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A REVIEW OF SPECIALIST ROLE DEFINITIONS IN BIM GUIDES AND STANDARDS

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SUMMARY: *Many handbooks and guides have been developed to assist with the adoption and implementation of BIM for organizations and projects. This paper examines the ways in which roles and responsibilities of BIM specialists are defined across an international selection of 36 of these documents. The purposes of BIM guides are examined and categorized, and the expertise and intentions of their developers are considered. The number and variety of guides and standards available raises concern, as findings suggest that while BIM practice generally is becoming more standardized, BIM specialist roles may be developing in an uncoordinated manner, even when companies and individuals consider themselves to be following best practice guidance. Specific shortcomings identified include a lack of definition of client-side roles in the BIM process, the inclusion of organisational BIM roles and activities in project-level guides and standards, and overlapping use of similar role titles to describe different functions within BIM project teams. The use of BIM guides to define project and organizational roles requires further attention in the wider professional context of BIM implementation and practice, in order to strengthen BIM practice and reduce ambiguity and uncertainty.*

KEYWORDS: *BIM specialist, professional practice, guidelines, handbooks, professional roles*

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1 INTRODUCTION

In order to establish Building Information Modeling (BIM) in the many facets of the construction industry where it has potential to impact, organizations have had to develop a range of new resources and capability sets. As part of this process, formal and informal BIM-specialist roles are becoming established in all aspects of architecture, engineering and construction (AEC), from initial design, project management and construction, through to operations and maintenance. However, literature suggests that the scope of tasks and responsibilities within such specialist roles remains both disparate and poorly defined (see for example Cus Babich and Rebolj, 2016; Wu et al. 2017).

Many countries, industry bodies, research coalitions and individual organizations have introduced guides and standards for BIM implementation and practice, which often include definitions of the key roles required for successful BIM implementation. One challenge for the authors of such documents is that industry adoption of BIM has progressed without the structure they seek to provide. As described by Samuelson and Björk (2013), BIM implementation has often started through bottom-up implementation in a company, as the result of an individual pursuing a personal interest or advantage, and only later has this limited introduction become adopted by the company as a whole. As a result, roles and processes have emerged in an ad hoc fashion, and in many cases continue to do so. Standards developers have had to balance the need to introduce a coherent yet representative structure, alongside the challenge of defining processes and roles that are still evolving in practice. Consequently, these guides and standards vary widely in their defined purpose and areas of interest. They also vary in terms of the level of support or requirement they entail, whether they represent mandatory or recommended practice, or are simply providing information for the industry or sector concerned. One of the commonly espoused purposes of BIM guides and standards generally is to achieve a higher degree of project collaboration. Hartmann et al. (2012) identified the prevalence of bottom-up BIM implementation, and noted that companies which followed this path tended to operate in low collaboration environments; hence the structured top-down approach taken by most BIM guides and standards would seem to be appropriate to achieve this aim.

A number of projects have acknowledged the plethora of guidelines available, and have sought to provide a synthesis across a range of sources. Fiatech (2013) for example, reviewed 28 BIM standards and guidelines, from the perspective of automated code compliance. Kassem et al. (2015) reviewed “noteworthy BIM publications” from eight countries, with the aim of producing a BIM knowledge content taxonomy to help practitioners and researchers identify and address knowledge gaps in the BIM domain. Many BIM guides have originated with public sector entities, and Cheng and Lu (2015) included a number of them in a review of public sector involvement in BIM adoption. Similarly, Sacks, Gurevich and Shrestha (2016) focused on BIM guides developed by large construction clients. A buildingSMART International project is currently collating a wide range of documents for future categorization and review, with the aim of producing a standardized international framework or template for future development of BIM guides, based on an analysis of standards already used in industry (Beange and Keenliside, 2015). The definition and description of BIM specialist roles is also in need of this sort of standardization.

The role of BIM specialists has been identified in the literature as an important factor in successful BIM project implementation. Howard and Björk (2008) identified the need for a specialized role in modeling and technology, applying standards and spatial coordination. However, as the adoption of BIM has increased, it has become evident that it is not just about software solutions or technology upgrades, but involves process change and change management. Additionally, it is increasingly recognized that the way in which BIM is adopted in a company or project varies according to the business objectives and desired outcomes of the parties involved. This analysis of requirements has to take place between, as well as within, organizations, thus adding a further layer of complexity to the BIM specialist role.

Conflict is evident in the literature when considering the extent to which BIM adoption affects industry roles. The Contractors’ Guide to BIM, produced by the Associated General Contractors of America, asserts that "BIM does not change the fundamental roles and responsibilities of project participants” (AGC, 2010, p19), and goes on to say that “the effective use of BIM does not require that the project participants assume any roles other than their traditional ones.” (AGC, 2010, p35). Conversely, Al Hattab and Hamzeh (2015) suggest that BIM affects all roles in a project, with a much higher degree of interconnection and interaction than traditional practice entails. They consider that BIM adoption involves a change to most, if not all, relationships on a project. If this is the case, there would be a corresponding effect on the scope of each role, as more communication, collaboration and shared decision-making takes place. The BIM Guide produced by ASHRAE for its members makes the same

argument, and states that the industry as a whole must consider "crossing organizational boundaries" and "reorganizing design and construction processes" to fully benefit from BIM (ASHRAE, 2009, p20). Gu and London (2010) take an intermediate position, with the claim that some old roles will become obsolete, and specific new roles will be introduced. With such disparate positions held by different participants, defining key BIM roles becomes a vital activity in successfully advancing BIM implementation.

A further difficulty for this area lies in the multiplicity of ways in which BIM roles are described. From their review of literature, Barison and Santos (2010) list upward of 40 different BIM specialist roles across a range of functions and organisation types. Similarly, from an analysis of online job postings, Uhm, Lee and Jeon (2017) found 35 different types of job titles relating to BIM. Although some of the diversity in job titles stems from differences in discipline-specific BIM roles, many of the titles that were identified in both of these studies have overlapping or aligned role expectations but with different names. This variability leads to a considerable amount of ambiguity and confusion around necessary BIM roles in organizations and project teams.

This paper addresses the conjunction between the development of BIM guides, handbooks, manuals and standards, and the need for greater definition and description of BIM specialist roles, by analyzing BIM roles and associated expectations required by the industry. This has been done by collecting and analyzing a wide range of BIM guides and standards developed internationally by government bodies, special interest groups, professional associations and client organizations. The following section examines the types of BIM guides and standards available, and reviews their development process. The next section provides an analysis of a selection of the many guides and standards currently available, specifically examining the definitions they provide of BIM roles and the associated responsibilities, and identifying commonalities of advice, purpose or structure. A further section discusses the findings and outlines the implications for practice.

