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Edited By:
Bimal Kumar
Farzad Pour Rahimian
David Greenwood
Timo Hartmann



Northumbria
University
Newcastle
United Kingdom

Professional pathways in BIM and digital construction

Kathryn Davies
Unitec Institute of Technology, Auckland, New Zealand
email: kdavies@unitec.ac.nz

Abstract

Increasing complexity in construction projects, together with widespread availability of technology applicable to many aspects of the construction industry, is driving demand for greater integration of information and communication technologies. The resulting transformations in technology and process require associated changes in professional roles and relationships in a digital context. Development of any professional role is a dynamic process, with no determined transition point when a profession can be considered to exist or not. Instead there is a cycle of development as skills, expectations, and specialisations evolve and are modified to suit the changing environment. This concept of the professional life cycle forms the framework for an exploration of changes in roles and practice in the context of digital construction. While traditional construction industry functions and responsibilities take place within well-established professional roles, a multiplicity of views has emerged regarding the status of roles which encompass digital construction. This paper uses practitioner narratives to explore aspects of technology adoption and implementation that are having an impact on the way such careers develop. Interviewees were selected who identified themselves, or were identified by their peers, as BIM specialists; many of these individuals also described involvement in broader digital construction initiatives. Taking BIM practice as a starting point, career factors identified by these practitioners are connected to a wider perspective of digital maturity in the industry, and to the concept of the professional life cycle: as digital practice continues to change and mature, the career possibilities and needs within the field also evolve. The findings show that the introduction of digital construction has progressed to a point where BIM is now common across many sectors of the AEC industry, and a range of other digital applications are becoming increasingly mainstream. This move to digital construction in many cases takes place within traditional roles that have expanded or changed to suit the changed environment. In other cases, new roles have emerged to fulfil specific needs for digital management of information, process and strategy in projects and organisations. However, even with this increasing involvement of specialist practitioners in BIM and wider industry practice, the status of digital construction with regard to professional roles is still not established. Many practitioners expressed feelings of insecurity regarding their current position, suggesting that work to provide greater clarity around career progression is necessary so that practitioners can be assured that digital skills have value and recognition.

Keywords: digital construction, professional identity, BIM roles, professionalisation,

1. Introduction

Development of professional roles is a dynamic process; there is no single moment when a profession can be considered to come into existence. Instead, there is a cycle of development, as skills, expectations, and specialisations evolve and are modified to suit the changing environment. This is evident in the multiplicity of views that has developed regarding the status of BIM as a professional role (Bosch-Sijtsema et al., 2019). As the wider context of digital construction develops, similar uncertainty exists in the status of practitioners specialising in other aspects of digital practice.

Roles in digital construction currently have little uniformity in titles or expectations. BIM is the most established element of digital construction, but the definition of industry standards and norms is still ongoing. Individualised practice from early BIM development has led to diverse descriptions of

BIM roles and associated practices, and BIM handbooks and guidelines both within national markets and internationally contain overlaps and discrepancies in how various roles are named and defined (Davies et al., 2017a). The lack of clarity regarding BIM professional roles and opportunities has been identified as a contributing factor in the shortage of skilled practitioners. Many universities are now attempting to address the skills shortage by introducing programmes to develop BIM skills in their graduates. However, education and training providers require definition of professional expectations and standards so that their offerings are suitable to meet industry needs. Practitioners currently in the industry need similar guidance enable them to upskill themselves into BIM positions. Equally, without such information, graduates and current practitioners are likely to be less interested in pursuing opportunities in BIM and digital construction as the direction and outcomes are unknown.

Nonetheless, while this may lead to misunderstandings about areas of responsibility and authority on project teams, there is still an overall consensus regarding which BIM roles are required at an organisational and project level. Currently, and for at least the near future, BIM practice necessitates the introduction of specialist practitioners, and also requires traditional practitioners to become involved in digital construction, taking them beyond their established positions. Development in other aspects of digital practice is now gaining pace in the construction industry, as BIM becomes a springboard for the adoption of other digital innovations (Rogers, 2019). Notable technologies include augmented and virtual reality, robotics, 3D printing, digital fabrication, laser scanning, photogrammetry, Internet of Things, digital twins and the many possibilities of artificial intelligence. However, despite rapid change and the proliferation of opportunity in this area, the industry appears still unable to resolve the names and types of technologies included under the “digital construction” banner, let alone the roles and practices that they entail. Thus, the routes practitioners have taken in establishing roles in BIM serve as an example of the possible evolution of other digital technologies, in terms of establishing digital construction as a professional pathway.

