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MODELLING ORGANIZATIONS' STRUCTURAL ADJUSTMENT TO BIM ADOPTION: A PILOT STUDY ON ESTIMATING ORGANIZATIONS

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SUMMARY: *Building information Modelling (BIM) promises a fairly radical revolution in all segments of the construction industry. Vital evidence has been used in many studies to elicit how fragmented processes in conventional construction systems, predominantly manual design systems and entity-based CAD often render design and project performance vulnerable. BIM is presented as having attributes that strengthen the frameworks for servicing efficiency in design and project performance. As BIM adoption continues to improve, various stake-holding practices that are involved in developing projects through integrated systems do require process models to help them simplify issues relating to multi-disciplinary integration – a direct opposite of what they are used to in fragmented systems. They also need to develop appropriate skills and strategies, including new marketing and administrative stratagems, to service intensive collaboration and other ethos of BIM. These are some of the inevitable changes to which organizations must respond in order to generate efficient results when adopting and deploying BIM. To examine organizational response to those process changes as promised in BIM, different organization models are explored with emphasis on their functional structures, namely: (1) matrix (2) networked (3) functional (4) divisional structure models. Data were collected from 8 construction and software development organizations in Australia through focus group discussions. 18 participants in core BIM skills took part in the study. Some interesting discoveries were made and reported on the industry's reactions to BIM adoption. Conclusively, this study confirms the nature and direction of potential changes that BIM trigger.*

KEYWORDS: *Building information modelling, estimating services, organization structure and marketing.*

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1. BACKGROUND

Building information Modelling (BIM) promises a fairly radical revolution in all facets of construction practices. Several recent studies have eloquently argued its applications in some imperative aspects of industry practice, research, teaching and learning paradigms in patterns that are vitally important to construction organizations and how they deploy their business models (Ashcraft, 2008, Azhar et al., 2008). Whilst conventional practices are still fragmented but gradually adapting to BIM ideals, the implications of BIM adoption to organizations are quite serious and unique. Different authors have argued that construction business systems are being reshaped by BIM e.g. from fragmented processes to integrated and collaborative procedures (Mao et al., 2007); from pseudo-manual to intelligent systems (Lin et al., 2003); from subliminal paradigms to virtual reality and simulated micro-worlds (Whyte et al., 2000); from limited relativity of subsystems to interoperable digital forms and similar alternatives (Mihindu and Arayici, 2008, Schevers et al., 2007).

Interestingly, these contemporary concepts have been argued logically in literature as instruments of process improvement in construction business. For instance, Ustinovicuius et al. (2007) had defined risks in construction processes and business structures as potentially relative to conventional fragmented processes, and they often come with consequences that may jeopardize project outcomes and clients' expectations. This perspective has been a longstanding challenge, and has been generously shared by several other previous studies (e.g. Acharya et al., 2006).

Consequently, it is evident that there was need for some major re-engineering of processes involved in developing a typical construction product. A particular item of interest in literature regarding this includes the need to step-up project design and documentation from fragmented tools to intelligent and integrative protocols. Arguably, this is one of the strongest points in BIM debate (Dean & McClendon, 2007). However, whether as short, medium or long term, limited attention of past studies has been focused on how this may affect various existing business models, organization structures and project delivery patterns.

A considerable reference point is how London et al (2008) outlined how certain skills areas in BIM may elicit marked improvements like gains in terms of accuracy, interactivity, productivity, cost savings and improvement in process quality and sophistication over the limitations of fragmented conventions which the construction industry appears to be bedevilled with. Several innovations of information technology (IT) have been introduced to the industry in the past years. However, many organizations seem to be rattled by the impact of market pressures that these could draw on their business strategies, especially regarding the best way to adapt, simplify, adopt and market certain IT and practice innovations within existing industry and legal structures.

There is significant evidence to show that BIM adoption and deployment do not generate automatic results except specific precepts are adhered to appropriately. In Holzer's (2007) view, BIM alone is not the only answer to construction problems; the solution is more than magic buttons and automated tools. To this end, Sher et al (2009) argued that stakeholders in construction development processes require realistic skills to service BIM frameworks. Additionally, another daunting task is how to develop workable process models on business motivations for individuals and organizations to simplify BIM deployment precepts in multidisciplinary settings. As the industry's reaction to BIM-triggered change is still slow, organizations need to understand the nature of this change, especially how to develop effective frontiers for coping with this change in the verge of competition.

Estimating services are ubiquitous and vital organs of project delivery systems. However, the future of estimating practice in BIM has been expressed as a major concern in some recent studies (Yu et al., 2006). It appears BIM has huge potentials to change how estimating practice is being conducted and marketed. For the sake of clarity, there are different opinions on this in literature and this would require substantial reflections. Whilst Cartlidge (2006) opine that IT sophistication (BIM inclusive) could mean a major marketing advantage for estimators, Broekmaat (2008) implicitly argued that there will be limited space for independent estimating practice in BIM. Therefore, in some ways that are different from other professional service disciplines, BIM potentially has the capacity to uniquely reshape estimating practice through emerging digital frontiers but in patterns that are not yet definitive in existing market orientation.