2 DOCUMENT REVIEW

A selection of documents from international sources has been compiled and examined for this review. Almost all of these are freely available online, although some require registration in order to download the documents. Very few are limited to membership of a specific organization, or require payment to access them. An initial wider set of documents was collected, primarily as a result of internet searches but also through recommendation from peers in academia and industry. This was reviewed for content, and those which did not fit analysis criteria were culled. A similar approach was taken to that used by Kassem et al. (2015) in their examination of noteworthy BIM publications, but in this case with a specific focus on documents which provide information on roles and responsibilities. Documents excluded were handbooks or guides developed by software providers; superseded editions of more recent documents; non-English resources; and handbooks or guides which considered BIM as a peripheral aspect of another topic, such as Integrated Project Delivery or Lean Construction. Also omitted are guides or standards which define the technical processes or information content of BIM projects, where no attempt is made to delineate roles or responsibilities. Where a BIM protocol template forms part of a BIM guide or standard, the role definitions that are described have been included; however a review of BIM contracts is outside the scope of this study. The resulting collection consists of 35 documents, which have been organized by publication date, country, developer type, and content. The final list is provided in Appendix A.

2.1 Included documents

Part of the complexity of identifying unified role definitions from the assortment of documents available lies in the variety of names that such documents go by. Guides, guidelines, handbooks, manuals, standards and protocols are all terms used in the title or description of the collected documents; however, even where the same term is used it does not necessarily have a common meaning in the different documents. For this review, the intent of the document was considered as well as its title. For example, there have been published works, notably Eastman et al. (2011), which are presented as BIM handbooks or guides, but cover a much broader scope. The range of documents reviewed were developed primarily for the purpose of establishing a standard method of applying BIM, for example as expressed in the Singapore BIM Guide: "…to outline the various possible deliverables, processes and personnel/professionals involved when Building Information Modelling (BIM) is being used in a construction project." (BCA, 2013, p1). The expressed purpose of each of the documents reviewed is identified in Appendix A.

The developers and issuers of the documents also vary in their remit and intentions, and in the degree of influence they have within their audience group. Kassem et al. (2013) offer six categories of document issuer: Research body, Governmental department, Community of Practice, Private industry, Industry body, and Local

authority. However, these boundaries are not necessarily clear-cut; for example, in many cases where a government department or local authority has developed a BIM guide, it is presented in their capacity as a client rather than as a governing body. This categorization has been loosely adopted, with additional notes where required. Again, Appendix A indicates the country and developer type for each document reviewed. There is a wide range of application, from national standards down to guidelines produced for use by a single client. Although material from all included documents has been included in the analysis, the more influential BIM guides and standards (generally national standards or documents from significant client organizations) have been drawn from for in-depth discussion and to illustrate specific aspects of the findings, as identified in the following review.

2.2 Development of BIM guides and handbooks

Little has been published on the development process of the numerous BIM guides and handbooks now in existence. Many different approaches can be seen in the types of documents developed, the scope or focus of the guidance, and the developers and their intentions in compiling the advice. A number of guides and handbooks can be considered to be seminal documents, in that they have been used as the model for others later developed in different domains or countries. Ongoing modification and revision has led to some current versions diverging considerably from the originating documents, but the initial contribution has been recognized. An example 'family tree' of such documents, in this case stemming from the US Veterans Affairs BIM Guide (VA, 2010), is shown in Fig. 1. This indicates the 'descendants' of the VA BIM guide, which has influenced a wide range of other BIM handbooks, both directly and indirectly.

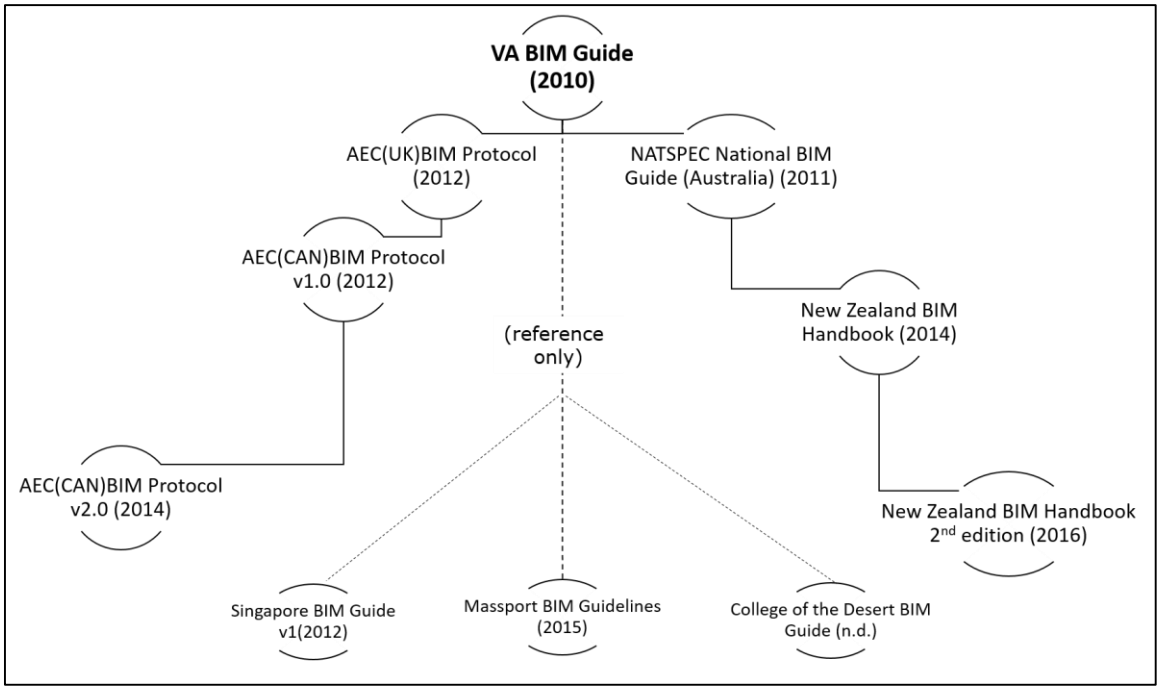

FIG 1: 'Family tree' of VA BIM Guide (2010) and levels of influence on selected descendent documents

The VA BIM Guide provides considerable detail in defining key BIM roles and their responsibilities, and outlines supporting roles with the requirement that the project proposal should include "BIM qualifications, experience, and contact information for the following: BIM Manager; Technical Discipline Lead BIM Coordinators for all major disciplines (Architect, Civil, MEP, Structural, etc.) …the Construction BIM Manager and Lead Fabrication Modelers for all trades" (VA, 2010, p7-8). More definition of the BIM responsibilities of these roles is also provided. This approach is closely followed in the AEC(UK)BIM Protocol (AEC (UK), 2012) and the NATSPEC National BIM Guide (NATSPEC, 2016). At the next level of development, however, the example provided by the original source has not been closely adhered to. The first version of the Canadian AEC BIM Protocol (AEC (CAN), 2012) was closely modelled on the UK version, and thus was quite similar in content to the VA BIM Guide. Local collaboration and revision of the Canadian document then occurred as the market became more mature, and the content of version 2 of the document (AEC (CAN), 2014) diverged from

its sources, while still retaining some elements of the original. Similarly, the initial draft of the NZ BIM Handbook was strongly influenced by the NATSPEC document, and therefore the VA BIM Guide. Over time, the relationship has decreased following amendments and revision based on developing knowledge and application of BIM in the New Zealand market, and the correspondence between the documents is now much reduced. The example documents shown at the 'reference' level of the family tree do not have such a close relationship to the original source, but identify the VA BIM Guide as influential in their development.