BIM practice is presented within a life cycle perspective that shows a continuum of development, beginning with early digital innovations, evolving through BIM adoption and connecting to other current and future digital construction technologies. BIM practitioners’ views are presented regarding the development of a professional identity through BIM practice. Related issues are then presented around different ways that BIM implementation and identity interact with the decision to adopt a BIM career. The subsequent discussion considers more overarching aspects of BIM practice which may influence practitioners’ decision to embrace or reject BIM as a career choice, including the potential development of roles within the professional life cycle framework.

2. Method

The following analysis is based on interviews carried out in New Zealand, Australia, The Netherlands, the United Kingdom and the United States, with 73 BIM specialists from a variety of roles, disciplines and company types. Participants either had a formal job description involving BIM (e.g., BIM manager, BIM coordinator) or were identified by their peers as the BIM champion or BIM leader in their company. Companies represented were equally diverse, and ranged from global multi-disciplinary consultancies which have been identified as world leaders for providing digital services in construction, through to small independent practices employing just a few people and finding their way into BIM adoption.

Loosely structured interviews were used to explore the impact of BIM on professional roles and relationships. This interview format provides a framework so that specific issues can be addressed, but has the flexibility to allow in-depth exploration of the interviewees’ varied opinions and experiences (Alvesson, 2011). Clandinin and Connelly (2000) argue that such a narrative approach is pertinent to study experience in a professional context, since narrative is central to how practitioners reflect on experience and relate it to practice.

The interview data was collected over the period 2013-2015. Although this means that aspects of BIM practice reflected on by the participants are not necessarily still current, the focus of this paper is not on the state of BIM but on how professional identity and roles have developed for BIM practitioners. Consequently, the perspectives from an earlier stage of BIM development are appropriate for application to a discussion of emerging roles related to digital construction. Several studies of identity

have previously been conducted within the construction environment. Gluch (2009) explored the identity of environmental professionals in a construction project context, and called for further research on the emergence of new professional roles in construction and their relationship with traditional roles and professional expertise. Identity of site-based construction workers has been examined from the perspective of quality (Styhre, 2012) and safety (Andersen et al., 2015), both studies concluding that practitioners' identity can be influential in shaping organisational and project outcomes in relation to practice. Other studies exploring the professional identities of project managers (Hodgson & Paton, 2016) and construction managers (Brown & Phua, 2011) also suggest that identity studies provide insights into practice, and argue the need for further research into identity work in professions in relation to the potentially conflicting demands of social, organisational and industry expectations. Based on these antecedents, the use of interview data with a focus on identity to explore the development of professional roles in digital construction is appropriate.

Thematic analysis was used as the primary approach for analysis of the interview data, using the methodology outlined by Braun and Clarke (2006). Thematic analysis involves "searching across a data set ...to find repeated patterns of meaning" (Braun & Clarke, 2006; p86), and involves an inductive coding process to identify and refine themes. The preliminary activity involved transcribing and editing interview recordings, followed by structural coding, based on the research questions and interview framework, in order to assign codes to features within the data that were related to the research questions and sub-questions (Saldaña, 2013). Several iterations through the data were required to code and collate the entire data, in a process that progressively served to develop a research 'storyline' (Stuckey, 2015). Once codes had been assigned to all of the data, each category was revisited, and broader patterns of action and interaction were identified. At this stage, the themes were reviewed to ensure they were clear and distinctive, and the connection to the storyline was established. This required a further iterative process of revisiting themes and reviewing in the wider context of the full data set. Re-coding and revising data was then carried out to refine the themes. Through this process, practitioner identity was established as one of the central themes. Representative quotes from the interviews have been used to illustrate the experiences and opinions expressed by participants, in order to connect the data into a theorised storyline (Golden-Biddle & Locke 2007).

3. The professional life cycle

A professional life cycle is concerned with the changes and developments in professional roles related to an innovation, that lead to the institution of a new professional service or practice. Professional roles develop in the wider industry context beyond both individual and organisational levels, and must balance the different needs and pressures of other factors such as the requirements of project partners and clients, and competition and relationships with other practitioners. A life cycle model of a professional service was proposed by Lawrence et al. (2016), in the context of LEED consulting roles. This model has been applied here to BIM and digital construction, and the changes that are taking place within the professional community as they become an established part of the industry.

A life cycle view of professionalism views BIM maturity from the perspective of the developing professional role of the BIM practitioner. It presents a progression path that is driven by the tension between customisation and standardisation. Lawrence et al. (2016) structures the life cycle into four stages: innovation, validation, diffusion and commodification. Service delivery and expectations move through each stage as practice progresses. Figure 1 illustrates the life cycle model of the BIM and digital construction professional environment, adapted from Lawrence et al. (2016).