The purpose of this paper is to develop conceptual process models for managing potential structural changes in public and private estimating practices that may arise due to BIM adoption. To achieve this, the structures of eight estimating organizations in Australia are explored in relation to steps been taken in the light of BIM revolution. Then, they were grouped and analysed using four conceptual variables of organizational functionality, namely: (1) matrix (2) networks (3) functional (4) divisional models. Through focus group method, several scenarios of organizational response to technological changes are considered, which include reactions to procedural changes from manual to non-CAD estimating applications, and from entity-based CAD to BIM estimating applications.

2. FUNCTIONALITY OF ORGANIZATIONS AND VALUE-BASED MANAGEMENT STRATEGIES FOR IMPLEMENTING BIM

Organizations are different in terms forms and functionalities, and do respond to structural changes in unique ways. According to Nadler and Tushman (1997), organizations are structured in line with their functional systems, and are streamlined to maximize their competitive advantage and corporate values. Examples of determinants of functional systems in construction organizations include the different forms, nature and orientation of professional services which are rendered in the industry. This could be conventional standalone disciplines like design, procurement, project implementation and facilities management; integrated professional services (IPS); executive, semi executive and non-executive functions and services, and other management innovations in project delivery systems. These variables are likely to impact how these organizations respond to market drivers such as technology, flexibility of corporate values, marketing style and nature of business in project delivery e.g. consulting, contracting, project management, public agency for regulatory functions or as concerned observers for research and policy-making purposes.

Quite a large number of recent studies have explored how information technologies are reshaping the construction industry (e.g. (Hore and West, 2008, Mihindu and Arayici, 2008)). However, these studies are not specific about individual disciplines or particular nature of professional services that are rendered in the construction industry. Evidently, these are clear dividing lines which cannot be underestimated as each professional discipline in construction deploys IT innovations in very distinct patterns and shape their marketing styles in line with these. Hence, a substantial change in market orientation [extrinsically] will trigger some major changes in organizations' reaction to both existing and new market climates. This is rather a complex phenomenon as there are limited theoretical resources on construction business systems, especially in this perspective.

Nonetheless, some studies agree that an appropriate way to simplify corporate response to systemic changes in a specific form of organization is through its functional systems (e.g. (Daft, 2000)). (Price, 2007) has also analysed the goals of organizational response to pressures in business environments. These include holistic approaches to creating, managing and measuring strategic and transactional values to support specific marketing options. As professional service organizations in construction are different in size, nature of business and functional structures, there is adequate resource in literature to base their general classifications on. This is has been a reliable way to establish the logical correlation between functional structures of corporate organizations and their variability as per corporate mission, strategy, governance, culture, communication and decision making processes and allied business subsystems (Robbins, 1989). The overarching debate which this study intends to trigger is how BIM will challenge these paradigms and adapt them to the new business models in digital spectrums. With estimating practice in view, this study adopts a set of four models of organization structure as enunciated by Price (2007), namely; matrix, networks, functional and divisional structure models. They are theoretically conceptualized as follow:

3. MATRIX STRUCTURE MODEL

In a matrix structure model, project teams are formed by bringing together skilled individuals from different parts of an organization to achieve set corporate goal(s). Figure 1 shows a typical matrix structure model. The main focus of the team is to carry out functions ranging from value engineering to project design, strategising and definitive implementation. The peculiarity of this formation is that few of the team members may not be from core construction disciplines, but could include conventional lawyers, economists, finance experts as well as designers, estimators, builders and purchasing experts. Barton (2000) has eloquently described the formation of a typical value management team for a proposed construction project.

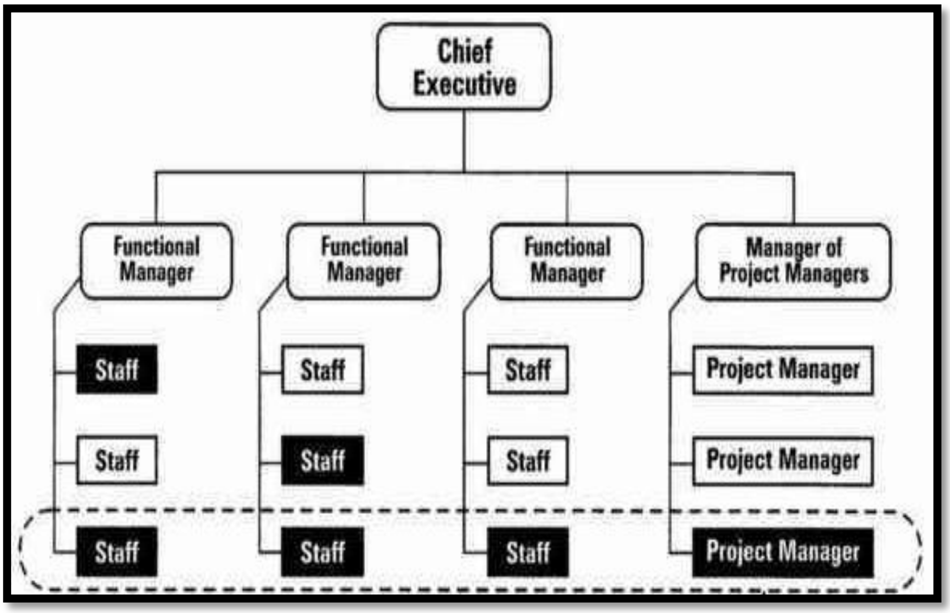

FIG. 1: Organization chart of matrix structure model (www.visitask.com)