This process of adaptation from a source is a common theme in diffusion of innovation research. Linderoth (2016) describes the phenomenon of "technology drift", where the differing levels of knowledge, interpretations of needs, or expectations of various participants in the process influence the ways in which adoption and use of the technology may diverge from initial intentions or definitions. In BIM, as with other technological developments, this is as true of roles and relationships around the technology as it is of software and associated processes. Thus each iteration or interpretation based on a standard will result in adjustments or developments that reduce uniformity of practice.

Even where specific identified documents have not been used as a model or development source, the creation of a new guide or manual generally begins with a review of existing documents, with material then tailored to the needs or context of a given environment. However, as Beange and Keenliside (2015, p78) state, "…this process of reviewing, analyzing and drafting guide documents is extremely labor-intensive and often results in paralleled or duplicated efforts that add neither value nor forward achievement in the development of standard procedures or best practices." Although these approaches of progressive adaptation or parallel development both lead to a degree of uniformity in process and advice, each iteration increases the likelihood of changes and variations, and thus inconsistencies and conflicts in the resulting guides.

3 GUIDELINES FOR BIM SPECIALIST ROLES

From each of the BIM guides identified, the sections which discussed roles and responsibilities were extracted, and tabulated according to the key descriptions or definitions of each. These were collated by the significant terms used, in order to identify a consolidated set of roles, and the associated areas of influence or responsibility associated with each. As explained in the Norwegian House Builders Association BIM Users' Manual (BoligBIM, 2012), these are not necessarily expected to be exclusive or self-contained positions within a company or project, and "in some organisations, the same person will be able to play several of the roles" (p19).

3.1 Role Definitions

As Barison and Santos (2010) identified from the technical literature, and later found in an analysis of BIM job advertisements (Barison and Santos, 2011), there is a wide variety of job titles which apply to BIM specialists. More recently, Uhm, Lee and Jeon (2017) identified 35 job types through a similar study of job postings, many of which had overlapping descriptions and requirements. These job types fall into the categories of project roles, with the primary function fitting within a project team; and organizational roles, where the role is primarily performed at the company level. It is very uncommon for the reviewed BIM guides and standards to distinguish between project and organizational level role definitions, but they often include descriptions of activities or role expectations that are clearly organisation-based rather than project-based. From the roles described in the reviewed BIM guides, a separation has been made based on an interpretation of the different spheres of activity. BIM roles with a project integration aspect fall into two main categories which are relatively uniform in scope and responsibility. These commonly comprise an over-arching project management and coordination role, which is supported by a second tier of specialist managers or BIM coordinators from each of the design and construction teams or technical groupings. Some handbooks also define BIM roles which are concerned with organisation-level BIM processes, and another two categories can be drawn in this area, the organizational BIM manager and the BIM modeller/author. Only 3 out of the 35 handbooks examined defined client, asset or facilities management BIM roles.

Table 1 shows the roles described in the guides reviewed, and indicates the variety of job titles that are used. The labels used in each of the four categories are not always obvious, and include duplicates and overlaps. For example, *BIM Coordinator* is included under both the BIM Manager (project) and BIM Coordinator categories. This is based on the same role label being applied to different role descriptions in different guides. Similarly, the very generic label of *BIM user* has been included in the BIM modeller category, based on the description of the role in the relevant guide. Furthermore, where specific role labels have not been named, these have been inferred from the role description; for example, in the CIC Penn State (2011) Project Execution Planning Guide, roles are

not labelled, but from the discussion of roles, the label of *BIM Coordinator* has been inferred for the project-level BIM Manager role (e.g. "one of the primary tasks is to define the coordinator(s) of the BIM planning and execution process throughout the various stages of the project" (p6), whereas *BIM Manager* is described in that document as the role responsible for quality control of the model for each party, which is defined here as part of the BIM Coordinator category. The following sections expand on the synthesis of role definitions and responsibilities for each of the four BIM roles identified.

3.1.1 BIM Manager – project role

The most commonly described role is that of project level BIM Manager. The person or persons taking this role can represent the lead designer, the main contractor, and/or a third-party entity acting on behalf of the client. At this level, the BIM Manager is responsible for the development and delivery of the BIM execution plan, and establishing BIM protocols for the project. According to the most common descriptions, quality assurance is also part of the role, as is maintaining oversight over BIM responsibilities and deliverables. Guiding the collaborative process is an important aspect of this role, including organizing BIM project meetings and managing project records. One area of potential ambiguity regarding the BIM Manager project role is the degree of authority held by this person. The role is often described in terms of the project stage, for example the *Design BIM Manager*, or the *Construction BIM Manager*. Particularly in documents based on the VA BIM Guide, these roles are expected to report to the *Project Manager* who has the oversight role. However, in many of the documents, the BIM Manager role is the overarching project role, and is expected to pass between different parties depending on who holds the responsibility for the particular project stage. For example, the

Information Manager is a role most notably described in the UK in the Construction Industry Council BIM protocol (CIC, 2013) and supported by the PAS1192 suite of documents, and PAS1192-2:2013 in particular (BSI, 2013). Although included here within the category of BIM Manager – Project role it potentially sits somewhat outside all four of the BIM-specialist role categories identified from other guides. The *Information Manager* is employed by the client to have oversight of the information requirements of the entire project. While it is clearly a project-based role, it is not necessarily a BIM role. Before any widespread development of BIM, and with no mention of BIM at all in the description of the role, Froese (2004) identified the *Information Manager* as a necessary function for successful management of IT solutions in the industry. As described in the CIC documents (CIC, 2013) the *Information Manager* is responsible for establishing and managing the information processes, protocols and procedures for the project, including aspects such as the common data environment for the project, file management and information exchange. The *Information Manager* does not get involved in design-related functions such as clash detection or model coordination. Accordingly, the role does not require a knowledge of BIM tools or processes. However, the CIC also add that the *Information Manager* role is generally expected to form part of a wider set of duties and so may be taken on by a person with other BIM-related duties. As noted by Paterson et al. (2015), in many practical discussions or interpretations of the role this overlap results in it being interpreted in in much the same way as a project BIM Manager.

3.1.2 BIM Coordinators – project role

The BIM Coordinator role is described as a secondary role under the leadership of the BIM Manager, representing each individual discipline within the project framework. For sub-trades and specialist consultants in particular, the job title often used for this role is *Model Manager*. The BIM Coordinator is responsible for the exchange of BIM models from their organization or discipline, including ensuring that models created within their team adhere to the agreed BIM standards and follow exchange protocols. Model coordination and clash detection is often described as falling within the remit of the BIM Coordinator; within a project team the BIM Manager leads the coordination activity but each BIM Coordinator takes responsibility for the coordination and management of their own model, and any required propagation of changes. Other responsibilities described for the BIM Coordinator role include quality control, ensuring that the discipline model conforms to the standards agreed for the project, providing guidelines for the discipline team on agreed project requirements, and communicating data transfer needs and processes with other disciplines.

Although further distinctions could be made in defining the BIM Coordinator role to address the discipline specific differences that arise, most of the guides elide these differences and refer to generic roles and responsibilities that apply to all disciplines. An exception is the Australian CRC (2009) National Guidelines for Digital Modelling which includes skills in the role description that are specific to the particular disciplines, for example structural analysis, extraction of quantities for cost planning, or carrying out sunlight and lighting studies.