At the very beginning of the life cycle, innovation is driven by experimentation and unique solutions, and is dependent on individual creativity. In the BIM environment, this has produced a multiplicity of adoption and implementation approaches as individuals have become enthused about BIM's potential and have introduced it into their company's practices. These individuals have often come from technical backgrounds; consequently, much of early BIM development focused on technical and process implications of BIM (Miettinen & Paavola, 2014). More strategic views of BIM adoption tend to occur at later stages of the professional life cycle, and have broader ramifications for the associated roles and the ways in which practitioners operate in the evolving BIM environment. BIM

can be used to deliver benefits without necessarily involving users in collaborative practice with other project participants (Davies et al., 2017b), but much of the advantage that can be derived from BIM

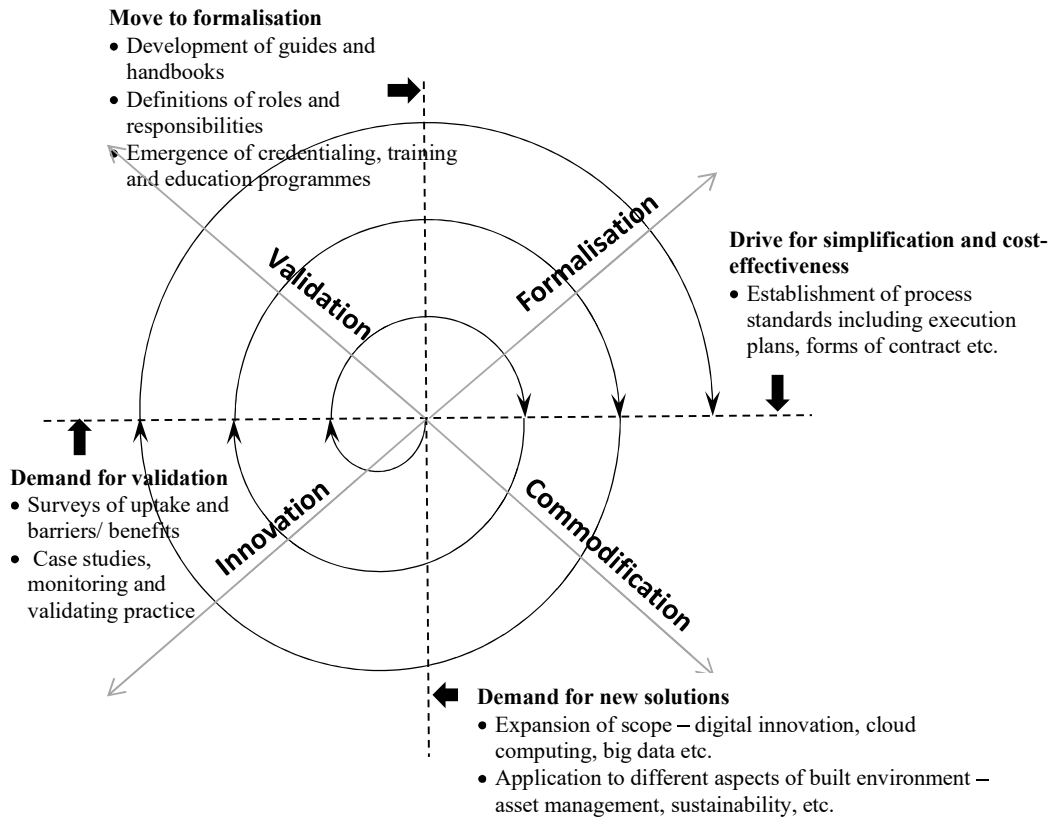


Figure 1 Life cycle model of digital construction as a professional service (after Lawrence et al., 2016)

adoption lies in the move to more collaborative project environments (Poirier et al., 2016). This transition requires further innovation by practitioners, to promote and manage the change in practice.

The second stage of the professional life cycle, validation, occurs when initial innovations draw wider attention, and more emphasis is then given to measuring and documenting outcomes, and to validating practice to ensure skills and knowledge are evaluated and monitored. Reported benefits from initial innovators in BIM increased demand across the industry, as outcomes reported for early-stage BIM development were generally highly positive. Individual companies sought to customise the successes of others for use in their own circumstances. This led to an increased drive for technical expertise, and high demand for skilled staff. Validation in the BIM context started at the relatively low level of establishing benefits and requirements of BIM, resulting in an initial validation stage based extensively on surveys and reviews of BIM uptake and benefits and barriers, and debate over roles required.

In the third stage of the life cycle, formalisation, the industry calls for formalised education and accreditation processes as the innovation takes greater hold and the practice becomes established. The many BIM guides, handbooks and other standards and specifications now available are evidence of the formalisation effort that has taken place in BIM. Much of this is to do with BIM practice rather than the professional roles involved, but the frameworks and standards also transfer into more defined requirements for skills and tasks of practitioners. Credentials for BIM practitioners have also started to emerge alongside expectations for training and education options. The advantage of this formalisation process is that practitioners have access to a foundation of support material such as case studies and standards to build their practice on. This allows them to establish baseline expectations quickly. As availability and use of these documents and the associated professional standards and credentials become more widely adopted, they feed back into validation processes at another stage of the cycle.

