ATTITUDINAL, BEHAVIOURAL, AND CULTURAL IMPACTS ON E-BUSINESS USE IN A PROJECT TEAM: A CASE STUDY

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SUMMARY: Maximum benefit from Information and Communication Technology (ICT) investment is widely believed to arise from its collaborative use across construction project teams. Ideally this integrates supply chain activities using various e-business strategies centred on a Building Information Model (BIM), used from the earliest stages of project feasibility, through design and construction phases onward into operation and decommissioning. Unfortunately this rarely eventuates, and this has less to do with technological compatibility and more to do with human interactions. A recently completed doctoral study has found evidence that boundedly rational decision-making behaviour arises out of individual decision-makers' attitudes which in turn affects the likelihood of ICT/BIM adoption across a project team. Another doctoral study has shown the link between individual attitudes, the formation of project team culture and it's receptiveness to ICT/BIM integration. This paper presents meta-analysis of data common to both studies of a particular Temporary Project Organisation (TPO) associated with the design and construction of a project. It investigates the link between the individual attitude formation of key project personalities and their subsequent ICT decision-making behaviour, resulting in the formation of a differentiated project team culture, and sub-optimal BIM-enabled e-business. It concludes that individuals' cultural traits are portable entities, partially evolved through personal experience, and partially developed out of interaction with others, and these traits will 'infect' the current TPO in both positive and negative ways.

KEYWORDS: ICT, BIM, temporary project organisation, e-business, attitudes, behaviours, project team culture.

1. INTRODUCTION

Building Information Models (BIM) capture the form, behaviour and relationships between the parts and assemblies of a building in database form, enabling them to be visualized virtually, and their behaviour tracked under different operating conditions, over the passage of time. Potentially this technology can trigger significant changes in the development, design and building process (Weisberg 2000), yet the technology has yet to gain widespread acceptance in the architectural, engineering and construction (AEC) sector, lagging behind other major industries producing 3D products.

BIM provides technological solutions aimed at standardising and streamlining business processes across the design, construction and operational phases of a building. BIM functionality combined with improved business process alignment between trading partners ought to naturally lead to increased uptake and integration across the AEC sector as a result of the claimed scope for increased profitability and value generation that BIM is said to present. However recent research indicates that psychological phenomena observed in individuals (Brewer, Gajendran & Beard, 2009) and across project teams (Gajendran & Brewer, 2009) can be just as important in determining the business outcomes of BIM adoption.

This paper builds upon the authors' earlier work (Brewer, 2009; Gajendran, 2010). It is highly significant in that it represents the first time that individuals' espoused values have been compared to their deeply held beliefs -- analysed in terms of attitude and subsequent behaviour of individuals -- and thereafter linked to the formation of project team culture. It specifically does so by reporting a meta-analysis of two independently conducted case studies of the same medium-sized construction project to extend an educational facility, worth A$30m. This project was deemed suitable for both studies as it utilised BIM, web-based information sharing, and a raft of other ICT. The case studies were completed as part of doctoral studies over several months during the construction phase of the project, and collected multiple data, which was subjected to three different forms of qualitative analysis.

The study revealed that in spite of the presence of various state-of-the-art ICT systems including BIM and web based information sharing the project participants were largely ignorant of their presence and would have been unlikely to use them if they had known of their existence, due to a lack of conviction as to their benefit. As a consequence the project team was characterised by a lack of integration, with "islands of automation" (Hannus, 1999: p36) being evident in certain participant firms. Ultimately this study concludes that this was due variously to the prior experiences and personal biases of key project participants, a team-wide lack of both technological alignment and the absence of clear leadership, especially during the early stages of the project when the project team and its socio-technological norms were being established.

2. LITERATURE REVIEW

It has sometimes been suggested that the low level of innovation is a consequence of a lack of conviction on the part of decision makers in the industry of the benefits - economic return - arising from its use. Classical economic theory indicates that this is a logical consequence of a rational cost benefit analysis undertaken by potential innovators, resulting in widespread rejection of its efficacy, and indeed on one level this appears irrefutable. However, such business decisions are made by humans, often on the basis of incomplete knowledge of the "facts", influenced by prior experience, and frequently, emotion, in a boundedly rational way (Simon, 1991). Business decisions made on the basis of bounded rationality are rarely optimal, instead resulting in "satisficing" solutions, outcomes that can be described as being "good enough".

