**Data-based policy developments?**

From the development of data orientated policy more generally74, there may be scope to clearly link and distinguish the relevance of BIM. Such propositions arguably represent a broader and expansive dynamic of BIM and that accord in part with the potential future expectations of some policy examples and conceptualisations. It further points to the potential for further and expansive developments around “data governance” and public procurement, see for example (Gleeson & Walden, 2016)75.

However, such approaches are likely to further qualify or delineate “BIM”, particularly as pertaining certain data structures and the role played in reference to the built environment. Linkages to determine the implication with or for BIM, including impact on the AEC industry, are likely to require further resolution and formalisation (Kuiper & Duffield, 2018a).

As a starting point, the following paragraphs identify potentially relevant Australian policy examples that focus on data generally, and where applicable, data concerning the built environment more specifically. Notably, these references do not identify or refer to BIM specifically.

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74 Relevantly, policy related data developments continue to progress at the international scale, whether proffered in terms of economic growth (Organisation for Economic Co-operation and Development, 2015) or for economic value determinations (HM Treasury, 2018).

75 Barns et al. (2017) discuss “urban governance” and “digital infrastructures” following shifts in approaches in Australia to encompass data management, use, access and distribution issues and emphasise the role of government as an enabler and facilitator of data-driven services. The authors profile the implications and “challenges associated with recent digital infrastructure investments and strategies” shifting from “vertical and government-controlled integration” to circumstances of mixed stakeholders, organisational and institutional forms.
Data collection, access and reform

Federally, the topic of data generally is the subject of on-going interest and development, including for example:

- from national perspectives, as presented in the State of the Data and Digital Nation (Australian Digital Council, 2019), under the themes of: policy and strategy; user experience; products and services; service enablers; internal capabilities; and data sharing and linking;
- data access and use as proposed by the Productivity Commission (2017)\(^{76}\), including by extension to issues relating to intellectual property (Productivity Commission, 2016b); and
- the collection and dissemination of national infrastructure data, as a discussion paper (Bureau of Infrastructure Transport and Regional Economics, 2017) and formulated plan (Commonwealth of Australia, 2018).

Approaches by Australian state-level entities exist, although the extent to which these differ either with federal or other states and territories would be subject to further inquiry. Like the intent and wording of international developments, the Victorian Department of Treasury and Finance (2012) (p. 1) acknowledge “the benefits associated with mandating a whole of government approach to the availability of Victorian government data\(^{77}\) for the public good”, and for use and reuse by the community and businesses. The proposed framework is intended to set the direction on the “release, licensing and management” of data subject to restrictions (including “privacy, public safety, security and law enforcement, public health and compliance with the law”) (Department of Treasury and Finance, 2012) (pp. 1, 3). More recently, Victorian Government approaches have encompassed a broader general scope in respect of data, including:

- guidance on data sharing for the public departments and agencies (Department of Premier and Cabinet, 2017);
- the development of a data reform strategy for the Victorian Public Sector, see (State Government of Victoria, 2018); and

\(^{76}\) Of note is that BIM is referenced in the draft version of Productivity Commission report but was removed in the final version.

\(^{77}\) “Victorian government data refers to datasets and databases owned and held by the Victorian government and stored in formats including hardcopy, electronic (digital), audio, video, image, graphical, cartographic, physical sample, textual, geospatial or numerical form” (Department of Treasury and Finance, 2012) (p. 1).
Arguably, these developments still face implementation challenges, including in terms of capability and resourcing needs (Barns et al., 2017). In Victoria, public sector agencies tasked with data objectives fulfil support roles\(^78\), including that pitch to:

- assisting other agencies, including to enhance data analytic capability and opportunities, see (State Government of Victoria, 2019); and
- the regulation of independent advice to the community and Victorian government about how the public sector collects, uses and shares information, including in respect of Freedom of Information requests, privacy and data protection (Office of the Victorian Information Commissioner, 2019).