Boxes in black are members in the matrix model

Although, the model is designed to optimize teamwork, individuals in a typical matrix structure model are responsible both to their line managers and the project manager involved (Asopa and Beye, 1997). Price (2007) added that the ultimate success of this model largely depends on project data are shared and managed amongst project actors (i.e. the team members). Several studies such as Whyte et al., (2000, Azhar et al., (2008) and Ashcraft (2008) have articulated how recent developments in managing information technologies and collaborative networks between project teams could foster significant gains in construction processes and why these are highly desirable to construction clients. Most of these benefits are encapsulated in BIM. However, as the level of awareness of BIM ideals is still fairly low (but significantly improving), organizations deploying this model need to develop a unique mechanism to deploy BIM in pattern(s) that is likely to be different from other models.

As Drucker and White (1996) suggested, matrix organization structure is very relative to construction systems. Construction professionals, especially estimators are multi-skilled; they can perform different functions within and outside construction business environments. A comprehensive discourse on construction estimators' roles are articulated in (Bowen et al., 2010, Nkado, 2000, Cornick and Osbon, 1994). Nonetheless, construction organizations have not been able to drive exceptional project success through matrix model due to a peculiar 'muddle' phenomenon, which is often triggered by fragmentation. Actors often need a lot of time to integrate, device collaboration, develop adequate trust to break boundaries and share values. The consequences of this challenge are better imagined. Evidence suggests they often lead to poor project performance and can render relationships very vulnerable. As indicated by Ingram et al., (1997), to deploy BIM appropriately, both the operators and actors of matrix model they may require a different injection and customization of attributes that would instil collaborative habits in project teams before BIM technicalities are deployed.

4. NETWORKED STRUCTURE MODEL

Sailer (1978) defines networked organization as a relationship pattern that combines a set of process nodes (i.e. persons, positions, groups, or organizations). Figure 2 below typifies the structure of network organization between different communities of knowledge. In particular, one of the main relevance of this system in construction is to bring service providers together (as individuals or firms) towards achieving project and/or business goals. According to Alstyne (1997), literature perspectives on structures of networked organization span beyond the limitations of physical boundaries, but include the management of digital innovations and technologization of micro-worlds, axiomatic and integrative communication and values.

Ahuja and Carley (1999) also explored networked structures in virtual organizations wherein geographical limitations are significantly eliminated. Several studies, including (Atkin and Björk, 2008, Igo and Skitmore, 2006, Love and Li, 1998, Reimers, 2001, Storer et al., 2009) have eloquently argued the take of construction organizations on this and how it has reshaped construction business systems. Unlike fragmentation ages, modern construction organizations now deploy electronic and mobile technologies, and sophisticated networks in numerous forms of day-to-day transactions. Huge volumes of sophisticated project data are now being shared electronically via internet, extranet and intranet, and are processed collaboratively via repository portals. In essence, networked technologies are not only a medium for data exchange, but also for solving complex problems collaboratively.

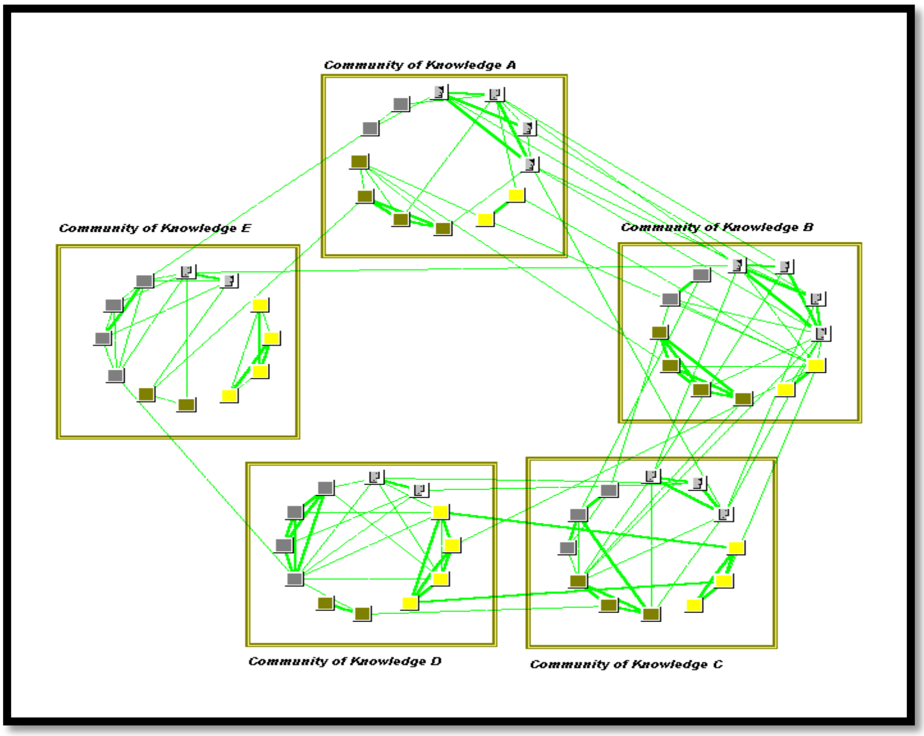

FIG. 2: Networked structure model (Krebs, 2005)