A better understanding of the influences that shape the attitudes of potential innovators and adopters of innovation, and particularly the attitudinal traits of strategic decision makers (Venkatesh, Morris, Davis, & Davis, 2003) who sanction and dictate their deployment within construction firms and construction project organisations would help innovation levels in the construction industry. However, the human dimension has been largely overlooked by construction industry researchers and policy-makers. At present, no research has been undertaken to comprehensively map the attitudinal profile of innovators in the construction industry.

The collaborative use of ICT in general and BIM in particular can be thought of as a business innovation in the classical sense (Heertje, 2006, page 26), with adopters being at the front of the innovation wave (Peansupap & Walker, 2006). This activity is conducted in the expectation of developing sustained competitive advantage

based upon the development of a set of core competencies (Porter, 2005) which in turn display the aggregation of synergetic capabilities having broad applicability and sustainable value generation (Gallon, Stillman, and Coates,1995). However a Porter-like conceptualisation of the value chain necessarily concentrates the consideration of innovation to the focal company, whereas the generation of competitive advantage through ICT/BIM is necessarily far more networked (Hakansson and Johanson,1992). Moreover, this type of innovation must be genuinely co-constructed rather than "imitative" (Manly and McFallon, 2003). The success of such an approach is largely dependent upon the attitudes and subsequent behaviours of the collaborators.

Describing the attitudinal traits or attitudinal profile of a particular population is a technique that is familiar to both market and academic researchers, across multiple fields and disciplines. However in each case the starting point has to be a pre-existing framework of reference such as Ajzen's (1991) model, or multidimensional attitude profiling (Gann & Salter, 2000). This approach underpins the mapping of the attitudinal domain within which ICT/BIM decision-makers for TPOs operate (Brewer, 2009; Brewer & Beard, 2009). Implicit in this is the understanding that a collection of decision-makers within a single TPO will necessarily develop a group culture, be that positive or negative.

Organisational culture has been variously described as a "strong prescription for success" (Martin et al., 2004) and "an interpretation for better understanding" (Willmot, 2000). However in both cases the concept of "cultural analysis" has been mooted as an appropriate mechanism to allow its investigation.

Culture is an emergent feature of a group, which springs from the underlying assumptions and beliefs of its members about what they share in common, how the world operates and consequently, how they should relate to it. This shapes their attitudes and often their consequent behaviour.

Schein (2004) defines culture as:

'a pattern of shared basic assumptions [beliefs] that was learned by a group as it solved its problems of external adoption and internal integration, that has worked well enough to be considered valid and, therefore, to be thought to new members as the correct way to perceive, think, and feel in relating to those problems' (p 17)

Group culture can manifest itself overtly through rituals and other behaviours, although often the most enduring cultural traits are embedded in the underlying beliefs held by its members (Schein, 2004; Rousseau, 1990). These beliefs can take one of two forms: espoused, and actual.

Espoused or claimed (beliefs) are usually those attributes that people want to be seen to possess, or believe they should demonstrate. By contrast actual beliefs are those made manifest through their unconscious behaviour. Literature (Schein, 2004) suggests that attempting to understand culture through surface level manifestations alone (e.g. overt behaviour) is unreliable. Schein (2004) recommends surfacing deeper psychological manifestations such as underlying assumptions or beliefs as a more reliable approach. Thereafter it is possible to observe "inconsistencies" or "conflicts" between overt behaviours indicative of claimed beliefs, and underlying beliefs.

The learning or transmission of cultural assumptions or beliefs from one person to another within a group is the way in which group cultures form, whether they form spontaneously (e.g. when a group is thrown together unexpectedly) or by design (e.g. through recruitment of like-minded staff). Various metaphors have been developed to explain the cultural development of groups, likening it to engineered control mechanisms (Archer, 2004), infection (Geertz, 1966), or evolution (Sperber, 1996): where the spread or promotion of cultural traits is not actively initiated or managed there has to be an alternative, naturalistic facilitation process, as in the latter two instances. In the context of this paper the development of project team culture and the cultural influence of the industry beyond the focal project is of central importance.