Conceivably, there may be circumstances in which certain data is relevant to and/or subject to asset management policy regimes\(^79\), see (Department of Treasury and Finance, 2016, 2017b)\(^80\). Whilst the link to public infrastructure as an asset is clear, the extent to which data about the infrastructure asset is an asset in itself may not be obvious. For the latter, identification and value may be attributed subject to review and qualification of such data\(^81\). Further there are distinctions between the role and

\(^78\) Other examples include public sector agencies with archiving and statistics based services and functions, each with discrete objectives and roles.

\(^79\) The Victorian Digital Asset Strategy (VDAS) sets out the policy linkages, including to the Asset Management Accountability Framework, along with the Gateway Review and design review processes, guidelines for investment management standard and life cycle, and high risk/value projects, front-end engineering design, critical infrastructure resilience arrangements, government risk management and value creation and capture (Office of Projects Victoria, 2019) (pp. 35-38). The extent to which BIM directly or indirectly attributes to fulfilling and complimenting these policies may be subject to further research.

\(^80\) Linkages to further relevant legislation, policies and standards associated with asset management accountability are also noted by Department of Treasury and Finance (2017b) (pp. 12-14). It extends to sector applications, including for example where “asset management in the roads industry is likely to become a far more data-intensive discipline in coming years” (Hart & Logie, 2018) (p. 116).

\(^81\) Generally, the Commissioner for Privacy and Data Protection (2017) (p.10) describes an “information asset”:

...as a body of information, defined and practically managed so it can be understood, shared, protected and used to its full potential. Information assets support business processes and are stored across a variety of media and formats (i.e. both paper based as well as electronic material). Information assets have a recognisable and manageable value, risk, content and lifecycle. An information asset can be a specific report, a collection of reports, a database, information contained in a database, information about a specific function, subject or process.

The Commissioner for Privacy and Data Protection (2017) (pp. 11-66) further sets out a framework for identifying and managing “information assets” premised upon the organisational context and understanding “information” value.

By way of contrast, National Archives of Australia (2015) (pp. 3-4) makes the distinction for assets as “information, technology, people and processes” in setting the “integration of information governance principles and practices” to: (i) optimise government programs and services delivery; (ii) enable information reuse for economic and social benefits; and (iii) protect the rights and entitlements of Australians. The Principles include that: (i) information is valued; (ii) information is managed digitally; (iii) information, systems and processes are interoperable (National Archives of Australia, 2015) (pp. 4-6).
necessity of data to enable the management of the infrastructure asset and the inherent value which is otherwise encapsulated in data (about infrastructure) as a future consideration or new insights and markets, see (Barns et al., 2017). Notwithstanding limitations in accounting standards in acknowledging data as an asset (Laney, 2018) (p. 21)\(^2\), determinations of certain data as an intangible asset may also be relevant (Department of Treasury and Finance, 2017a).

**Data, infrastructure protection**

Another potentially relevant line of enquiry concerns the recent developments concerning the general data protection frameworks and approaches that have been developed and enacted, including in the UK and Australia. Appreciably, there are discernible differences between the intent and application of the regulatory frameworks that focus on General Data Protection Regulations (GDPR) (particularly personal data) rather than data or representations about and as concerning the built environment. Although the link to public procurement for the former is evident, including in terms of contract amendments (Crown Commercial Service, 2017). Such challenges are acknowledged more generally and that point to the need to define data characteristics and the types of data based services (including professional scope), and develop regulatory frameworks for data sharing/services, and data compliance and measures (Australian Computing Society, 2017) (p. 3). Establishing qualifications around those systems, entities or individuals that are best placed to “do” data is another potential consideration.

Other developments and public forums\(^3\) concerning Defence and cyber-security awareness have been raised in relation to the built environment context and applications. By extension, these matters tip into related Australian policy developments and regulatory frameworks that address:

- cyber security matters concerning critical infrastructure, including in reference to the Security of Critical Infrastructure Act 2018 (Cth)\(^4\); and

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\(^2\) Further, Australian Computing Society (2017) (p. 23) note “with the challenges associated with recognising the value of data, and quantifying the potential risk of release of data, it is not surprising that so many individual data custodians are paralysed by concerns about the consequences of releasing or sharing data. It is also not surprising that, without an accounting framework for data in an accounting sense, that data is undervalued as a factor of production in the Digital Economy”.