Today's construction organizations are fluid and adaptive in manners that are not exclusively strange to networked structure model. Moreover, although several authors have demonstrated the relationships between networked structure model and BIM ideals, however not all networked operators and actors are prepared to deploy BIM. Moreover, (Holzer, 2007) has argued that not all mechanisms for networking are thoroughly collaborative, and thus may not drive project success a lot farther than fragmental conventions. Conventionally, estimators provide their professional services through information networks as data from different design and construction domains. However, some emerging evidence suggests that BIM system will substantially reshape estimating practice; at least some of the limitations of the current estimating processes could be resolved in BIM. Azhar et al., (2008) and Olatunji et al., (2010b) have identified some of the ways in which BIM can influence estimating practice.

Whether or not a specific technology impact on how a networked structure model is run, especially in moments of rapid changes, all operators and actors in this type of model require flexible, workable and contextualized skills and resources to realize certain business objectives and service both internal and external marketing interests. Apart from these, some studies have identified possible limitations of this model. For example, Jarvenpaa and Ives (1994) identified some of these challenges to include how to develop and manage flexible and efficient architecture to support adaptive information repository. Other limitations which are vitally important to achieving project success when networked structure model is deployed in an organization include how to establish new and/or adaptive value frontiers, attitudes and behaviours that can drive effective information sharing in different network loops without dissipation.

Another significant challenge is how to build interoperable databases to support integrated networks involving simultaneous multiple users, multi-tasking and discipline-specific tools. A procedure for valuing inputs and ownerships of efforts also has to be developed and protected, as well as sustenance of personal freedoms and privacy for operators and actors of this model. Arguably, other major challenges may evolve for most construction organizations deploying this model as newer technologies and processes become available. Nonetheless, the seriousness these challenges pose is such that contemporary construction managers and estimators will need significant re-training and equipment to cope with how conventional networked system could cope with process integration in BIM (Sher et al., 2009). Potentially also, new disciplines are likely to evolve to take care of these possible skill gaps and strengthen other new and upcoming opportunities in e-network systems, especially those involving disciplines that maybe be reshaped significantly with BIM.

5. FUNCTIONAL STRUCTURE MODEL

Organizations using Functional structure model have unique attributes that recognise lines of command across defined and independent skill specialities and responsibilities (Price, 2007). Figure 3 below illustrates a typical functional structure model in a manner that is relevant to construction business environment. In the model, each functional line manager represents professional disciplines [i.e. project consultants like designers, estimators, construction managers and others] that are partly or wholly sourced from within or outside the client organization. Another main distinguishing feature of this model includes the fact that actors in the model are predominantly skilled authorities with distinctive professional responsibilities to service a particular set of project goals. Apart from extensive sophistication at individual discipline or skill levels, this model allows actors and operators of the model to deploy integrative innovations with a view to close skill gaps and benefit project goals in the long run.

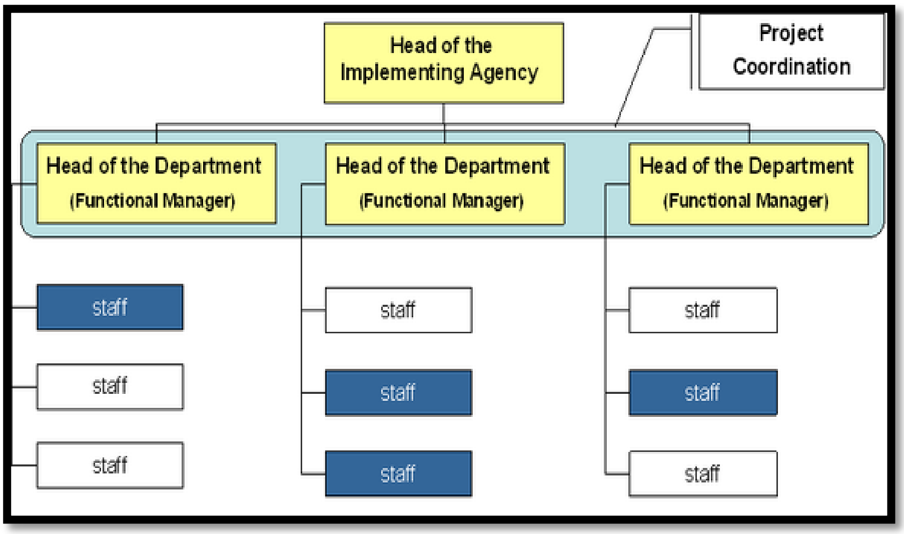

Fig. 3: Functional organization structure

Contract actors in project development activities

Conventionally, interoperability and closing skill gap had both been major challenges for this model. This is because, on the one hand, closing skill gap will necessitate multi-skilling, while the structural orientation of this model is division of labour which, regardless of technological sophistication involved, still encourages fragmentation. Thus, it can be counter-productive when important functional skills are either lacking, insufficient or not complementary (Kalay, 2001). Moreover, this model is vulnerable to internal conflict because members of project teams could deploy their freewill to prioritise self-interest and discipline biases rather than engage in objective interaction and collaboration.