TABLE 1: Role categories identified in BIM guides

	Project roles															**Organizational roles**				
	BIM manager (project)									BIM coordinator						BIM modeller			BIM manager (organizational)	
Country & Guide Name	BIM Manager (VDC Manager)	BIM Facilitator	BIM Coordinator	(BIM) Project Manager	Design Team BIM Manager/ Construction BIM Manager	Project Model Manager	Information Manager	BIM Process Manager	BIM Lead Coordinator	BIM Coordinator	Discipline BIM Coordinator/ Design BIM Coordinator	Lead BIM Coordinator	BIM Discipline Manager	Model Manager	Project Model Leader	BIM Modeller	BIM Users	Model author	BIM Manager	Information Model Manager
Australia – NATSPEC (2016)	✓			✓	✓						✓	✓								
Australia – CRC (2009)	✓					✓				✓				✓						✓
Belgium – ADEB-VBA BIM Work Group (2015)								✓					✓							
Canada – AEC(CAN) (2014)	✓																			
Finland – COBIM (2012)			✓								✓									
Hong Kong – Housing Authority (2009)			✓																	
Hong Kong – HKIBIM (2011)				✓												✓			✓	
NZ - NZ BIM Handbook (2016)	✓										✓			✓						
Norway - BoligBIM (2012)		✓																		
Singapore – BCA (2013)	✓										✓						✓	✓		
UK – CIC (2013)			✓				✓				✓									
UK – AEC(UK) (2015)	✓									✓						✓			✓	
USA – AIA (2013)						✓										✓				
USA – AGC (2010)							✓													
USA – CoD (2011)	✓			✓																
USA – CURT (2010)							✓													
USA - Fermilab FESS (2015)	✓													✓						
USA – Georgia Tech (2013)														✓						
USA – GSFIC (2013)														✓						
USA – Indiana U (2015)														✓						
USA – LACCD (2016)	✓												✓							
US – Massport (2015)					✓						✓									
USA - NYC-DDC (2012)	✓										✓									
USA - NYC-SCA (2014)						✓									✓					
USA – Ohio DAS (n.d.)						✓														
USA - OSU (2017)				✓		✓							✓	✓						
USA – PANYNJ (2017)									✓		✓						✓			
USA – Penn State (2011)			✓																✓	
USA – Tennessee OSA (2015)	✓									✓										
USA – USC (2012)																				
USA - VA (2010)	✓			✓	✓						✓	✓								
Europe – EU BIM Handbook	These documents do not specify individual roles, but discuss more generally the importance of defining roles and responsibilities within a BIM project framework.																			
USA – ASHRAE (2009)																				
USA – DASNY (2013)																				
USA - DoD-MHS (2014)																				
USA – GSA (2007)																				

3.1.3 BIM Manager – organizational role

Although almost all of the guides and handbooks reviewed are concerned with the project-level processes involved in BIM implementation, many of them also define a BIM Manager role in terms of organizational as well as project responsibilities. Most commonly, this includes responsibility for training, as well as hardware and software issues. For example, the Hong Kong BIM Project Specification (HKIBIM, 2011) lists training and technical support of modelling staff as roles of the BIM Project Manager. Similarly, in the New York City Department of Design and Construction BIM Guidelines (NYC-DDC, 2012), specification of the BIM Manager role is primarily at a project level and in terms of interaction with NYC-DDC as the client, but it also stipulates the level of proficiency the BIM manager must have in the selected authoring tools, and assigns them the responsibility for coordinating BIM training. In practice, the BIM Manager for an organisation is often the BIM Coordinator (ie the discipline-specific BIM representative) at the project level, so it is not uncommon for the same individual to undertake project and organizational tasks (Davies et al., 2014). However, these are not project level requirements and thus do not need to be specified by the client in order to achieve successful BIM implementation.

3.1.4 BIM Modeller – organizational role

The BIM Modeller role is described as a production role in developing the BIM model, a role that has a variety of job titles including model author, BIM operator, BIM user or BIM technician. Although BIM modellers work on project documentation, this has been classified as an organizational role because it is the documentation itself (whether the full model or other product) that is the project contribution, and not the process by which it is produced. It is generally an operational decision within an organization as to how that product is achieved. Consequently, few of the documents reviewed concern themselves with defining the modeller role. There are several exceptions, however. Although it does not provide much detail on the responsibilities of those in the role, HKIBIM (2011, p23) specifies that "BIM Modellers (technicians and operators) will have particular discipline experience … with a minimum of 3 years of 3D CAD modelling knowledge." The Singapore BIM Guide (BCA, 2013) uses the term Model Authors to refer to both the party which creates and takes responsibility for a model, and the individuals creating the models for that party. On one hand, the role description is concerned with project issues such as information quality and delivery, while on the other it provides advice on organizational concerns including software use and relationships with software vendors.

3.1.5 Skill sets and capabilities

Another approach taken in some of the guides and handbooks is to define roles in terms of the skill sets and capabilities required. Succar et al. (2103) divide BIM competencies into abilities, activities and outcomes. All three of these types of competencies are used by the various guidelines to define BIM specialist roles, with some focusing on actions and responsibilities, and others also including abilities or skills requirements. The level of detail in the specification of roles also varies. For example, the Singapore BIM Guide states that the *Design BIM coordinator* is responsible for a given set of tasks: "Define discipline-specific BIM uses including analysis; Coordinate between BIM modellers, design consultants and cost consultant; Coordinate with contractor and subcontractors; Ensure Modelling Quality Control" (BCA, 2013, p25) while for the same role the NATSPEC (2016) guide is much more specific in defining expectations of the role: "These individuals shall have the relevant BIM experience required for the complexity of the project and shall have, as a minimum, the following responsibilities for their discipline: Coordinating technical discipline BIM development, standards, data requirements, etc. as required with the Design Team BIM Manager; Leading the technical discipline BIM team in its documentation and analysis efforts; Coordinating clash detection and resolution activities; Coordinating trade items into the Design BIM (depending on procurement plan)" (NATSPEC, 2016, p7).

Table 2 presents a selection of the specified abilities, activities and outcomes, grouped into the focus areas of technical, process, people and strategy. These are based on the roles categorisations identified in Table 1, and have been drawn from a selection of different BIM Guides.

The need for many of these abilities and activities, particularly at the technical and process levels, is not universal but is dependent on the BIM uses identified for application in a specific project. The Penn State BIM Guide (CIC Penn State, 2011) is the leading example of a handbook that has specifically addressed this aspect, with an appendix of BIM uses definitions that includes a summary of the team competencies required for each

identified use. These competencies are not defined as specific role requirements for individual roles, but indicate the experience and abilities necessary within the wider project team that is involved in the identified BIM use.