\(^3\) In January 2018, the author attended the Cambridge Centre for Smart Infrastructure and Construction hosted Cybersecurity for Smart Infrastructure briefing and workshop (see https://www.smartinfrastructure.eng.cam.ac.uk/news-and-events/CybersecurityforSmartInfrastructure). BIM was specifically profiled as part of these presentations.

\(^4\) The (Australian Government & Critical Infrastructure Centre) identifies 6 security principles, including to: (i) protect against insider threats by identifying sensitive job roles and undertaking pre-employment screening
risk management and organisational resilience for owners and operators of critical infrastructure (Commonwealth of Australia, 2015a) (p. 11), (Commonwealth of Australia, 2015b) (pp. 7-8).

The extent to which BIM assists or exacerbates these concerns is not clearly delineated in the research literature, including whether certain data categorisations are warranted.

Other potential directions, something else?
Whether the current data orientated developments will necessarily evolve into information based directions (Kuiper & Duffield, 2018d), including for policy development and social physics (Pentland, 2014), may be subject to further debate (including in respect of BIM). Whether this amounts to “informational policy” is likely to involve further conceptualisation development. Inadvertently though, it renders the statement that “[t]here is no universally applicable definition of what information a Building Information Model must provide” (Borrmann et al., 2018) (p.6) moot or requiring reinterpretation. It further stands aside from the objective to evoke information.

Of interest is the extent to which institutional regimes apply in the context of technological systems, including transactions, and in contrast to those examples that set rules as to the behaviour between people. Rules that concern the relationship between people and technology, arising from technology to technology interaction, are already evident. Appreciably, this scope differs from those rules about technology, focusing instead on the interaction, relationships or engagement with technology, particularly in operational integration terms. This line of inquiry draws in organisational research, to incorporate approaches in consideration of administration coordination, including via impersonal methods (such as regulations, contracts, when applied or not), and relative to integrated operations (Alter & Hage, 1993) (p. 94). In this sense, there may be linkages to examine policy that is directed at supporting coordination, with the intent for cooperation, not only in relation to people and organisations, but also in respect of the relative systems, be it technological orientated or otherwise. Finding, measuring and quantifying the minimum or optimal basis may be another avenue for research, including as an informational basis, see (Kuiper & Duffield, 2018d).

using a risk based approach; (ii) know where your sensitive information or bulk data is stored, who has access to it and how will it is protected; (iii) limit access to physical facilities and services to individuals with a genuine and legitimate need; (iv) ensure key technologies, such as industrial control systems, are secure by implementing effective cybersecurity practices; (v) understand and manage risks in outsourced and offshored functions; and (vi) embed organisational security culture through governance and by promoting security-conscious behaviour.

85 For example, section 58K(2) of the Fair Trading Act 1987 (NSW) states a “person engages in prohibited conduct in relation to the use of a ticketing website if the person uses any software to enable or assist the person to circumvent the security measures of the website and to purchase tickets in contravention of the terms of use of the website that are published on the website”.

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However, in recognition of informational approaches (Kuiper & Duffield, 2018d), policy directions may further see development that reflect a combination of key informational features. The net result may envisage approaches that incorporate: data (elemental expression); people and technology (network infrastructure), and coordination/integration (transitions of state) to drive informational outcomes. Conversely, it may see the widening of innovation conceptualisations (which arguably incorporate these), to cover “non-innovation” applications or more general dynamics of societies.

Concluding comments
Despite the gaps surrounding the definitions of “BIM policy”, there are multiple features and perspectives that can be profiled, examined or analysed for the purposes of research. One example includes contemplating the relationship between public policy and BIM via or through the domain of public procurement, broadly defined. Whilst such approaches open and extend the examination of BIM into new and deep areas of existing research, it further highlights the scope of challenges and opportunities that arguably warrant attention for practical and effective application. Key to this research includes considering the relativity of BIM in reference to the institution of “government”, its component parts and the mechanisms and tools used to drive or affect positions and/or change. By extension, it includes highlighting the reference to BIM in terms of existing policy framework, approaches and types (such as mandates) in the relative jurisdictions. It further plays out in how such policies are applied, implemented and practically operationalised to ultimately achieve the intended or desired outcome, or some other result by design or unintended consequence.