Many authorities regard the integration of ICT/BIM into construction industry supply chain activities as both desirable and imperative (e.g. Department of Trade and Industry, 2001). This runs counter to its cultural norms and project-centric structure. A conceptual model of the TPO is therefore useful to analyse cultural influences on ICT use in this context (Brewer, Gajendran, & Chen, 2006). Such a model is illustrated in Figure 1. Derived from concepts originated by the Industrial Networks School of supply chain management (Ford, 1997; Hakansson & Johanson, 1992) it notes that each organisation within the project consists of a network of interacting actors, resources, and activities, all of which are necessary in order for it to function. Crucially this is

extended to include the project, which itself becomes an actant. The model therefore posits that a TPO accretes around a project rather than an individual actor (e.g. the client).

The model illustrates that there are a number of ways in which TPOs can be influenced by each other, and that these are not always contractual. Indeed they may not be formally recognised at all, rather being the product of a network of informal contacts and communications (Wasserman & Faust, 1994). The model suggests that whilst the adoption of ICT might facilitate the communication of ideas and information within a TPO this is only one of a number of possible communication channels (Gajendran & Brewer, 2007).

Figure 1 (Brewer, Gajendran, & Chen, 2006) illustrates the relationship between two TPOs formed to complete two projects. It shows the way in which most participants in each project have formed a tactical process link with their project, doing so principally for contractual reasons and without the expectation of a continued business relationship with it beyond its completion. It also shows that project participants who are actively employed on more than one project actually span the boundary of each TPO to which they belong. Moreover the case of Supplier 5 suggests that organisations that are not formally part of a TPO, but that have a strategic business relationship with a TPO member also span the TPO's boundary. In short Supplier 5 and Sub-contractor 2 both have the potential to influence the cultures of TPOs A and B.
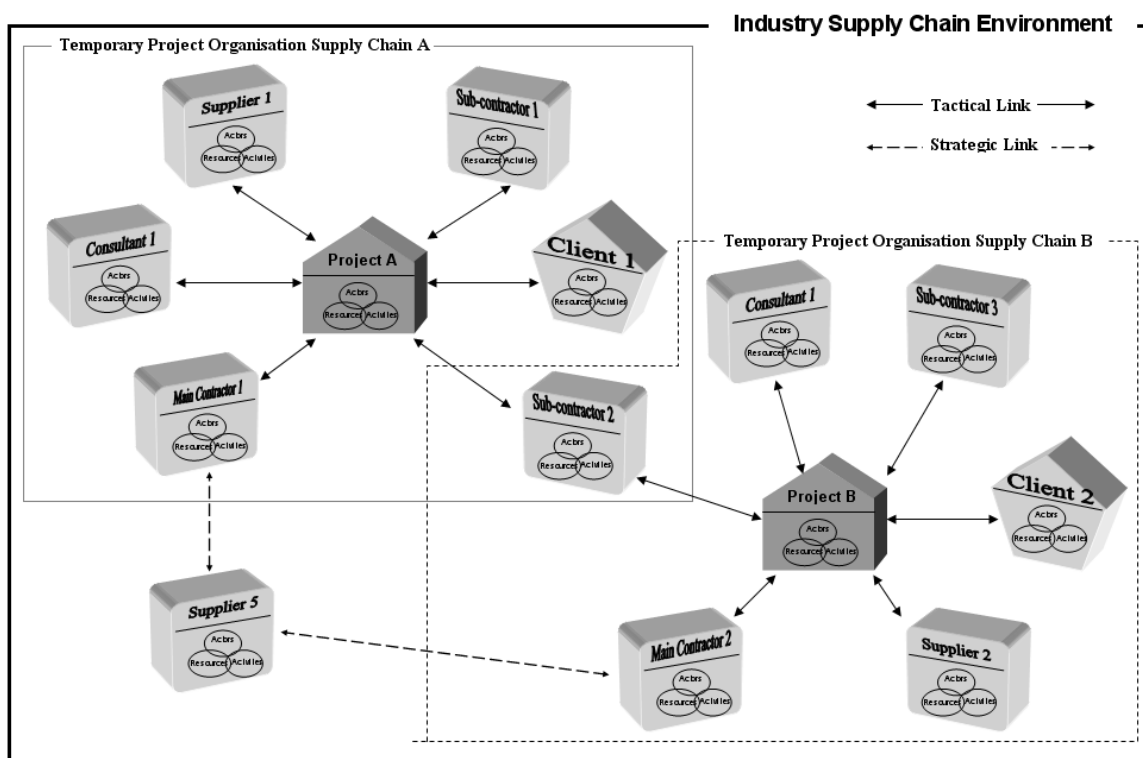

FIG. 1: Interaction between two TPOs (Brewer, Gajendran, & Chen, 2006).