Once formalisation has been addressed, the final stage of the professional life cycle comes into play. Commodification leads to the basic activities involved in the profession becoming standard practice, through which they are simplified and regulated. This means that practitioners can follow practice guidelines and focus on straightforward implementation, rather than having to develop their own approaches. Those with greater knowledge are then freed up to develop innovation, for example expanding the scope of BIM to incorporate other industry innovations or interests, or moving practice into new areas of application, and thus moving the cycle through another iteration.

In this way, the professional life cycle model provides a framework for monitoring and directing progress in the development of BIM as a professional role. By using the life cycle model as an overview of the professional continuum, the interests of practitioners can be matched to appropriate roles as the stages progress. When disproportionate emphasis is placed on one stage of the cycle, as currently appears to be the case with innovation, it is difficult for the role to mature.

4. Professional identity

Identity work is an ongoing process of reflection and sensemaking that takes place at multiple levels (Lepisto et al., 2015). Expression of identity in a work environment is primarily concerned with how an individual prioritises their knowledge and skill within their work activities. Identity work in a professional context is relational, in that it commonly takes place in response to pressure and expectations of others; for example, direction from managers, examples provided by industry or professional leaders or other role-models, or defined models of behaviour established by professional memberships. Professionals must negotiate the value and importance of these various relationships with respect to the developing identity, in order to establish legitimacy in the role that they are claiming.

The BIM practitioners interviewed often had considerable latitude in determining both their own role and how they enacted BIM practice within organisations and project teams. Because they were appointed or moved into a new role within an organisation that often had little or no experience of BIM practice, they frequently had a significant influence on setting the direction of BIM practice within the organisation. Many noted that they were employed in their current role for the specific purpose of implementing BIM for their company. Even where an organisation already had a BIM framework in place, it was common for interviewees to state that they had no specific job description, and often that they did not have a formal position in the company structure or hierarchy. Individuals were in many cases responsible for determining the scope and requirements of their own position.

My task isn't on paper what I should do, so I just make things myself. I have to make my own function, I still have to make it, my job description. I have to figure out for myself what it is.

Interview 43—The Netherlands, Construction company

As a result, the professional identity of the practitioners had a significant impact both on their own roles and on how BIM and digital construction developed in their practice environment. Two identity frameworks were used to investigate different aspects of this. First, *claimed identity* looked at how practitioners positioned themselves in relation to professional practice, BIM experience and motivation, based on their statements that claimed or rejected views of their identity in relation to BIM. This is related to narratives of how practitioners performed their BIM roles, and how they saw themselves connecting from their professional level with organisational and industry level identities. Second, *performed identity* reveals the different enthusiasms that practitioners bring to their role, and approaches they take to their BIM practice. The performed identity is not simply what people do in a BIM role, but why they do it; the motivation and drivers for their BIM interest and involvement.

4.1. Claimed identity

Not all of the practitioners were comfortable in claiming a BIM practitioner identity, or accepting the 'BIM specialist' label that they had been given by their peers. Although they were associated with BIM, these practitioners either did not see it as part of their professional identity, or were not confident that they have the necessary skill or commitment to claim a BIM practitioner identity. The identity

work for practitioners who refused the BIM identity outright commonly downplayed the BIM component and focused on their discipline role. They often identified very strongly with a traditional industry role, and saw BIM as just one of a range of tools or skills that was useful in achieving their primary goals. Respondents in this category included architects, an architectural draughtsperson, and a quantity surveyor. All agreed that BIM was a central part of how they worked, and that they were interested and engaged in using BIM as well as developing and sharing their BIM knowledge. Despite their level of involvement, however, BIM was not just incidental to their professional identity but was actively rejected in their narratives; they did not consider themselves a “BIM professional.”

Tentative acceptance of the identity came from several practitioners who were interested and willing to develop a BIM identity based on their level of interest and knowledge in BIM, but with the caveat that they weren't ‘really’ involved in BIM. Their identity work asserted the value of BIM to them personally, but ascribed their status as a ‘BIM specialist’ less to their own expertise per se, and more to the slight advantage they held over the general level of ignorance in the wider industry. There was also an element of cautiousness with many practitioners in claiming solo or hybrid BIM use as ‘real BIM’. The low level of BIM knowledge in the industry was both blamed for restricting the use of BIM, and credited for elevating the interviewees, with what they considered their incomplete or insufficient BIM skills, to the status of BIM specialists. Another source of hesitation in claiming BIM identity lay in the lack of definition of BIM roles. Practitioners in many cases observed that their status within their organisation and project teams was unclear, to others and even to themselves.