Australian perspectives and approaches concerning BIM appear to loosely align with global trends that include reference to BIM by governmental and public entities. More recently, however, the context of BIM appears to have shifted or converged with digital/data orientated propositions, including the pre-text of “digital engineering”. The surrounding discourse arguably joins a well-established path and ongoing developments by the spatial industry highlighting the necessity and value of data, including of and about the built environment. It further sees linkages to more recent conceptualisations (or trends), be it about big data, digitalisation, smart infrastructure/cities and Industry 4.0 etc. For policy or approaches attempting to wrangle data integration for scaled and social orientated purposes, the inference of BIM is likely to become just one within the sea of options, types, tools or data structures. The effect for policy scope and intent in this sense means the breadth of policy may encompass or accommodate BIM adoption through to about or relating to BIM data.

86 Of note is that informational outcomes also reflect different value propositions than that currently being ascertained for and about data, see (Kuiper & Duffield, 2018d).
Leading from the raised discussion, other non-BIM policy related research and sources are likely to offer valid insights for considering, contemplating or establishing linkages to and between BIM. Two key examples include innovation and data orientated policy research, particularly in relation to public procurement. However, research into policy development relative to informational conceptualisations may offer an alternative option and new insights for contemplation beyond current approaches.

In any event, given policy approaches to BIM are likely to be multi-dimensional, it is also likely there are opportunities to reframe the question for government consideration of BIM (at least as one of the overarching institutions charged with bettering the community). In this sense, a starting premise to ask becomes: what is the public impact of BIM? Couched in these terms, the impetus about BIM is not limited to any particular sector, entity or application, rather what BIM contributes, whether in terms of data, performance and capability or states of knowledge.

Subject to determining whether the public impact of BIM is justifiably sufficient or relative (either to certain stakeholders, time etc.), a follow up question is determining the extent of change that is required to accommodate intended objectives. Subject to the adopted goals and given the hybrid role of public procurement (and that draws upon tools such as policy) and relationship to public infrastructure projects, extended institutional and structural implications are possible. Any proposed advancements concerning BIM as an industry function and towards widespread BIM adoption may also emerge as an indirect consequence, albeit subject to timing. Appreciably, this position is discernibly different for public sector agencies considering and contemplating the application of BIM for or as part of the respective operations and delivery of service, including whether these activities are outsourced or not. Unless the environment or external circumstances or industry, including internal leadership, determine otherwise, organisations and individuals will necessarily follow their own direction and purpose. By implication, the extent to which individuals and organisations engage and interact with each other but are misaligned about BIM, certain tensions and friction will require resolution.


References


Working Paper 00: Australian “BIM” and policy


Department of the Prime Minister and Cabinet. (2003). Cabinet Implementation Unit Toolkit, 2 Governance. Retrieved from


Nam, T., & Pardo, T. A. (2011). *Smart city as urban innovation: focusing on management, policy, and context*. In E. Estevez & M. Janssen (Eds.), Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance, Tallinn, Estonia, 26-29 September 2011 (pp. 185-194). ACM.


Annexure A

The following table documents Australian examples of BIM references in policy or public agency material, with further comments detailing the adopted position or statements made.