In the context of the current research question it is clear that the principles embodied in this model have the capacity to impinge upon the formation of culture in relation to the adoption and use of ICT/BIM within a project setting, both in a positive and a negative way.

Brewer (2009) develops a model of innovation and attitude to explain the influences affecting the behaviour of decision-makers considering the innovative use of ICT across TPOs in the construction industry. Using Ajzen's Theory of Planned Behaviour (1991) as the point of departure it acknowledges that the ideal decision ought to be to integrate ICT throughout the primary participant organisations in a particular TPO, with its ultimate expression in the adoption of web based communication plus online access to BIM information. A meta-analysis of case study data (Brewer, Gajendran & Beard, 2009) confirmed the model's applicability for analysing the decision-making of key individuals operating within BIM-centric contexts.

The collective attitudes and behaviours of a group of people in large part serve to define their group culture (Schein, 2004). Culture has the ability to influence all areas and activities within organisations, and whilst these are usually thought of as being an individual firm, club or institution, cultural concepts can equally be applied to project teams. It has been observed that the culture of a construction project influences its level and quality of ICT uptake and integration.

Previous research identified the Critical Success Factors (CSFs) for integration of ICT as being: Organisational Commitment; Organisational Attitude to Communication; Rights and Duties of Organisations (in relation to ICT-mediated communications); Investment Drive, and; Risks related to ICT Usage (Brewer & Gajendran, 2006). Subsequent cultural analysis of these revealed that the cultural values espoused by the industry were analogous to the desired cultural values for an optimised project environment, which in turn ought to facilitate ICT integration. Unfortunately in practice it has been found that very few real life project cultures reflect these cultural ideals, resulting in a wide disparity between the levels of ICT integration experienced by participants in different projects.

Analysis of the literature reveals that sub optimal ICT/BIM integration across a TPO can result as a consequence of poor, or non-existent leadership at both the intra- and inter-firm levels (Peansupap & Walker, 2006), which may well eventuate as a consequence of the perception of business and/or political risks (Maidique, 1980). Such a position may be in stark contrast with the business advantages espoused by proponents of the technology such as software developers and vendors, and clearly alludes to the presence of complex, bounded rational underlying attitudes in the minds of key decision-makers.

Green, Thorpe, and Austin (2001) indicate the need to identify and understand the mechanisms by which the change of risk preference and perception are facilitated, echoing the seminal 12 question, choice dilemma questionnaire (Wallach, Kogan, and Bem, 1962). In essence they found that groups were more prepared to live with a higher level of risk than the individuals of which the group was comprised, and Bateson (1966) explains that this phenomenon would likely be caused by the greater attention to a particular issue arising out of group discussion. On the other hand Myers and Bishop (1970) considered that group attention to a particular issue tended to polarise individual members, propelling them towards extreme positions of which they had an existing predisposition. In both cases a risk-shift would be apparent, both in terms of the attitudes and behaviours of individuals within the group, and the resultant culture(s) that formed within the group.

It is often argued that the project-centric nature of the construction industry necessarily imposes a short-to medium-term perspective on many of its participants, and indeed this is often reflected in the decision-making relating to ICT/BIM innovation within construction-related firms (Irani, Hlupic, Baldwin & Love, 2000). Nevertheless it is equally observed that the leadership required to maximise the likelihood of successful ICT/BIM innovation (Peansupap & Walker, 2006) is reliant upon those leaders having a long-term vision that extends beyond the individual firm and project (Ford, 1997).

It follows that a comparison of the actual culture of a project with the espoused culture provides a basis upon which to identify the issues that lead to sub-optimal levels of ICT integration. The Cultural Analysis Framework for ICT integration proposed by Gajendran & Brewer (2007) maps the actual cultural characteristics of the environment into which ICT is deployed, comparing it to the cultural stereotypes first identified in their CSF study.