TABLE 2: Expectations of selected BIM roles

Role	Technical	Process	People	Strategy
BIM Manager (project role)	Ensure software is installed and operating properly	Lead development of BIM Management Plan/BIM Execution Plan	Provide BIM point of contact with client	
	Determine reference points used for project	Ensure compliance with BIM Management Plan/BIM Execution Plan	Train project staff	
	Analyze model content to ensure it is fit for purpose	Management & quality control of model dissemination; revision management	Facilitate technical meetings with BIM technicians	
	Carry out clash detection & provide clash reports	Coordinate file management processes		
	Assist in preparation of project outputs, such as data drops			
	Assemble composite models			
BIM coordinator (project role)	Carry out clash detection & provide clash reports	Provide guidelines for discipline team on agreed project rules	Team contact person in matters connected with BIM	
	Ensure functionality of team contribution to merged models/ integration of design models	Contribute to keeping BIM Management Plan/BIM Execution Plan up-to-date	Allocate and coordinate BIM tasks within own discipline	
		Ensure discipline model complies with BIM Management Plan/BIM Execution Plan	Communicate with other disciplines	
		Manage discipline-based quality assurance, formulation of BIM reports & data management	Represent team at interdisciplinary model co-ordination meetings	
BIM modeller (organizational role)	Production & modification of information in discipline-specific model			
	Must have appropriate technology skills to produce the model			
BIM Manager (organizational role)	Implement BIM technology	Create company-level BIM processes and workflows	Engage external stakeholders	Formulate corporate BIM objectives
		Develop company-level BIM standards and protocols	Collaborate with partners and internal teams	Plan & manage best practice/ research
			Company-based change management and training	Prepare and manage BIM training strategy

4 IMPLICATIONS FOR PRACTICE

4.1 Moving beyond technical skills

BIM co-ordination requires an individual (or organization) with both the technological capabilities with the BIM tools and systems used, and the contractual or financial knowledge and authority to enforce a coordinated process (Merschbrock, 2012). Without these elements, each party to the project follows their own individual processes with little incentive for a unified approach. As a result, the BIM specialist is also expected to move beyond a purely technical role and must also possess skills in leadership, communication, documentation writing, review and quality assurance procedures, in addition to discipline knowledge and proficiency in model authoring and coordination software.

The widespread and increasing adoption of BIM throughout the construction industry suggests that technological capabilities are now becoming less of a barrier. McGraw Hill (2014) found in an international survey of contractors that almost two-thirds of the organizations surveyed had a high level of engagement with BIM, a finding that is supported by surveys across a variety of regions and industry sectors. However, Eadie et al. (2013) reported that lack of expertise was still seen as the biggest barrier to successful BIM implementation. Given that technology skills have been reported as adequate or excellent across many organizations in the industry, this implies that the process-focused and collaboration aspects of BIM roles are the factors that present more of a challenge, and attention in these areas are required when establishing roles and defining skills. Table 2 confirms that technical skills are only a partial view of BIM roles, and are sufficient only for functioning at the production level.

4.2 Client influence

BIM development is often driven by client expectations and requirements; consequently, many of the BIM guides and handbooks currently available have been written from a client perspective (Wong et al., 2010). The majority of the client authority documents identified in this review have come from the US. In many cases these are from influential government clients, and have become de facto industry standards, in that their use has been applied beyond the initial client domain. Some of these clients have been leaders in developing standard approaches to BIM, and have been influential in the development of other more widely distributed manuals. For example, the US Veterans Affairs guide (VA, 2010) was an early leader in establishing the requirements for project use of BIM, as previously described. The General Services Administration BIM Guide in the US is another similarly influential document (GSA, 2007). However, these two documents take very different approaches. The GSA Guide focuses on the information requirements of the BIM model, with no specification of roles or protocols, while the VA, as previously discussed, provides process definitions that include key roles and responsibilities.

Early leaders in the BIM field tended to take an informational rather than a prescriptive approach in establishing BIM guidelines, and as such have covered the field more broadly than more recent documents. However, this has resulted in the somewhat anomalous situation that, for the majority of client handbooks reviewed, the focus is on the design process and in specifying the workflows and standards of the building delivery up until occupancy. Accordingly, where definitions of roles and responsibilities are given, these tend to be focused on the design and construction teams and not on the client-side representation. If they are to obtain long-term benefit from BIM adoption, clients need to codify the roles and responsibilities for managing BIM data and processes for facilities and asset management, and must develop the information management skills of their own employees, or work with third party BIM specialists who can deliver this competency (Love et al., 2014). It is curious therefore that very few of the client-developed handbooks do this. It is accepted that clients must clearly identify their information requirements, and the fact that they need to do this as part of a BIM process is set out in almost all guides, regardless of developer type, but the client-side roles are very poorly defined.

It may be that these client organizations have defined in-house roles separately as part of their facilities and asset management processes, instead of within their BIM handbook. If this is the case, there is a risk that where the handbooks form part of their relationship with design or construction teams, the personnel responsible for the end-use of the BIM data are being excluded from the process of developing the information requirements. This can be seen as one of the problems stemming from the separation of capital expenditure and related decision processes, and operational expenditure and ongoing management aspects, as described by Whyte et al. (2012).

4.3 Differences in discipline

A number of professional bodies internationally have produced guidance documents for their membership. Examples of these include the RICS in the UK, the Norwegian Home Builder's Association, and ASHRAE and the Associated General Contractors of America in the US. Each of these organisations has taken a different approach to how they advise their members on BIM implementation, and in the level of definition provided to their discipline of roles and responsibilities. The ASHRAE guide, for example, is an introductory document which is more of a deliberation on the changes that BIM introduces to practice, rather than guidance on how to achieve it. Some "first steps" are articulated, including the advice around roles that suggests the appointment of a *BIM champion*, and the need for a skills inventory and training provision to ensure all staff have an appropriate level of understanding of BIM processes (ASHRAE, 2009). The Norwegian Home Builders'

Association's BIM manual, in contrast, is a detailed set of implementation advice that takes a much more prescriptive approach (BoligBIM, 2012). Checklists are provided for the activities of the *Planning manager / BIM coordinator*, as well as for traditional project roles operating in a BIM environment.

Almost all of the guides included in this review consider the BIM specialist roles required for the design side of the process. A smaller proportion addresses the needs of the construction stage. Very few consider BIM roles in the operation and maintenance of a facility. The differences in critical risk factors in BIM projects identified by Chien et al. (2014) suggest that although design and construction teams may both include BIM specialists in roles with similar titles, their areas of concern will be slightly different, with the design side more concerned with BIM standards as a critical risk factor, and the construction team more concerned with interoperability and management processes. Ahn et al. (2015) provides case studies of four construction organisations in which the BIM roles align slightly differently from those described from the design team side. The BIM manager operates as an organisation-level responsibility and handles implementation and software, whereas the BIM coordinator takes the project-level BIM role, which involves interaction with the specialty contractors and coordination of the model. Many of the roles and tasks listed in the BIM guides are generic in nature, and do not clearly articulate these different areas of interest.

A further complexity is the use of outsourced expertise to perform BIM project and organisational functions. However, this is not linked to discipline, but is an approach used by a range of parties in BIM projects (Papadonikolaki et al., 2017). Outsourcing includes the use of third-party providers or of contracting particular BIM functions to other parties within the existing project team. Although the BIM roles in these cases will reside with different organisations, the functions and requirements of the various roles are still the same for the project as a whole, and are managed by specific contractual arrangements. None of the BIM guides reviewed explicitly identify outsourcing as a factor in relation to role definitions.