On the other hand, technological sophistication along functional lines is not synonymous to achieving project success. Previous studies like (Anumba, 1996, Chang and Chen, 2004) have expressed the fear that these technologies may not always work together to optimize trust and at the same time detect errors, conflicts, mistakes, omissions and feasibility problems. Rather, the overarching position that will impact on project success is not necessarily to encourage more independent technologies but to foster relativity within existing tools. It is clear from literature that BIM is potentially a prime actor in achieving this. At least, all actors in BIM do have appropriate framework for thorough integration and effective collaboration across all functional disciplines.

On the other hand, these are also impacted by external factors like the nature of responsibilities prescribed by clients, clients' commitment to facilitate these success factors and legal frameworks to drive them. Therefore, co-ordination of functional capital and tools across conventional skill divides has been a major limitation of this model. Possible outcomes of encumbrances to collaboration scenarios have been reported in (Olatunji et al., 2010a). At the moment, there are strong indications that this model still renders construction processes vulnerable due to sporadic conventions being used by construction professionals to strategize their etiological procedures in a fast changing business climate.

6. DIVISIONAL STRUCTURE MODEL

All organizations have functional divisions that facilitate their corporate goals in ways that enable them respond to external pressures. Such include general administration and management, technicals, research and development, marketing and finance. While these divisions are made to perform specific functions, they also relate intrinsically and extrinsically to service the interest of the organization. However, in the case of BIM, BIM and other recent digital technologies are no longer mere marketing strategies, but rather are very serious items which should be in the consciousness of clients as well as all knowledge management paradigms (teaching, learning, research, theory and design practice).

As the maturity and uptake of BIM ideals differ in different parts of the world and organizations, it will be interesting to explore how organization device division to monitor and manage trends of development in the digital world and how such are being domesticated. Following Bushman's theory as documented in (Bushman, 2007), divisional structure model for implementing BIM could be broken down into three areas. These are product development, marketing and general administration. Aside these, central to strategising for BIM adoption are how to develop, manage and market new frontiers in digital service products. Although some organizations will structure this sector as a new department, others may only need to make ad-hoc provisions for maintaining and improving old products as per present client needs and market orientation, and when required, find a way to integrate newer trends. Alternatively, other organizations rely on external relationships and alliances to implement this.

Nonetheless, the limitations of this model are not very difficult to come-by. According to (Shadad, 1999), the implementation of prototypes of research findings or breakthroughs can be complex, slow and asymmetric except when they are targeted at immediate market gains or are exclusively driven by specific components of the market. Consequently, the pattern that organizations may adopt in deploying BIM may be dynamic, informal and based on immediate project needs, thus making long term projections somehow difficult.

While this divisioning system is common to many construction organizations and all divisions are very relevant in corporate strategising for BIM, however not all divisions may possess the same level of core technical ability to drive BIM. Product development division can be the technical core of BIM implementation; most significant decisions regarding its adoption can be influenced by management department and re-modelled by the marketing unit. Quite often, each division and sub-unit use different technical concepts to express their values and run their process sub-systems. A major challenge therefore is ensure that appropriate information flows across divisional links without dissipation and co-ordination problems. Bureaucratic control is another challenge; more time and resources are required to service divisional interests, and this could be frustrated by internal crisis.

7. RESAERCH METHOD

The aim of this research is to explore how a typical professional service industry responds to technological changes in the industry. As BIM triggers rapid changes in design and project development systems, different disciplines running these systems are likely to be impacted by BIM differently. Estimating practice is a major role player in project development, but most of its traditional conventions are being challenged by BIM. Conventionally, estimators rely on CAD and paper-based industry standards to measure quantities of construction works before buy-out market values are articulated in relation to a particular construction method and available resources. While these indicators are rigid, non-parametric, fragmented and could trigger several negative consequences, BIM models can store and automate necessary metadata in such a way that estimating practice is being reshaped either in ways to reconcile the old procedures with the new process or to implement a distinct new course.

BIM is not the first technology to challenge the relevance of the estimating industry; previous studies by (Best et al., 1996, Cartlidge, 2006) suggest that this ubiquitous discipline is still grappling with other technologies prior to BIM. The frameworks of this study therefore include exploring how changes in estimators' adoption of past technologies for measurement and project planning (e.g. CAD and dedicated computer-aided applications for quantity estimation and database management) have affected their business strategies. This is later compared to BIM principles and how their organization structures have impacted on their commitment to BIM adoption.

This research was conducted in Australia. Some authors have reported that BIM adoption in Australia is still slow (e.g. (London et al., 2008, Succar, 2009)). Asides, although many estimating practices are used to CAD and other dedicated applications for quantity estimation and database management, only few estimating organizations have significant experience in BIM. Consequently, a compact research strategy was adopted. While some past studies used personal interview methods (e.g. (Aranda-Mena et al., 2008)), this study adopts focus group as the research method. The major advantages of this method include rather than relying on subjective biases of individual interviewees, participants in focus groups are more objective and constructive in their arguments. Instead of reporting the impression of an individual interviewee, focus groups summarize collective opinions as well as multiple opinions leading to that conclusion.