3. RESEARCH METHOD

The research presented in this paper arises out of a meta-analysis of two earlier interview-based studies of the same construction project -- an educational institution in regional Australia, investigating alternative ways to accommodate an academic unit -- undertaken as part of separate doctoral dissertations. In one instance the interviews were treated as individual units of investigation rather than components of a case study, and it is the current research that brings them together to provide a comprehensive explanation of the project in a case study. A new research approach therefore had to be developed in order to coherently knit together the disparate data. The approach taken was exploratory, with the intention of generating theory.

The original data collection was completed over several months during the construction phase of the project, and collected interview data, questionnaire data, participant-derived supply chain maps, and other peripheral data offered by the participants. Six representatives from primary stakeholders in the TPO (head contractor, client's

representative, architect, quantity surveyor/project manager, lift subcontractor, structural engineer) were interviewed on two separate occasions. At the first interview each was asked about both their firm's stance in relation to the five critical success factors for ICT integration (Brewer & Gajendran, 2006) and their own personal attitude towards them. The interview was augmented by their completion of a questionnaire that had also been distributed by post as part of a national survey (Brewer & Gajendran, 2006). The interviewees were also helped to sketch a diagram of the TPO supply chain as viewed from their perspective, indicating both the nature of the relationships with their trading partners, and the nature of the ICT mediated interactions with each of them. In the second interview they were quizzed about the behaviours of both themselves and their counterparts from trading partners within the TPO, exploring cultural traits and their consequent impact upon the conduct of the project. All interviews were conducted using semi-structured principles.

The use of multiple data sources was chosen to increase the possibility of identifying confirmatory/conflicting data during analysis and interpretation. Analysis of the data thus generated from each phase of the study was directed by one or other of this paper's authors as part of their doctoral studies, supported by a research assistant.

In order to conduct the current meta-analysis it was necessary to develop a new protocol for application to both sets of interview data. At its heart were the precepts of content analysis, coding the data for characteristics associated with key concepts. Since these could not simply mirror the findings of the donor studies they therefore had to emerge from the data itself, during reading. Figure 2 illustrates the process used.
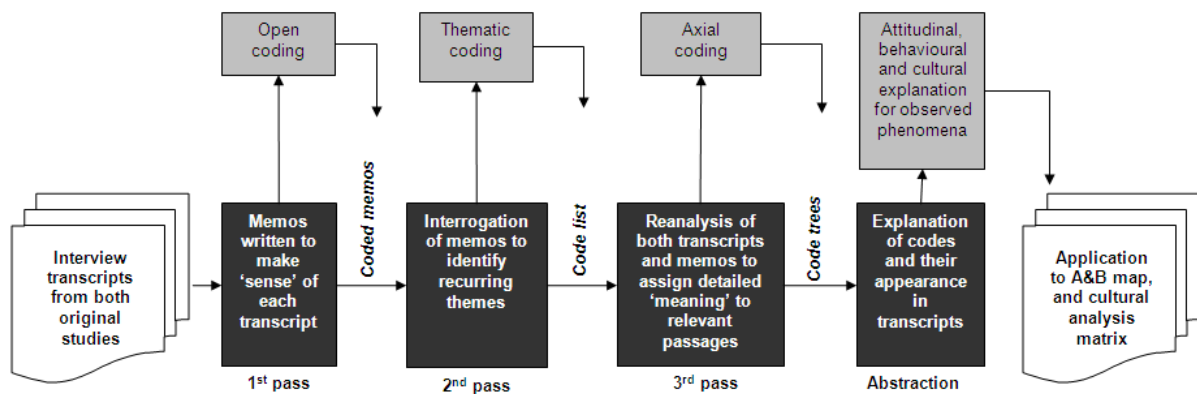

FIG. 2: Methodological design (adapted from Brewer & Gajendran, 2010).