<table>
<thead>
<tr>
<th>Jurisdiction, description</th>
<th>Publishing/ affiliated entity</th>
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<tbody>
<tr>
<td>Federal/Commonwealth</td>
<td>Australian Government</td>
<td>Australian Government response to the House of Representatives Standing Committee on Infrastructure and Communications report: *The Australian Government already supports the use of imaging technology and Building Information Modelling...*In November 2016, the National Digital Engineering Working Group, established under COAG, released National Digital Engineering Policy Principles to promote consistent use...</td>
<td>(Australian Government, 2017) (pp. 10-11)</td>
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<td>Note: Council of Australian Governments (COAG)</td>
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<td>Also see response to the Australian Infrastructure Plan (Commonwealth of Australia, 2016) (p. 64).</td>
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<td>Standing committees</td>
<td>On infrastructure, transport and cities</td>
<td>Raised as part of the inquiry into smart information and communications technology (ICT) in the design and planning of infrastructure. <strong>Recommendation 7</strong> included: <em>The Committee recommends that the Australian Government, as part of its infrastructure procurement processes, require BIM to LOD500 on all major infrastructure projects, exceeding $50 million in cost, receiving Australian Government funding, including projects partially funded by Federal Government in partnership with state, territory and local governments, and that it focus on tendering mechanisms that will facilitate this outcome, on a project-by-project basis, with a view to ultimately establishing BIM as a procurement standard.</em> BIM is discussed specifically, along with geospatial technology, internet of things, machine learning ad mobile laser scanning. Raised as part of the inquiry into the Government’s role in the development of cities. BIM considered in terms of technology supported urban regeneration, with cross reference to the above report.</td>
<td>(House of Representatives Standing Committee on Infrastructure Transport and Cities, 2016) (pp. xiv, 4-10)</td>
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<td>Note: Level of development/detail (LOD)</td>
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<td>(Anticipated Government response)</td>
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<td>State ministerial representative groups</td>
<td>Transport and Infrastructure Council (as part of COAG)</td>
<td>Reference to BIM for use “to create highly detained and shared digital models of new infrastructure, improving investment and operational decision-making over the entire life of an asset”. <strong>Key activity 2.3</strong>, to “develop a national approach to the use of building information modelling in the delivery of major projects” via the Infrastructure Working Group.</td>
<td>(Transport and Infrastructure Council, 2016) (p. 11)</td>
</tr>
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</table>
| Government advisory bodies | Infrastructure Australia | In reference to best practice, it is noted:  
*Developing and retaining skills and facilitating innovation will provide a platform so best practice is applied now and improved over time. There are skills shortages in some sectors and areas of innovation, such as digital engineering and Building Information Modelling (BIM), where we are behind our peers – these, and others, require immediate attention.*  
BIM developments are also profiled from other jurisdictions.  
**Recommendation 10.4** states:  
*Governments should make the use of Building Information Modelling (BIM) mandatory for the design of large-scale complex infrastructure projects. In support of a mandatory rollout, the Australian Government should commission the Australasian Procurement and Construction Council, working with industry, to develop:*  
• Appropriate guidance around the adoption and use of BIM; and  
• Common standards and protocols to be applied when using BIM. | (Infrastructure Australia, 2016) (p. 162, 169)  
Also see (Infrastructure Australia, 2015) |
| Productivity Commission | As part of the inquiry into public infrastructure:  
**Recommendation 12.5** states:  
*For complex infrastructure projects, government clients should provide concept designs using Building Information Modelling (BIM) to help lower bid costs, and require tender designs to be submitted using BIM to reduce overall costs. To facilitate the consistent use of BIM by public sector procurers, Australian, State and Territory Governments should:*  
• facilitate the development of a common set of standards and protocols in close consultation with industry, including private sector bodies that undertake similar types of procurement  
• include in their procurement guidelines detailed advice to agencies on the efficient use of BIM. | (Productivity Commission, 2014) (pp. 27, 44) |
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|                          |                             | References in respect of transport technology, with cross reference to the smart ICT recommendations. A further comment to note is Finding 4.2 which states: Governments do not necessarily need to be involved in the development of standards, but where standards are mandated (as a form of technical regulation), following good regulatory principles would mean that standards:  
  • are the minimum necessary to achieve regulatory objectives;  
  • maximise interoperability;  
  • follow international standards where practicable and relevant, unless use of standards based on Australian technology would deliver higher net community benefits; and  
  • are developed in consultation with the private sector.  
In negotiating international standards, the interests of the Australian economy rather than individual businesses should be of primary consideration. Also refer to Finding 4.8 which states: Technologies embedded in infrastructure and greater use of digital platforms to link infrastructure with users and suppliers offer governments considerable scope to:  
  • assess infrastructure usage and the responsiveness of demand to pricing and to introduce efficient pricing technology;  
  • augment and maintain public infrastructure in ways that minimise disruption to its use; and  
  • optimise investment in public infrastructure, better matching the build requirements to evolving needs. Finding 4.9 (in part) states: Governments need to find ways to exploit, in their program delivery and policy making processes, the increased transparency that comes with digital technologies; and avoid locking in details of policy responses at early stages without scope for genuine re-evaluation ‘en route’ to the end objective.  
Potential links to inquiries concerning data availability and use, and intellectual property. | (Productivity Commission, 2016a) (pp. 9, 11, 191) |
### Jurisdiction, description