The roles are not defined very well. It's a very unusual kind of way of working, and it's what you make it as well. You get people screaming at you from some perspectives, and other perspectives are like ‘I don't know what you do, I don't even know why you work here, I don't know what your role is.’ It's probably something that I think sometimes too!

Interview 14—Australia, Multi-disciplinary design practice

Because of this lack of clarity regarding their role, practitioners felt they were open to challenge from colleagues, and unsure of their authority or ability to act. While they may have been willing to accept a professional BIM identity based on their own knowledge and skill, the absence of identity in relation to the organisation and wider industry left them in a tentative position.

More widespread were the practitioners who claimed BIM as part of their professional identity, but who emphasised that it was just one aspect of their role. Peer recognition of a BIM practitioner role was one of the challenges for a number of the participants, who considered that their contribution was often considered secondary, suggesting that “there is sometimes that tendency [to see you as] just the technician” (*Interview 2—NZ, Multi-disciplinary consultancy*), even when their qualifications and experience were equal to those of their peers. Many practitioners in architectural practices were often at pains to make clear that their identity did not lie solely in being a BIM practitioner, but that they had design skills and involvement as well. Similarly, in construction companies, practitioners often emphasised their breadth of experience, to illustrate that they were not ‘just’ BIM practitioners.

I've done lots of engineering stuff, I'm very technical-minded. One of the criticisms of most people in BIM is that they're not, there's not much commercial focus there.

Interview 57—UK, Construction company

A sense of risk was expressed in the narratives of a number of interviewees who balanced BIM identity alongside another professional alignment; a concern that BIM may become a dead-end path rather than offering the prospect of a new career direction. One interviewee described the BIM direction as people having “deviated away from their careers” (*Interview 46—UK, Multi-disciplinary consultancy*), and indicated that in future he could switch back to his previous design-focused role. In this case, despite his successful career and rapid promotion to a senior BIM role, such a comment indicates that ‘BIM practitioner’ is not a core part of his professional identity.

For others, however, the evolving role was not seen as a conflict, but as an opportunity to develop additional skills and add or extend parts of their role that they enjoyed. Being identified as a BIM practitioner, in this mindset, was an opportunity to test out a new professional identity, without having to commit fully to one or the other.

They call me a BIM specialist. It's a big word! Three years ago, the manager asked me to come and work here because they wanted to do BIM. He didn't know what BIM was, but he heard BIM is hot so we had to do BIM. I had a little experience in introducing BIM in an organisation. He asked me, will you do the same here. I'm still a cost engineer. I come from within the projects and I like estimating the cost, just digging deep in the project. But I also like to talk with people, let them know what they're doing right and what they can do better. So I'm also the BIM manager at some projects.

Interview 44—The Netherlands, Cost consultancy

Expressions used to describe this diversification from an intended career path included “another string to my bow” and having “different hats if I want them”. Other interviewees saw it the other way around, and identified that having an architecture or construction background could be ‘a safety net’ to revert back to if their current role turned out to be unnecessary beyond a transitional stage of BIM adoption.

A minority of participants fully accepted a BIM identity, and did not qualify their BIM identity with ‘but’, ‘and’ or ‘almost’. To these individuals, all of their experience and the range of tasks and activities they were involved with did not detract or sit alongside their BIM identity, but contributed to the characteristics of the role they had constructed. In this case, the identity work asserts the practitioners’ holistic professional identity, claiming all the varied aspects of their job as part of the BIM role.

4.2. Performed identity

Narratives in which participants described their expectations, motivations and ambitions in relation to their roles were examined to identify how practitioners articulate their professional identity in relation to performance. Five core types were identified that reveal the different enthusiasms that practitioners bring to their role, and approaches they take to their BIM practice. These types are not fixed or exclusive, and some practitioners described adapting their persona to deliver the outcomes they see as necessary at a particular time. This sense of balancing identity across multiple roles corresponds with the debate from industry over whether BIM generalists are more valuable, given the range of work that BIM practitioners might be expected to carry out, or whether the depth of knowledge required to effectively deliver BIM within a particular discipline means that specialists are necessary (Wu and Issa, 2013). Participants described their roles in terms that include elements of most, if not all, of these identities, but tended to emphasise or express a particular identity type that they feel most closely represents themselves—their personality, aptitude, performance, and preferred ways of working. The identity types are not simply *what* people do in a BIM role, but *why* they do it; the motivation and drivers for their BIM interest and involvement.