By way of example, codes were developed during the re-analysis of both sets of interviews that revealed links between individual interviewees' prior experiences relating to the control of intellectual property in an ICT mediated environment and their behaviour in the current project: this is summarised in the relevant cells within the A&B map. These were thereafter traced on a participant-by-participant basis to describe their impact on the creation and subsequent evolution of this particular TPO's culture: this is summarised in the Cultural Analysis table. This process was replicated in relation to all of the attitudinal/behavioural/cultural traits thus linked in this research

4. RESULTS

Initial analysis of the project revealed that the architect and the rest of the design consultants were located in the State capital, with the architect having previously worked satisfactorily with the structural engineer (though not on the original base building). On the basis of satisfactory prior experiences in the cost planning and bid evaluation processes the regional office of a major quantity surveyor was approached by the client to be their project superintendent. The head contractor was also locally based and had prior knowledge of the project, having been responsible for the construction of the base building. However their involvement arose from success in a competitive tendering process. The main procurement strategy for the project was construct-only. AS2124 was chosen as the main contract following legal advice suggesting that AS 4000 was less effective for risk minimisation.

The majority of the sub-contractors were domestic, contracted directly by the head contractor. The nominated sub-contractors had a long-term relationship with the client, being responsible for campus-wide fire and security services. Figure 2 illustrates the structural relationships between the various TPO participants.

The use of diverse ICT was evident in various parts of the TPO at different stages of the project. The use of BIM during the design stage by the architect was not continued into the construction stages. This was largely a consequence of a lack of BIM capability in other parts of the TPO. The architect also provided an online file sharing facility in the form of an FTP website, with the intention of facilitating TPO-wide electronic information exchange however its use was not mandated in the conditions of contract.

The following sections report the outcomes derived from the analysis of multiple data obtained during the case study, and do so in three ways: firstly, by reference to the CRC-CI CSF model (Gajendran, Brewer & Chen, 2005); secondly, by application of the A&B map (Brewer, 2009) to interview transcripts, and; thirdly, by analysing stakeholder attitudes and behaviour from a project culture perspective.

4.1 CRC-CI CSF Model

The CRC-CI CSF model was developed using a national survey across four broad sectors of the architectural, engineering, and construction industry (Gajendran, Brewer & Chen, 2005). The same survey instrument was administered to each of the case study interviewees, and the results thus obtained were compared to those from the national survey. They were largely found to be within one standard deviation of the sector norms and the case study interviewees could therefore be said to share the espoused attitudes of their colleagues in the industry.

Using evidence from the analysis of the interview transcripts, and coding this to the overarching categories contained within the model it was possible to develop case study-specific statements relating to the use of ICT in the project. These statements were then circulated to the interviewees for approval and sign off: the following sections summarise their content and represent a shared, group response from the TPO.

4.1.1 Organisational Commitment

- The architect provided extranet facilities for the use of all members of the design and construction teams.
- The architect was willing to use the extranet to share BIM data with others in the TPO, as well as converting BIM data into two-dimensional drawing sheets for those who were unwilling or incapable of working with the BIM data in its native format.
- Serious design consultants were both willing and capable of participating in a limited amount of data exchange using CAD capabilities, though not in a true BIM way, and usually not through the extranet.
- The client's representative had a commitment to the use of ICT, particularly email, as a preferred communication medium.

4.1.2 Organisational Attitude

- To a greater or lesser extent all of the TPO members directly involved in the case study expressed the belief that ICT was the way of the future, and that their organisation was actively involved in preparing for such a future.
- With the exception of the architect who's stated posture was strategic in intention, but generally project-by-project in implementation.
- By contrast the architect was treating the case study project as a BIM trial, but intended to make it a core business practice into the future.
- All case study participants emphasized the high level of commitment required to make ICT/BIM and integral part of their future, citing it as a significant hurdle to be overcome.

4.1.3 Industry Regulation

- Despite the presence of high-level BIM and other ICT infrastructure it was commonly reported that the issue and receipt of drawings was problematic.

- The use of an FTP site did not ensure accurate version control at site level, nor did it ensure that information thus distributed was ultimately read.
- Ad hoc "workarounds" included using e-mails with PDF attachments as proof-of-receipt.

4.1.4 Investment Drive

- All participants interviewed were of the opinion that the overriding concern for their organisation was the likelihood of a return on their ICT investments, and the payback period.
- ICT was regarded as a tool that facilitated business improvement, not a revolutionary advance that would change their business in a radical way.
- BIM would not be adopted if the promise of improved profitability was not clear and present. Thus far the architect was the only participant to report a positive outcome in this regard. The adoption of ICT for presentation purposes was a business necessity, the absence of which would be likely to result in lower business levels.