A total of 18 participants from 8 different organizations took part in the research. Each of the structure models described above is represented by 2 organizations in order to articulate an average of opinions. Moreover, this is made up of estimating units of 2 major public departments in charge of public works; 2 private consulting organizations with a wide range of experience in different forms of projects and office networks; 2 large contracting organizations with extensive experience in different project packaging practices and have managed many local and international office networks, and; 2 software development companies.

All the study participants have had at least first degree in construction subjects and have worked on virtually all types of construction projects. Their years of experience ranged from 9 to 35 years. They are all in middle and top management levels in their organizations; only 12.5% are females while 87.5% are males. A breakdown of professional background of participants indicates that about 20% are IT professionals, 10% are architects, 10% are design engineers, 20% are estimators in government departments of public works, 20% are estimators in contracting companies while 20% are estimators in integrated project delivery (IPD) and independent consulting organizations. Participants from government offices of public works operate matrix and divisional structure models; those from software development sector operate matrix and functional structure models; those from contracting organizations operate networked and divisional structure models; while those from consulting practices operate functional and networked structure models.

Trigger questions are in 3 parts: part 1 is on the personal experience of participants, part 2 is on the organization where they work, while part 3 is on their perception on CAD and BIM, and how their practice are being reshaped by both. Each of the 8 sessions lasted for an average of 47 minutes and 12 seconds. Before taking part in the study, participants consented formally that their contributions be captured digitally with audio devices. This was subsequently transcribed and processed for analysis.

8. FINDINGS

Due to strategic difference in the nature of business of participants in the construction industry, it is very clear from preliminary analysis that participants use information technologies and digital innovations in different ways. Apart from generic uses, each particular specialized use is determined by the degree of responsibilities that they have to influence project decisions, and whether or not such will trigger a substantial competitive or marketing advantage. Consequently, participants' response to specific change agents in BIM (e.g. technologies, skill gaps, policy frameworks and pressures triggered by market or clients' interest and demand) are dynamic and based on market orientation (i.e. whether or not there is enough awareness in the market as per that particular innovation or whether or not a client is willing to risk trying it out

Predominantly, participants' awareness of BIM is promising as all of them have heard about its potential capabilities. However, the level of deployment is still low because of low drive from clients and substantial uncertainties in the market. It appears most clients are less bothered with what is used as long as immediate project goals are met. Interoperability of various discipline tools and sound public policy frameworks to operationalize BIM are other possible debacles against BIM adoption. These confirm previous discoveries in (Succar, 2009).

Nonetheless, micro implementation of BIM in many of projects that have been executed by these organizations and participants shows that some of the BIM deliverables are real and are impacting the practice of estimating. For instance, with auto-quantification and metadata, estimators now have more options to generate more accurate results than they would achieve in CAD and manual methods – they can rely on IFCs, remodel BIM models in line with their chosen methods of documentation, base price evaluation on construction model that they have simulated from BIM models or adopt all data from BIM models as 'as-is'.

There are some other BIM deliverables with participants agree could be many years off; particularly, a perfect harmonization of multi-disciplinary tools to design, estimate, simulate construction processes and integrate all lifecycle information in single; and a full resolution of definitive and universal legal instrument for BIM implementation. Although these deliverables are real, many organizations are still trying BIM out and will require more years to conclude their standpoints.

As an overarching focus of the study, participants are asked direct questions on how BIM is reshaping their practice conventions and organization structures. The aim is to identify specific steps being taken by organization to respond to BIM and allied innovations. In consonance with previous studies such as (Kagioglou et al., 1999, Mohamed and Tucker, 1996), participants agree that most organizations will require training to acquire the new skills to drive BIM – examples of these skills have been documented by (Sher et al., 2009). These skills are both generic and specific to each particular structure model that the organization is operating. Other forms of training or technical support may be necessary once specific procurement routes have been defined for a particular project where BIM will be deployed. Parallel to this is the acquisition of appropriate tools to drive BIM e.g. upgrade or acquire new hardware and software, recruitment of new hands and designing of steady marketing strategies to project BIM-allied services. Apart from training and adapting how professional services are marketed, participants also agree that there is need for steps to be taken to moderate BIM adoption at industry level. Table 1 below summarises highlights of responses to changes arising from BIM adoption as argued in the focus group discussions.