The following five types of BIM performance identity were identified from the narratives (with representative quotes in italics):

1. **Implementer** – “*I'm the kind of person who will work it out, and make it work*”; pragmatic, task focused, using BIM to provide value.
2. **Interpreter** – “*I can find out things that are better for another person than he could decide or find out by himself*”; interface between people and technology, translating technology into industry context.
3. **Instructor** – “*There would always be myself falling into a training role to teach them how to do things*”; supporting others in skills development, teaching people how to make better use of BIM.
4. **Inquirer** – “*I'm always looking into why. It's a very important question in my life.*”; not satisfied with following a process, has a need to know all of the angles.
5. **Innovator** – “*A kind of person... that needs to be a couple of steps ahead*”; sees BIM as a stage in an improvement process, more drawn to advancing the industry than to BIM specifically.

Most of the BIM practitioners interviewed came into BIM via a technical orientation, which aligns with the *Implementer* identity. An interest or aptitude for CAD or BIM tools, or for IT and computing more broadly, led to their identification as a technical leader within their company, which often then became a BIM champion role because they knew more about the software and technology process than anyone else. Although this may have led to the technical aspect of their work being overtaken by other

elements of the BIM role, the practical implementation aspect, generally focused around technology, has remained a core element of practice for many, and ‘making things work’ was a central part of their identity narrative. Several practitioners in the implementer type identified that their motivation does not come from using BIM as a tool or technology, but is based more on the appreciation that BIM enables them to contribute in a meaningful way to the final product, i.e., the built environment that results from their efforts. In this sense the implementer role may also have a creative impetus that contributes to the motivation of the practitioners.

It’s one of the things that drives me, that satisfaction of achieving a building, you hear that from a lot of people who have been in the construction industry for a long time, they love driving by a building and saying, ‘I worked on that.’

Interview 70—US, Construction company

For some practitioners, the desire to make things work was not so much about doing it themselves but in enabling others to work more effectively. Practitioners whose BIM identity was more other-centred than self-centred have been labelled *Interpreter*. In an interpreter role, the practitioner sees themselves as a bridge between BIM and those using it. This identity is based on understanding the different and potentially conflicting needs of different project partners or industry parties, and being able to act as a broker to enable BIM adoption and implementation. Practitioners with an interpreter identity often expressed a need for variety and challenge in their role. For these individuals, this came not just from making things work, as for the implementer identity, but from coming up with new approaches or processes that address specific problems that other practitioners may be facing. The work to interpret or interface between users and the necessary technology and processes was commonly underpinned by a desire for improvement, enhancement or simplification of existing practices. Interpreter tends to be a process-focused role, but also contains a strong element of working to develop and upskill other practitioners.

One thing I’ve always had is three or four people, up to 12 people, that I work with, share the basic skills and coach people through things. I’m better at that than independent work... If there’s a problem that needs to be solved, I can solve the problem, say ‘this is how you solve it’, but not necessarily doing the leg work, turning the handle after that... Hence why working with a team works for me because I know where my weaknesses are, so I know the people I need to target to help fill that gap.

Interview 57—UK, Construction company

Where this aspect of sharing skills and knowledge dominated over the problem-solving aspect, the professional identity has been labelled the *Instructor*. The need for BIM practitioners to take a leading role in educating other members of their organisation and supply chain has been identified in the literature (Succar et al., 2013) and is evident in job advertisements for BIM roles (Uhm et al., 2017). Thus it was not unexpected that peer-to-peer teaching, organisational training, and industry coaching and education was noted by almost all participants as a significant component of their role. For some interviewees, however, the instructor role was their motivating purpose as a central element of their BIM practitioner identity. Several noted that they had fallen into informal teaching roles during their studies or in previous positions, and relished the opportunity that BIM provided to continue that work.

For these practitioners, because their enthusiasm for BIM was based around the opportunity to teach others, their personal development in BIM ability was often driven by wanting to understand more about the technology and process in order to teach others more effectively. In some cases, however, the drive to understand all of the various roles and requirements in the BIM environment came more from a personal quest for knowledge; this professional identity has been labelled the *Inquirer*. Very few of the practitioners stepped into well-defined roles or established BIM practice. As a consequence, they had to be largely self-directed in developing their capabilities and finding sources of information to learn from. For practitioners who fit the inquirer type, this opportunity to drive their own learning within an embryonic field was a central attraction of the role. They were often passionate, self-declared ‘BIM evangelists’, who took every opportunity to learn and share their knowledge.

It’s interesting stuff, so you’re driven to learn, driven to talk to people, to meet with different software vendors, to meet with different industry peers, just different, just cross-pollination I suppose, with respect to exposure... I’m the sort of person who, you need to be personally

interested in something for it to be worthwhile, so you want to invest your time and your efforts in it, and then you look for opportunities where you can start.