4.4 Diversity and divergence

In the USA particularly, the development of a large number and variety of BIM guides has resulted in diversity rather than standardisation. Many State governments and other authorities have established BIM guides, to support design and construction teams producing buildings where they are the client. Many of these have mandated BIM use on their projects, and so the guides tend to be prescriptive in approach. This client-specific focus has resulted in a proliferation of client guides, with often several different guides in effect within a single state. In New York City, for example, the Department of Design and Construction has published a BIM Guidelines document, specifically for use in their own projects but with the stated aim of standardising the approach to BIM taken by any public agency procuring buildings in New York City (NYC-DDC, 2012). However, the Dormitory Authority of the State of New York (DASNY) also stipulates a BIM process, as does the Port Authority of New York & New Jersey, and the New York City Schools Construction Authority. Each of these takes different approaches to defining BIM processes, and the level of definition of BIM roles is quite diverse, ranging from the brief description in the DASNY Guide of *Design Professional*, which is used to refer to the team member in charge of managing the coordination of the 3D Model in each discipline, through to the more detailed role descriptions of the *BIM Manager* and *Discipline Trade BIM coordinators*; and the *BIM Lead Coordinator*, *BIM coordinators* and *BIM Users*, in the New York DDC BIM Guidelines and the Port Authority of NY & NJ, respectively. This level of repetition and overlap is evident across a wide range of jurisdictions in the USA, and reflects the decentralized nature of standards development in that country, as well as the many levels of government across national, state and local authorities.

5 CONCLUSIONS

The most obvious conclusion from this review of specialist BIM roles is that while there are a large number of BIM guides and standards, there is little standardisation. A plethora of different labels, terms and job titles are evident across the many documents available. Although many of the documents stem from common sources, the coordination of project roles across the different guidelines is limited. Multiple interpretations of the same roles and responsibility sets are evident, depending on the guidelines followed in each case. Nonetheless, despite this variety of naming and labelling, the roles defined generally fall into two project roles and two organizational roles—project BIM manager (or information manager) and BIM coordinator as project roles, and internal BIM manager and BIM modeller in the organizational roles. However, there are overlaps in many cases between how the roles are referred to and how they are defined, which may cause confusion for both clients and project teams when establishing project protocols and employing appropriate personnel.

A number of the BIM guides reviewed were found to include organizational roles as well as project roles in the descriptions or prescriptions of tasks and activities. This raises concern about the intention and scope of the BIM guides which do this. In many cases, these are client-prescribed documents that seek to establish standard approaches to their projects. However, where attention is given to internal BIM roles within project organisations, the clients are effectively attempting to mandate a particular allocation of responsibilities even beyond the project environment. Conversely, it is interesting to note that many of these client-driven BIM guides only specify roles and responsibilities in the project team, and neglect to address how the client-side organisation will be managed for the BIM context, either during the design and construction phases of a project, or in the transition to operation and management of the facility.

Both of these issues are particularly evident in the USA, where a wide variety of individual organisations have created their own BIM guides for use on their projects. Although these are essentially the same across most of the documents reviewed, each organisation introduces minor—or occasionally significant—differences. As a consequence, problems may arise if project teams see a document that is largely similar to one they have worked with previously, and mistakenly assume that the systems align with their previous experience. The client-by-client approach evident in the USA is in contrast with many other countries which have taken a national approach in defining an overall national BIM standard for use across any BIM project. Such a standard provides a general structure for BIM projects, including role definitions in the context of information frameworks and wider project requirements. This means that when projects are undertaken, the BIM execution plan (BIM management plan/ BIM protocol) is individualised for the client and the project team, but is based on a standard pattern of BIM practice and roles. This allows for a framework that responds to specific project needs, but does not impose a complete change of requirements based on what the client has previously defined. As the market for BIM projects increases, this uniformity is likely to improve, with greater awareness of the skills and responsibilities of BIM specialists developing along with increased uptake of the technology and processes. The development of a unified framework for BIM guides, as proposed by buildingSMART, could be useful to avoid repetition of effort across national and local levels. However, this approach needs careful attention so that it avoids creating a façade of consistency which may mask important differences in practice, as outlined above.

Overall, this review highlights that a considerable part of the problem of unifying BIM implementation lies in semantics, rather than technology gaps. Surveys and case studies indicate that, to a large extent, the required tools and skills for successful BIM adoption already exist in industry. However, the adoption of BIM and increased drive for collaboration brings a change in focus and a much greater requirement for alignment in practice, and in how practice is described. Historically, the wider construction industry is made up of individuals and organizations working independently, and often esoterically. The advent of BIM requires that individualized company practices, and the descriptions and definitions of associated roles and relationships, move to a higher degree of consistency.

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Appendix A – BIM Guides and Handbooks