TABLE1: Summary of responses to changes arising from BIM adoption

Strategies for organizational response to BIM	Matrix structure	Functional structure	Networked structure	Divisional structure
1. Industry response to BIM adoption:	**Adopt responsive strategies for deploying industry guidelines on BIM adoption:**	**Take active part in developing industry and corporate guidelines for BIM adoption:**	**Mediate industry guidelines for collaboration and BIM adoption:**	**Create and sustain lasting frameworks for deploying BIM tools:**
i. Standardize and adopt workable guidelines for multi-disciplinary integration of values and defragmentation of processes.	Define and customize firm's policies and models for teamwork and multi-disciplinary integration.	Adapt the ethos of professionalism and corporate policies to trigger collaboration and effective communication	Develop new standards and guidelines for web-based collaboration and virtual enterprises	Adopt best practices for process and value integration
ii. Reward innovations in teamwork and management of collaborative knowledge to support BIM	Promote assignment goals through innovations and knowledge sharing in teams	Identify appropriate motivation strategies and reward knowledge regeneration in integrated teams	Service industry expectations on the integrity of e-business	Promote thorough collaboration through corporate standards
iii. Develop new sets of legal frameworks to service electronic data management in construction, including remunerations, commercialization and ownership of BIM models	Develop process models for marketing professional service delivery in e-construction	Create new industry and client friendly standards for marketing professional services rather than simplistic business motives	Define standardization of ethics and control sophistication in web-based and e-data management	Adopt new and adaptive corporate goals for managing BIM process models
iv. Encourage multidisciplinary and collaborative research	Increase platforms for multidisciplinary integration	Simplify system integration, openness and transparency	Simplify openness and define the fuzzes of interoperability	Improve co-ordination and create new research bases
v. Set guidelines for controlling e-market fluidity	Define transparent models for responding to changes.	Protect firm's integrity in e-market's functionality bias	Simplify web-based professional service delivery	Protect firm's integrity in e-market's business bias
2. Establish and customize an adaptive commitment to sustainable marketing of professional services in the industry:	**Create specific discipline and office for managing BIM and integrative conundrums:**	**Identify and engage new disciplines in BIM:**	**Map out definitive strategy for moderating BIM and allied innovations:**	**Action and regulate industry guidelines on BIM adoption:**
i. Study and map out the direction of market drivers and interests in relation to firm's business focus (e.g. recruiting, rebranding, strategic modification, breaking new grounds and commitment to research and development).	Prioritize BIM precepts and allied innovation as core aptitude in integrated service delivery and as new forms or phases of professional services are being offered.	Rebrand conventional service delivery in favor of new market direction in BIM	Adopt best practices in reconceptualizing improved marketing strategies in driving BIM adoption , and in accordance with all standardized and adopted guidelines in the industry	Reward commitments to breaking new grounds and deploy sustainable marketing models that can service industry requirements on BIM adoption
ii. Explore the impact of BIM on firm's business interest and develop adaptive response to changes	Focus on reconciling the relationship between marketing feasibility (e.g. negative and positive indicators of market response to BIM) and the nature of firm's business	Repackage professional service delivery with BIM innovation (e.g. process integration, project visualization and animation)	Develop workable parameters for measuring market response to networking in relation new and future BIM marketing concepts in BIM	Measure and standardize firm's response to market drifts in favor of BIM, and update strategies to upkeep relevance in future market movements
iii. Establish major drivers of business incentives in BIM	Concentrate on limiting SWOT weakness to non-marketable skills and improve	Focus on integrated services through	Strengthen reliable platforms for collaboration and digital data management systems	Constantly review potentially strong marketable precepts and improve co-ordination Continually strengthen

	integrative skills	thorough collaboration and value-adding innovations		framework to service BIM deployment in corporate management
iv. Provide workable frameworks to service BIM adoption processes (e.g. software applications, hardware and humanware).	Improve capacities of hardware and procure integrative applications – with appropriate technical support and maintenance	Adopt web-based repository system and virtual enterprise mechanisms.	Focus on formulating new process models and integrative applications, and update existing facilities	Update marketing strategies based on industry's constant response to BIM adoption
v. Design and define strategies for 'digesting' BIM while conventional procedures respond to changes.	Develop and continually review customize process models for deploying BIM	Strengthen frameworks and resources for generating, using and transferring digital information.	Continually measure the performance of strategies for deploying and marketing innovations in BIM	
3. Training:	**Resource development:**	**Skill improvement:**	**Skill refreshals**	**Training and re-training**
i. Strategize through appropriate systemic policy modification, resourcing and corporate development in favor of BIM concepts.	Develop corporate mission for adopting and deploying BIM	Engage best practices in human resource development and reward staff commitment to integrative innovations	Encourage uptake of integrative and collaborative skills	Adopt adaptive skill management models
ii. Review and update academic and professional training curricula in favor of BIM concepts and innovations.	Train and re-train existing staff. Academic and professional bodies should incorporate BIM concepts in curricula	Improve facilities for training and retraining of staff, and trigger development of new skills in employees	Focus on generating new skills for driving thorough collaboration in microworlds	Define skill needs for integrative systems and create avenues for generating such skills
iii. Adopt responsive training methodologies for educators, staffers and policy makers.	Make provisions for trainers and major stakeholders	Allow constant and strategic trainings for trainer and provide more windows for collaboration	Explore training methods that correspond with firm's or network's business model	Promote methodologies for multi-skill development
iv. Encourage personal development	Reward hard work and personal development	Provide avenue for and promote collaborative development	Promote collaborative development	Reward innovative and collaborative research
v. Invest in research and development	Encourage research and development	Be responsive to new research skills	Reward richly objective and dedicated research	Apply results of richly objective and dedicated research

9. DISCUSSION

As indicated in Table 1, professional bodies and other regulators of professional services will need to do more if BIM adoption will move to the next level of its implementation. Although, some BIM implementation guidelines and case studies have been published (e.g. (Aranda-Mena et al., 2008, Fusell et al., 2007, Olofsson et al., 2008), it is not yet clear how many professional institutions have tested or adopted these guidelines for its members. At present, legislative and policy instruments are also weak in support of these findings. Therefore it is expedient that stakeholders collaborate to harmonize their values and develop a workable model upon which government policies could be based.