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<tr>
<td>Public departments</td>
<td><strong>Australian Government response to Productivity Commission inquiry into public infrastructure:</strong> “The Australian Government supports the use of modelling technology” but does not “endorse any specific technology in procurement activities”. Through the Department’s Bureau of Infrastructure, Transport and Regional Economics (BITRE): Potential link as pertaining to infrastructure data. <strong>Recommendation 2:</strong> Encourage industry-wide use of building information modelling, and support pilot projects that demonstrate the benefits of applying new technologies. <strong>Recommendation 10:</strong> Consider Building Information Modelling as a key part of the Government procurement process.</td>
<td>(Commonwealth of Australia, 2014) (p. 15) Note: This department is currently referred to as Department of Infrastructure, Regional Development and Cities (Commonwealth of Australia, 2018) (Built Environment Industry Innovation Council, 2012) (pp. 14-15, 19-20) Facilitated further reports (i.e. (Allen Consulting Group, 2010; buildingSMART Australasia, 2012))</td>
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</table>
| Industry/public sector based (national focus) | Sets out goals to:  
  - develop a framework in support of digital engineering by the building and infrastructure sectors and encourage innovation and efficiencies in delivery and management of public infrastructure  
  - promote consistency/openness in data requirements  
  - increase capacity and capability.  
  Includes the development of guides and approaches to asset information requirements (AIR) and BIM process consistency. | (National Digital Engineering Working Group, 2016) (Australasia BIM Advisory Board, 2018a, 2018b) |
| Industry based (national focus) | **NATSPEC** Industry repository promoting industry practice and standards publication and guidance on BIM.  
**Austroads** Focused on roads transport and traffic agencies with interstate and international representation, the guide includes reference to building information management and modelling (including as digital engineering).  
**APCC/ACIF** Construction industry guidance material focusing on BIM skill and project team integration. | (NATSPEC, 2019) (Gordon, Sharp, & Martin, 2018) (pp. 16, 23) (ACIF/APCC, 2014, 2017) |
| State/Territories              | **Victoria (Vic)**  
**State level centralised or authorising agencies**  
**Department of Treasury and Finance** | As part of the State’s budget papers, for construction technologies, *Through its Future Industries Construction Technologies Sector Strategy, the Government is supporting the accelerated adoption of new technologies across the Victorian construction industry*.... | (Department of Treasury and Finance, 2017c) (p. 3) |
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|                          |                             | *The Government’s BIM implementation plan, which will be released later in the year, will further detail the uptake in BIM and building expertise in BIM technologies in Victoria.*  
*BIM continues to gain momentum in Victoria and across Australia, and is becoming better understood throughout the infrastructure construction and management sector....*  
*Over 2017-18, the Government will receive initial data and information sets on selected BIM projects to better understand project efficiencies, delivery outcomes and lifecycle management.*  
*This complements the work Victoria is engaged with as part of the Council of Australian Governments Transport and Infrastructure Council National Digital Engineering Working Group...*  
As part of the State’s budget papers, for infrastructure that addresses Victoria’s needs, the:  
*Government will also pilot Building Information Modelling (BIM) on select projects to enhance project efficiency and outcomes in delivering buildings and infrastructure, with potential staged implementation of BIM across infrastructure projects in the future.* | (Department of Treasury and Finance, 2015) (p. 10) |
| Departments              | Department of Economic Development, Jobs, Transport and Resources (DEDJTR) (part of Transport for Victoria) | Recognises the lack of “universal definition of BIM” but that “it is accepted that BIM provides for high levels of collaboration, detailed information sharing and storage, and transparency in construction projects and asset management”.  
Identified focus including to advance the use of BIM, including to:  
• develop a plan with industry to provide for the greater uptake of BIM; and  
• build expert skills in BIM technologies.  
Other identified focus areas included to support innovation and growth, including to leverage government procurement to promote innovation in construction technologies, as well as capitalising on digital technologies to attract capability and promote Victoria as the national hub for digital innovation in the construction industry.  