Interview 15—Australia, Property development and management company

Understanding BIM practice for practitioners in this type is often about developing a better knowledge of wider industry connections and the roles played by others in the BIM process. For some practitioners, however, BIM technology, roles and practice may be seen as a current interest that is just one element of a wider quest for knowledge and new ideas. These have been labelled the *Innovator*. Ahn et al. (2016) identified that BIM experts often go beyond the current implementation role to a more research and development focus to identify potential advancements in practice that could be adopted by their project team or organisation. This was evident in some of the companies with more advanced BIM practice, in that the BIM practitioners interviewed had, in addition to their BIM role, a specific responsibility to identify and evaluate potential applications of new technology that would benefit the company or its clients. As one interviewee noted, this was not necessarily an aspect of BIM practice, but “BIM is the easy term, people understand that”, whereas the role was much broader in scope:

...trying to figure out, what are those next things that are coming down the pipe from industry, what are our competitors doing, what are we doing in the company that need to get bubbled up to the greater good.

Interview 73—USA, Multi-disciplinary consultancy

Specific innovations described by participants included lean construction, supply chain management, big data, use of drones and virtual reality. If the same questions were asked now, just three or four years later, that list is likely to be far more extensive as ideas around digital construction have become more widely disseminated. In this respect, BIM can be seen as an enabler, opening the door to further applications and innovations. Many of the BIM practitioners expressed keen interest in technology as a central driver to their involvement in practice, and so these same people and characteristics can be assumed to be driving the development of roles and practice in digital construction.

5. Identity and practice

Many of the practitioners expressed a feeling of constant struggle to carve out the time required to adequately perform their BIM role. Because they were identified as BIM specialists, they were expected to develop and disseminate BIM skills as well as implement practice standards and processes for appropriate BIM use within their organisation. Set against this was the need for them to be ‘hands-on’ with BIM in project delivery, commonly because of a lack of other staff with the necessary BIM skills. For many, this meant their BIM role was less about management of the virtual project within the BIM framework, which they saw as a priority, and more about producing the deliverables for the physical project which was a priority to other project participants. The necessary reframing of processes and relationships to enable effective BIM use was thus constantly undermined by a lack of resourcing and the prioritisation of traditional project roles over performing a BIM identity. Despite BIM practitioners’ assertions about the value of their strategic and process-centred BIM activities to their organisation and project teams, the cues they received from their environment frequently relegated BIM to a technical delivery role. In such a situation, the practitioner’s BIM identity is threatened by a fundamental misalignment between the individual’s assertion of the importance of BIM and the changes it brings, against existing work practices and the established institutional logic. The overriding influence in the conflict between establishing longer term, more fundamental standards, and immediate project needs, is the established industry norm that project requirements take precedence over other factors (Jacobsson & Linderoth, 2010). This jeopardises the progression necessary for roles to develop through the professional life cycle, to a point where they become more defined and practice becomes embedded.

From the practitioners’ perspective, despite the attractions, a BIM career was seen as an uncertain prospect. Many of the practitioners expressed apprehension that their career trajectory in their organisation was potentially limited because of the path they had taken. Very few senior management positions exist for those with a technical focus, and strategic BIM roles were considered by many to be short-term positions, necessary during the adoption phase of BIM but redundant once BIM practice is

embedded. As a result, most saw their current career path as a dead end. This view mirrors that asserted by Akintola, Venkatachalam & Root (2017), that BIM practitioners are only likely to have a longer-term role as technical support, rather than as a core professional role in organisations and project teams. From this perspective, BIM roles will reduce in importance and scope as BIM becomes more embedded in the industry. However, this treats BIM as a complete technology in itself, and BIM integration as a destination rather than a process. It overlooks the ongoing development of BIM and its place as a component of digital construction. Supporting professional identities that include BIM or digital construction allows practitioners to participate in the evolution of digital practice in the industry.

The professional life cycle model suggests that a variety of roles are required that encompass different levels of focus. Scott (2008) distinguishes between different types of professional authority, with three categories identified, namely creative professionals, who generate new frameworks and rules of practice that underpin the work of others in their field; carrier professionals who transmit and interpret the profession's ways of working to others, and "must adapt and translate their messages to fit specific recipients and varying local circumstances"; and clinical professionals who are involved in actively applying the principles and frameworks of their profession to the problems of their clients or environment. Scott further makes the point that every profession has a set of parallel or subsidiary semi-professional roles that operate under the authority of the core professionals. From this perspective, it appears that the BIM profession is following a similar pattern to established professional groups. Not all BIM roles are necessarily held by BIM professionals, but represent a core of BIM professional roles, with individuals acting as creators, carriers or appliers within their domain of specialised expertise and knowledge, supported by technicians or associated roles that enable them to deliver the professional services their clients (whether in-house or external) require. This way of viewing professional roles aligns with the professional life cycle, with different types of role filled by practitioners with varying interests and levels of expertise, according to the needs of the role. Practitioners whose identity is invested in innovation and inquiry are likely to be less interested in validation and formalisation, whereas interpreters and instructors will be strong in those areas. Those who are more aligned to implementation have an obvious role within the commodification stage.