Asides, the peculiarity of organization structure seems to have little credence in how some professional institutions develop their policies and this often have severe consequences in how they are implemented by member organizations and individuals. As clearly established in this study, the way technology is reshaping practice conventions is such that professional guidelines should be adaptive to cope with business climates. To buttress this, participants agree that operators of different structure models will need to customize macro or universal guidelines in slightly different patterns. For instance, while operators and actors of matrix structure model need to concentrate on adopting firm's policies and models for teamwork and multi-disciplinary integration; operators and actors of functional structure model will need to take active part in how macro policies guiding BIM implementation formed. For the operators and actors of divisional structure model, each component of such guidelines may require further domestication by different division, depending on the roles they will play in a specific pattern of BIM deployment.

It is also evident from analysis of participants' deliberations that the industry reward for innovation is rather weak. There are many formal and informal innovations in the industry that have not have not been articulated. Doing this will not only help the praxis of these deliverables, it will substantially lower the threshold of the industry's reluctance to capture digital innovations like other industries. One of the ways to do this is through research. However, generic R & D departmental efforts and pedagogical research may not be adequate, there is need for dedicated studies to focus on definitive application of digital innovations both at integrated and independent levels. To support this, organizations could develop and implement different models to promote the ethos of collaboration and integration.

Another important determinant of success in BIM implantation is how BIM is packaged and marketed. There are limited definitions of professional services that are involved in the development of BIM models as per the responsibility of individual contributing trade and in relation to specific contract types, procurement routes and project delivery systems. This therefore creates knowledge gap on how to value professional services that are involved in BIM modelling and appropriate mechanisms to market same. Possible options for facilitating this, as identified by discussants, ranged from concentrating on BIM innovation rather than fragmented alternative to rebranding conventional practices in favour of thorough integration and effective collaboration.

This will also involve limiting SWOT weakness to non-marketable skills – some of these, in connection with estimating practice; have been articulated by (Masidah and Khairuddin, 2005, Morledge and Kings, 2006). Particularly for operators and actors of networked structure model, platforms for digital data management and collaboration will need to be strengthened - some of the benefits of these have been reported in (Luciani, 2008). This is not only going to be a major business incentive, it will trigger new innovations especially regarding adaptive process models and improved capacity utilization to sustain competitive advantage in digital innovations.

Apart from macro actions and marketing, training is another contributor to effective implementation of BIM. While operators of matrix structure model may have to develop new resources to handle BIM, operators of other types of model may only need to re-appraise and refresh their existing resources. Where substantial training is inevitable, an appropriate starting point is to re-brand the corporate mission of the organization. This is because it will trigger a sense of regeneration upon which future foundation for improvement will be laid. Generally, other forms of training may be limited to handling of hardware and software as well as re-aligning behavioural patterns in line with the ethos of BIM – collaboration, trust and integration.

10. CONCLUSION

The research framework is focused on four organization structure models and their strategic responses to potential changes that could be triggered by BIM adoption. In Table 1, results from focus group discussions in which 18 middle and top level staff members of 8 estimating organizations in Australia are presented. Analysis shows that different organization structure responds to market changes as triggered by BIM in slightly different ways. Primarily, respondents focus on systemic response of the industry to BIM adoption, contemporary strategies for marketing e-professional services and skill development in relation to the ethos of BIM operability such as thorough collaboration, value integration, effective communication and robust digital management systems. All respondents agree that BIM triggers major changes and improvements over conventional design processes, and those attributes require dedicated attention to service appropriate skill development in relation to established market drivers in BIM – some of those skill needs and market drivers have previously been identified by (Aranda et al., 2008, Sher et al., 2009). Rather than relying on rigid and fragmented data in entity-based CAD, BIM proposes automated and integrated data management. Although, (Olatunji and Sher, 2009) identify some limitations in some current formats of BIM models to drive improved estimation processes, respondents agree that those challenges will be surmounted in the future.

On potential revolution that BIM may triggers in estimating practice, respondents agree with past studies that estimating practice is currently under marked challenges, and should be open to systemic modification in the nearest future. Masidah and Khairuddin (2005) and Poon, (2003) have reported that some services rendered by estimators are grossly unnecessary and detrimental to clients' interests. While some respondents agree that BIM adoption will provide reliable launch-pad for regenerating estimating practices in a new era, others opine that the market is yet immature to definitively determine the direction of these changes and what they might imply on estimating services' marketing models. Of the four organization structure models, matrix model is the most fragmented and may require major adaptive steps to attune it to BIM precepts. Major recommendations of respondents in this regard include the need to improve resource platforms and dedicated research on thorough multidisciplinary collaboration in ad-hoc teams. Although, functional structure model is easier to adapt to BIM precepts than matrix structure, respondents opine that knowledge management and skill improvement are the single largest challenges of this model. To address this, firms may focus on providing integrated services and simplification of integrated systems.

Moreover, while network structure model already have frameworks for interoperations and virtual enterprise, divisional structure seems to be challenged by slow market response to innovations of digital technologies and changing existing market drivers in favour of the latest paradigm shifts in BIM. To this end, respondents recommend that organizations with network structure firms should develop appropriate parameters for managing BIM market drivers and adaptive skill to service market reactions to future changes while divisional structure firms should continually update their marketing strategies and be committed to dedicated empirical research on roles of potential changes as propelled in BIM.

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