Organisation	Name	Date	Country	Developer type	Notes on document purpose	Notes on roles
ADEB-VBA BIM Work Group (Denis, F. et al.)	Building Information Modelling – Belgian Guide for the Construction Industry	2015	Belgium	Industry collaboration (Industry working group)	"This document and its annexes present a "generic protocol" as well as general rules and fact sheets allowing the stakeholders to define the collaboration rules and thus, optimize the working process." (p7)	Sets out roles and responsibilities for owner's representative (*BIM process manager*) and other stakeholders (*BIM discipline managers*) but defines BIM roles as adjunct to traditional roles.
AEC (UK)	AEC (UK) BIM Technology Protocol - version 2.1.1	2015	United Kingdom	Industry collaboration (Industry working group)	"… builds on the frameworks defined by the UK (and relevant International) protocols, specifications and documents …as well as existing, proven internal company procedures to: provide consistent platform-independent guidance for implementation and use of project BIM technologies." (p6)	Does not provide a fixed title and job description but identifies the tasks to be undertaken under Strategic, Management and Production roles. Lists nominal roles of *BIM Management (Strategic), Coordination (Management)* and *Modeller / Author (Production).*
American Institute of Architects (AIA)	Guide, Instructions and Commentary to the 2013 AIA Digital Practice Documents	2013	USA	Industry body	"The primary purpose of E203–2013 is to initiate, at the outset of a project, a substantive discussion about the extent to which Digital Data and BIM will be utilized, and how Digital Data and models can be used and relied upon. Once a general understanding is reached, the project participants use E203–2013 to document the agreed upon expectations regarding scope and anticipated Authorized Uses of Digital Data and BIM… This guide is intended to provide an in-depth look at this set of Digital Practice documents, and to provide guidance on how the documents are intended to be used" (p2)	Briefly describes roles related to *Digital data management, Model management,* but in general states that roles and responsibilities must be established for each project
The American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE)	An Introduction to Building Information Modeling (BIM): A Guide for ASHRAE Members	2009	USA	Industry body	"… identifies the current state-of-the-art of the industry with respect to software applications and related protocols, and provides additional resources and suggested reading material for members planning a transition to BIM." (p3)	Does not specify roles but notes the need for a skills inventory and training provision to ensure all staff have an appropriate level of BIM understanding; suggests *BIM champion* role.
The Associated General Contractors of America (AGC)	The Contractor's Guide to BIM—Edition 2	2010	USA	Industry body	"We hope that this document helps more contractors to understand and participate in the use of these tools and better prepares them for this trend with the promise of revolutionizing our industry" (p. vii)	Roles identified include *Information Manager, Model coordinator, 3D modeling technicians;* detailed list of tasks and activities but they are not allocated to roles.
Building and Construction Authority (BCA)	Singapore BIM Guide Version 2	2012	Singapore	Government agency	"… aims to outline the various possible deliverables, processes and personnel / professionals involved when Building Information Modelling (BIM) is being used in a construction project. Users can use the Guide to clarify the roles and responsibilities of project members when using BIM in a construction project. The roles and responsibilities are then captured in a BIM Execution Plan, to be agreed between the Employer and project members." (p1)	Strongly focused on defining roles and responsibilities throughout a BIM project; identifies core roles of *Project BIM Manager, BIM Coordinator for Consultant, BIM Coordinator for Contractor.*
BuildingSMART Finland	Common BIM Requirement 2012, Series 11: Management of a BIM project	2012	Finland	Industry collaboration (Industry body)	"The need for these requirements arises from the rapidly growing use of building information modeling in the construction industry. During all phases of a construction project, the parties to the project have a need to define more precisely than before what is being modeled and how the modeling is done" (Foreword)	Describes in some detail the design team roles of *BIM coordinator* and *Design discipline-based persons in charge*.
Canada BIM Council (CanBIM)	AEC(CAN) BIM Protocol	2014	Canada	Industry collaboration (Industry body)	"This document intends to provide the beginnings of a Canadian based compliant, platform independent protocol for designers BIM authoring tools based on internationally recognized standards and adapted only where required to meet the Canadian AEC industry needs." (p6)	Defines *BIM Manager* as a cross-platform professional responsible for model management, but does not specify the role.
CIC Research Group, Pennsylvania State University (CIC Penn State)	BIM Project Execution Planning Guide and Templates - Version 2.0	2011	USA	Research group (with industry collaboration)	"This Guide provides a structured procedure… for creating and implementing a BIM Project Execution Plan." (p.i)	Does not define roles but provides a structure for doing so within a project. Mentions *BIM Manager* involvement in the process but does not specify the role.
College of the Desert (CoD)	BIM GUIDE Protocols and Project Execution Plan	2011	USA (California)	Client (Educational institute)	"This guide will cover the overall process of developing a BIM project workflow and the basic understanding of College of the Desert's standard." (p4)	Provides outline of responsibilities for each stakeholder, including owner's representative.
Construction Industry Council (CIC)	Building Information Model (BIM) Protocol	2013	United Kingdom	Industry collaboration (Industry body)	"The Protocol identifies the Building Information Models that are required to be produced by members of the Project Team and puts into place specific obligations, liabilities and associated limitations on the use of the models." (p.iv)	Specifies role of *Information Manager* (fully documented in a separate publication *Outline Scope of Services for the Role of Information Management*)
The Construction Users Roundtable (CURT)	BIM Implementation: An Owner's Guide to Getting Started	2010	USA	Client (Industry body)	"The booklet is offered as an informational publication only. CURT intends only to synthesize current thought and trends concerning the topic." (pii)	Describes the need for BIM skills and training but does not define specific roles.
CRC Construction Innovation	National Guidelines for Digital Modelling	2009	Australia	Research group	"The purpose of these guidelines is to assist in and promote the adoption of BIM technologies in the Australian building and construction industry, and try to avoid the uncertainty and disparate approaches that created inefficiencies with the implementation of 2D CAD over the past three decades." (p5)	Provides descriptions of skill sets required by *modellers, discipline model managers, project model manager* and *information model manager.*
Department of Defense Military Health System	MHS Facility Life Cycle Management (FLCM) Building Information Modeling (BIM)	2014	USA	Client (Government department)	"The primary function of this document is to ensure coordinated BIM standards for the MHS with a FLCM perspective." (p1)	Sets out activities required from *Design and Construction Agents* with regard to BIM, but does not specify particular roles.