In prompting engagement and discussion in industry, the discussion paper states:  
“[n]ew IT systems such as Building Information Modelling (BIM) are being deployed to improve design and management of the construction process, as well as the operational efficiency of the building once completed”. | (State of Victoria, 2016) (pp. 7, 9, 18-19) |
<p>|                          |                             | Also refer to (Boston Consulting Group, 2015) |</p>
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<td></td>
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<td>Insights sought relate to determining how BIM uptake can be encouraged and the associated costs/benefits.</td>
<td>(Office of Projects Victoria, 2019) (pp. 2, 14, 35-38, 40-41)</td>
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<td>Victorian Digital Asset Strategy, Strategic Framework acknowledging role of BIM and digital engineering for assets and project best practices, including for the promotion of: ...harmonisation and collaboration across jurisdictions. The VDAS aligns with the NDEPP and has been developed by the VDASSC in collaboration with Transport for New South Wales (TJNSW), Infrastructure New South Wales (iNSW), the Queensland Government’s Department of State Development, Manufacturing, Infrastructure and Planning, various Victorian Government project delivery agencies (Office of the Coordinator General, Rail Projects Victoria, Level Crossing Removal Program, and North-East Road Link Project, as well as NATSPEC, and the Australian BIM Advisory Board. Links to other relevant Victorian Government policies and involved entities are also set out.</td>
<td>Note: National Digital Engineering Policy Principles (NDEPP), Victorian Digital Asset Strategy Steering Committee (VDASSC).</td>
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<td>Office of Projects Advisory group Victoria</td>
<td>Proposed reform directions include: 5.3 Adoption of Building Information Management and other digital technologies and support to the workforce to adjust to digital disruption, with specific measures including: • reduce barriers to the adoption of technologies such as pre-fabrication and BIM across the Victorian construction industry, e.g. by sponsoring demonstration projects or supporting its adoption on private sector projects; • supporting the trial of other new construction technologies, including addressing regulatory and cultural barriers if required, while maintaining safety standards; working with the construction industry and unions to ensure the workforce is well positioned to adjust to the challenges of digital disruption.</td>
<td>(Premier’s Jobs and Investment Panel, 2017) (p. 42)</td>
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<td>VicRoads</td>
<td>Exploration of opportunities for VicRoads to transition to digital engineering and BIM.</td>
<td>(Hampson &amp; Shemery, 2018) (p. 1)</td>
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<td>NSW Government</td>
<td>Includes qualified reference to BIM only for different procurement approaches but repeatedly as part of “contractor skills”, including “BIM management”, “building information model (BIM) and digital engineering”.</td>
<td>(NSW Government, 2018a) (pp. 8, 10, 19, 22)</td>
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| Government advisory bodies | Infrastructure NSW | As part of the identified challenges and opportunities, productivity developments through ensuring construction sector capability and capacity, via the use of BIM. The use of new technology is identified to improve operating and maintenance practices. The definition of Digital Engineering is provided as:  
  *A new way of performing engineering services (design, construction and maintenance of buildings and infrastructure) in which all plans are digital and can be loaded into augmented reality systems to provide real-time information to construction and maintenance teams. Also known as Building Information Modelling.* | (Infrastructure NSW, 2018) (pp. 51, 58, 218) |
| Public infrastructure asset entities (owners or managers) | Transport for NSW (TfNSW) | BIM reference as “3D ‘BIM’ model”, including for technologies (software for reviewing BIM models), with links to technical guidance and project deliverables. | (NSW Government, 2018b) (pp. 3, 9, 10) |
| Inter-department, public sector based | Via collaborative engagement in industry | Vaux (2017) (slide 36) lists a number of different stakeholders consulted, in reference to the digital engineering related developments by the TfNSW, including:  
  - Transport for NSW; Future transport;  
  - NSW Roads & Maritime;  