6. Identity and industry maturity

Digital construction is still very much a concept under development. Even when focusing specifically on BIM, which may be considered a relatively mature application, it is clear that practice is not uniform internationally or even nationally, despite ongoing efforts from governments and industry leaders. Change has yet to penetrate lagging industry sectors in developed BIM environments (Ganah & John, 2014), and many less advanced construction markets still exist, particularly in developing countries (Bui, Merschbrock & Munkvold, 2016). The five countries included in this research were selected because of the different levels of BIM maturity that they are widely perceived to represent. However, very little variation was evident in the views expressed by practitioners. Many compared their own country's practice with other BIM environments, and were cynical about the progress claimed.

There's a heck of a lot of good people talking about this sort of stuff, but we've done a lot of global tours and we've been surprised by how little – there's pockets of areas where people have done it, but it's more sales pitch than substance. *Interview 37—NZ, Engineering consultancy*

Although there have been many surveys and evaluations published which show the rapid progress of BIM adoption in different international contexts, and within different disciplines and project environment types, practitioners were similarly dubious regarding how accurately such reports reflect the reality of practice. Practitioners in all countries considered local practice to be much more uneven and poorly developed than the various surveys represent, and as a result they were skeptical about the reported advances in other countries as well. It was widely believed that there is as much disparity in practice within each country as there is between countries, even in the environments that are perceived to be leading the way in BIM adoption internationally. This is reflected in the range of practitioner identities expressed, even within companies and countries that are held up as examples of best practice.

Balanced and objective representation of roles and responsibilities is necessary to allow practitioners to make an informed choice to move into a career in digital construction. Confusion around practice and progress acts as a disincentive to embracing a professional identity that centres on digital application or innovation. Practitioners who might otherwise be interested in moving into digital practice may be averse to do so when it is unclear how the industry is responding even to BIM and more widely recognized applications. The lack of transparency about the scale of the challenge involved may prove off-putting and is harmful to all involved if decisions are made based on biased or incomplete information. An overly rosy view is likely to give way to cynicism, when touted changes turn out to be illusory, or to disillusionment, when expected transformations do not eventuate. An unduly negative view is likely to deter practitioners from engaging if progress is not seen to be taking place.

7. Conclusions

For most of the practitioners interviewed, BIM was a central part of their professional identity, and they took pride in their involvement in BIM practice. A range of identity performance preferences were identified, comprising implementer, interpreter, instructor, inquirer and innovator identities. This variety indicates the range of interests and abilities expressed by BIM practitioners, and thus the diverse types of roles they were comfortable in engaging with. Practitioners' identity preferences were not always well aligned with the organisational and project roles they were expected to fill, making it difficult to achieve their goals. Most practitioners were not wholehearted in embracing a BIM identity, but were quick to assert their ongoing involvement with traditional roles and skills. There is an apparent stigma to being perceived as a BIM practitioner that some feared may limit their progression or opportunities in their organisation. The lack of a clear career path for BIM practitioners is a strong influence in this reluctance to fully accept a BIM role. The range of roles in which practitioners are expected to be actively involved also contributes. The requirement of balancing involvement in strategic, process and technical activities across organisational and project layers of responsibility leads to conflicting priorities and responsibilities.

The life cycle model of professional development provides a framework that may prove useful in structuring BIM practice and further development into digital construction, as a professional pathway. This model provides a representation of the profession that encompasses different levels of professional activity from innovation, through validation and formalization, to implementation as standard practice. It allows for definition of a range of professional roles that contribute to the overall progression of practice, and incorporates views that allow for the full range of identity and performance preferences expressed by practitioners. Connecting this, or a similar framework, to the current efforts in curriculum development and certification of BIM professionals would provide a certainty and status for BIM practitioners that is currently lacking. The diffusion and maturation process for BIM professional roles is clearly still ongoing, while at the same time new digital technologies are being adapted and adopted for use in construction. The speed at which practice and expectations are evolving means that capabilities of individuals and companies, as well as the industry in general, must be designed and redesigned to remain relevant and effective. BIM is not the end point of the current drive for industry improvement, and it is necessary to continue the cycle to develop and establish professional roles, knowledge and skills through and beyond current best practice. By using the life cycle model to provide an overview of the professional continuum, the efforts of practitioners can be fitted to their strengths in the interest of both practitioner and practice.

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