(DoD-MHS)	Minimum Requirements					
Dormitory Authority of the State of New York (DASNY)	Building Information Model (BIM) Standards Manual	2013	USA (New York)	Client (Local body)	"…describes the processes, procedures, and requirements that should be followed for the preparation and submission of BIM on all projects." (p4)	Locates responsibility for BIM with *Design Professionals* but does not define roles in detail
European Union (EU BIM)	Handbook for the introduction of Building Information Modelling by the European Public Sector	2017	Europe (European Commission)	Client (Public works)	"The purpose of this handbook is to reach for this prize by encouraging the wider introduction of BIM by the European public sector as a strategic enabler; and to adopt an aligned framework for its introduction into the built environment and construction sector" (p4)	Does not identify specific roles, but discusses the need for clarity of responsibility, authority and scope of information management roles.
Fermi National Accelerator Laboratory - Facilities Engineering Services Section (Fermilab FESS)	Building Information Modeling (BIM) Guide	2015	USA	Client (Research institute)	"…provides a compilation of the FESS/Engineering policies and procedures specific to the utilization of in-house projects and projects developed by outside A/E Consultants. This BIM Guide provides guidance for the A/E Consultant services and is intended as a supplement to the A/E subcontract." (p.ii)	Sets out requirements and responsibilities for *Design Team BIM Manager*, describes activities of the *BIM collaboration team* and notes the need to define responsibilities for a *model manager from each design discipline.*
Georgia Institute of Technology (Georgia Tech)	Georgia Tech BIM Requirements & Guidelines for Architects, Engineers and Contractors	2016	USA (Georgia)	Client (Educational institute)	"The intent of these requirements is to create a prescriptive framework with which Building Information Modeling (BIM) enabled teams will coordinate with Georgia Tech, the Board of Regents, the Georgia State Finance & Investment Commission, and other applicable groups on requirements to being BIM compliant." (p2)	Defines a set of BIM proficiencies, and sets out BIM requirements that the *Design Team* must meet but does not define specific roles; requires roles to be defined in the BIM Execution Plan. BIM Execution Plan template lists responsibilities of the *model manager.*
Georgia State Financing and Investment Commission (GSFIC)	GSFIC BIM Guide	2013	USA (Georgia)	Client (State government)	"… describes the standards that all BIMs for GSFIC construction projects shall abide by." (p4)	Appendix F (BIM Execution Plan) lists responsibilities of the *model manager* from each party in the project.
Hong Kong Housing Authority	Building Information Modelling (BIM) User Guide for Development and Construction Division of Hong Kong Housing Authority	2009	Hong Kong	Client (Government department)	"Standards and guidelines are important for effective model building, electronic file exchange, data and information compatibility, people communication, not only for in-house staff, but also for our consultants and contractors." (p4)	Provides brief outline of responsibility of *project BIM coordinator* and notes other project team members.
Hong Kong Institute of Building Information Modelling (HKIBIM)	BIM Project Specification Rev 3.0	2011	Hong Kong	Industry collaboration (Industry body)	"… establishes a process for adopting BIM on building projects. Clients, project managers, architects, engineers, quantity surveyors, contractors, manufacturers and facility managers can produce a BIM Project Specification with reference to this document." (p3)	Defines roles of *BIM Project Manager* and *BIM modellers*
Indiana University	BIM Guidelines & Standards for Architects, Engineers, and Contractors	2015	USA (Indiana)	Client (Educational institute)	"Required on all construction (new and addition/alteration) with total project funding of $5M or greater, required on any project that involves a portion of a facility that has already been delivered with a BIM requirement. Encouraged on all other projects." (p1)	Defines a set of BIM proficiencies, and sets out BIM requirements that the *Design Team* must meet but does not define specific roles; requires roles to be defined in the BIM Execution Plan. BIM Execution Plan template lists responsibilities of the *model manager*.
Los Angeles Community College Districts (LACCD)	LACCD Building Information Modeling Standards Version 4.2 Design-Bid-Build	2016	USA (California)	Client (Educational institute)	"…developed to define a process and establish requirements, procedures and protocol for the utilization of BIM in the various stages of our projects." (p1) Similar but distinct document provided for Design-Build projects.	Defines BIM workflow including roles and collaboration procedures, in particular a *BIM Facilitator* for the design team, *Discipline BIM Lead Modelers* for other participants, and a *VDC manager* for the construction team.
Massachusetts Port Authority (Massport)	BIM Guidelines for Vertical and Horizontal Construction	2015	USA (Massachusetts)	Client (Public authority – transport)	"…for design, construction, civil, and facilities professionals working on all MPA projects. It specifies the guidelines and project model standards to be used within a BIM/Lean collaboration environment. The goal of the guide is to assure consistency in processes and BIM development from MPA's various service providers across multiple types of projects." (p1)	Provides detailed descriptions of key roles including *Prime Design BIM Manager, Construction BIM Manager, BIM Discipline Coordinators* and *Trade BIM Coordinators*. Also details the expected collaboration environment. Specifies client-side roles including the *Design Technologies Integration Group (DTIG) BIM Manager* and the *client's Project Manager*.
NATSPEC	NATSPEC National BIM Guide	2016	Australia	National standard	"…to assist clients, consultants and stakeholders to clarify their BIM requirements in a nationally consistent manner. This will reduce confusion and duplication of effort." (p1)	Gives detailed description of collaboration processes and project roles, including *Design Team BIM Manager, Technical or Trade Lead BIM Coordinators* and *Construction BIM Manager*.
New York City Department of Design and Construction (NYC-DDC)	BIM Guidelines	2012	USA (New York)	Client (Local body)	"… provides guidelines for the consistent development and use of BIM across multiple building types and for a wide range of municipal agencies. …The guide is intended to ensure uniformity in the use of BIM for all New York City Public Buildings projects." (p 6-7)	Lists minimum responsibilities *for BIM manager* and *Discipline trade coordinator* roles.
New York City School Construction Authority (NYC-SCA)	Building Information Modeling Guidelines and Standards for Architects and Engineers	2014	USA (New York)	Client (Public authority – education)	"…describes the processes, procedures, and requirements that shall be followed for the preparation and submission of BIM Models for SCA Capacity (Line) Projects (new building and additions), as well as to produce, release, and receive data in a consistent format so to maintain an efficient exchange of data between disciplines and the compatibility of each disciplines' Model(s)." (p1)	Defines consultants' BIM roles with a design team *Project Model Manager* and a *Project Model Leader* for each discipline.
New Zealand BIM Acceleration Committee	New Zealand BIM Handbook 2nd Edition	2016	New Zealand	Industry collaboration (Industry body)	"Its primary focus is on the design and construction phases of the building life cycle. To realise the maximum benefits of BIM, the information/data created during the design and construction phases must be fed into facilities and asset management systems and used throughout its life cycle." (p5)	Provides some detail on required tasks and briefly describes roles of *BIM Manager* and *Discipline BIM Coordinators.*
Norwegian Home Builders' Association (BoligBIM)	BIM User Manual Version 2.0.	2012	Norway	Industry body	"The manual delves into the different parts of "working BIM". It seeks to give practical advice associated with the	Provides detailed checklists of tasks and activities based around traditional roles; defines *BIM Co-ordinator* as key BIM role.

					processes, modelling and utilisation of the model itself." (p4)	
Ohio State University	Building Information Modeling (BIM) Project Delivery Standards Version 2.0	2017	USA (Ohio)	Client (Educational institute)	"…a reference manual for Design and Construct project team members to understand what relevant 3D geometry and data shall be delivered." (p4)	Provides detailed descriptions of BIM roles and responsibilities, including client roles of *Project Manager* and *Model Manager* as well as *Design and Construct Model Managers*, and *Discipline Model Managers*,
Port Authority of NY & NJ (PANYNJ)	E/A Design Division BIM Standard Manual	2017	USA (New York & New Jersey)	Client (Local authority – transport)	"… describes the processes and procedures required for the preparation and submission of BIM Models for Port Authority of NY & NJ projects." (p1)	Defines various project team roles including *BIM Lead Coordinator, BIM Discipline Coordinators, BIM Users.* It also defines the role and responsibilities of the *CAD\BIM Support Group* on the client/facilities management side.
State of Ohio Department of Administrative Services (Ohio DAS)	State of Ohio Building Information Modeling Protocol	No date	USA (Ohio)	Client (State government)	"…provides general guidance that ensures that building owners know what they should include in their requests for qualifications, agreements, bidding requirements, contracts, and other documents affected by this new medium and process." (p2)	Locates the role of the *model manager* with the architect, unless specifically designated otherwise.
State of Tennessee Office of the State Architect (TN OSA)	Building Information Modeling Standards (BIMs) Version 1.1	2015	USA (Tennessee)	Client (State government)	"…for the consistent development and management of BIM on state building projects" (p1)	Specifies BIM roles for the design team, including *BIM Manager* and *BIM Coordinators.*
University of Southern California (USC)	Building Information Modeling (BIM) Guidelines Version 1.6	2012	USA (California)	Client (Educational institute)	"… defines the Design and Construction scope of work and deliverables for using Building Information Modeling (BIM) on new USC construction projects, major renovations and other projects as required by USC…" (p5)	Defines USC BIM involvement and responsibilities as the owner, as well as the role of the *Design BIM Facilitator/BIM Engineer.*
U.S. General Services Administration (GSA)	GSA Building Information Modeling Guide	2007	USA	Client (Government department)	"…an introductory text serving as a foundation and common starting point to support BIM technology in general and individual BIM applications in specific. As an overview, this Series is an over-arching and executive text to be used as a reference guide for GSA members and associates when determining what BIM applications would be appropriate for their specific project, and throughout the adoption and application of the selected technology." (Introduction p.v)	Notes that defining roles and responsibilities of team members is an important requirement in establishing a scope of services for a BIM project, but does not provide any definitions itself.
U.S. Department of Veterans Affairs (VA)	VA BIM Guide v1	2010	USA	Client (Government department)	"…moving both the organization and its service providers to BIM as effectively and efficiently as possible, and to integrating BIM process requirements and Integrated Project Delivery (IPD) methodologies into its delivery requirements." (p4)	Defines a range of BIM project roles in some detail, including *Design Team Project Manager, Design Team BIM Manager; Technical Discipline Lead BIM Coordinators (Design and Trade), Construction BIM manager*

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