  - Transport Light Rail; Transport Sydney Trains; Transport NSW TrainLink; Sydney Metro;  
  - NSW Transport Assets Standards Authority; NSW Transport State Transit; Open data;  
  - Austroads; Rail Industry Safety and Standards Board;  
  - Infrastructure Australia; National Digital Engineering Working Group;  
  - Consult Australia; buildingSMART Australasia; NATSPEC; and  
  - Sustainable Built Environment National Research Centre. | (Transport for NSW, 2018) (pp. 4, 6) |
<p>| Queensland | Queensland Government | As part of the implementation actions for the State Plan, “[t]he state will progressively implement the use of BIM into all major state infrastructure projects by 2023”. | (State of Queensland, 2016) |</p>
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| Inter-department, public sector based | Via collaborative engagement between the public sector agencies | Documented Building, Construction and Maintenance Forum in which BIM raised and discussed. Reference to Queensland Building Information Modelling Working Group (QLDBIMWG), including representatives from:  
• Department of Agriculture and Fisheries  
• Depart of Communities, Child Safety and Disability Services  
• Department of Education and Training  
• Department of Infrastructure Local Government and Planning  
• Department of Premier and Cabinet, Arts Queensland  
• Department of State Development  
• Department of Science and Information Technology  
• Department of Housing and Public Works  
• Department of Natural Resources and Mines  
• Public Safety Business Agency  
• Queensland Health, Queensland Treasury  
• Stadiums Queensland  
• Department of Transport and Main Roads  
• Workplace Health and Safety Queensland | (Queensland Government, 2017) (pp. 14, 17-18, 24-26)  
Also note in contrast the proposed list of stakeholders for 3D Cadastre development for Queensland and links to an unspecified “National Digital Built Environment Workgroup” (ACIL Allen Consulting Group, 2018) (pp. 26-27). |
| Departments | Department of State Development, Manufacturing, Infrastructure and Planning | Sets out principles for BIM implementation. | (State of Queensland, 2018) |
| | BIM as a forward work program as part of Queensland’s smarter infrastructure agenda. | | (Advance Queensland & Queensland Government, 2018) (p. 18) |
| | Department of Transport and Main Roads (TMR) | Sets out:  
... the Digital Engineering Policy for Transport and Main Roads. It provides an overview of the departments plan for the implementation of Building Information Modelling (BIM) processes and methodology in the delivery of road infrastructure projects. Transport and Main Roads will review this policy for continued suitability at a minimum annually, and circulate to all staff | (State of Queensland, 2017) (p. 1)  
Public infrastructure asset entity (owners or managers) |
| | Department of Infrastructure, Local Government and Planning | The BIM policy and principles for Queensland apply to  
• all Queensland Government departments, agencies and statutory authorities.  
• the full lifecycle of all new state infrastructure assets, including all vertical (e.g. buildings such as hospitals and schools) and linear infrastructure (e.g. roads and railways).  
• smaller new projects and existing assets where cost effective. | (State of Queensland & Department of Infrastructure Local Government and Planning, 2017) (p. 3) |
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<tr>
<td>South Australia</td>
<td>Department of Planning, Transport and Infrastructure</td>
<td>Sets out an approach to implement BIM for building projects in South Australia, including “to encourage the use of BIM on capital works projects and make it a requirement on strategic key projects” and “continue to investigate the direction of BIM”. Template contract conditions for consultant appointments, including provisions related to BIM. Includes reference to BIM related procurement documents including: BIM requirements and core/project specific brief provisions.</td>
<td>(Government of South Australia &amp; Department of Planning Transport and Infrastructure, 2017) This document supersedes previous versions dated 2014. (Department of Planning Transport and Infrastructure, 2019)</td>
</tr>
<tr>
<td>Local Government</td>
<td>Sunshine Coast Council</td>
<td>Part of the Council's Smart City strategy to use BIM to create smart buildings, including for major new buildings and infrastructure to achieve effective asset management.</td>
<td>(Sunshine Coast Council, 2017) (p. 33) Note: Referenced as one example only.</td>
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</tbody>
</table>
Author/s:
Kuiper, I; Duffield, C

Title:
Profiling Australian Building Information Modelling (BIM) and policy perspectives for public procurement of infrastructure projects

Date:
2019

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