4.1.5 Rights and Duties

- From the client downwards there was an acceptance of electronic communication for the distribution of contractually binding documentation.
- Equally there was a feeling that by placing documents on the extranet or by emailing a response to a situation, these actions might "deal" with issues but was not guaranteed to "resolve" them.
- Across the TPO there was a lack of concern about leakage/misuse of intellectual property that had been shared electronically.
- At an industry-wide level there was a general feeling that the legal community was lagging in regard to addressing the particular issues that electronic document exchange posed.

4.2 Attitude & Behaviour Model

The simplified model shown in Figure 3 has been derived from Brewer (2009) specifically for this analysis and shows that individual attitudes to ICT innovation arise as a consequence of a number of issue domains. The first set of these contains external considerations include human, technological and business processes. The second domain is comprised of an internal component relating to personal considerations. Lastly the decision maker is influenced by environmental influences including technological push, cultural pull and changes accrued during the passage of time. The model indicates attitudes may be influenced by intra-firm and inter-organisational considerations, and that temporal consideration may be reflected in the time frame over which the effects of decisions are believed to occur.

The overall structure of the model is triangular, linking the various influences to reflect their interdependence. At their heart are personal issues related to the individual decision maker. Whilst the external issues reflecting business experiences have often been reported, the internalised personal issues are often overlooked when investigating influences on business attitude.

The model is subjected to two contextual influences, namely "technological push" and "cultural pull". Ultimately these are in a constant state of flux, and change over time.

In its original form this model mapped the domain within which the overwhelming majority of ICT decision-makers attitudes could be located. However it made no attempt to identify the attitudinal profiles of individuals, nor provided a mechanism with which to do this. The current study has focused on the four issue domains and addressed them in terms of the operational contexts within which they will be considered by the individual decision maker, and the term over which the decisions are thought to have an impact. A matrix (Table 1) was developed specifically for this purpose, to be populated with summaries obtained from the thematic re-analysis of interview data, representing the first attempt to apply the generalised map (Brewer, 2009) to a specific project.
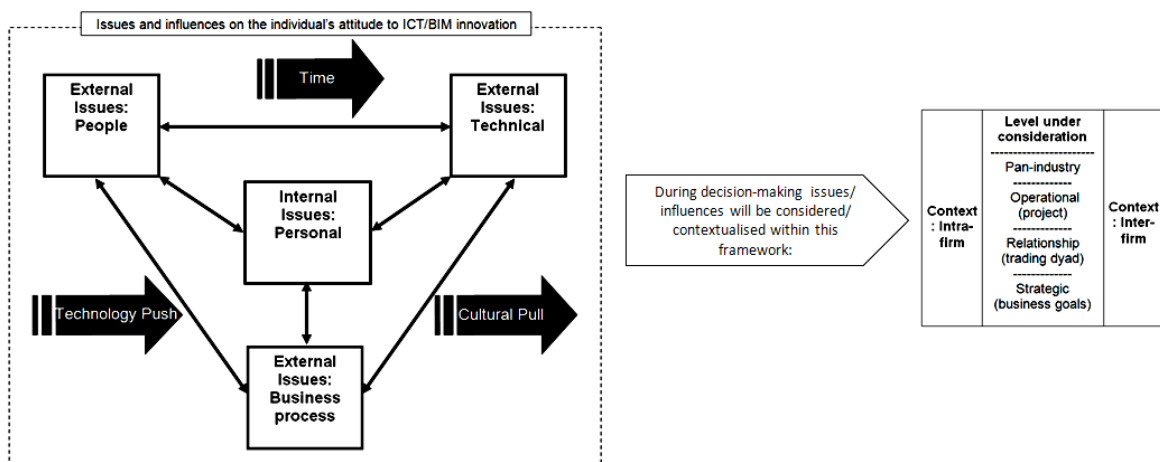
FIG. 3: Attitude and Behaviour model for ICT/BIM innovation (adapted from Brewer, 2009).

Thematic re-analysis of the interview data was conducted with the intention of separating the personal attitudes and consequent behaviours of interviewees in relation to ICT/BIM from their espoused values. To put it colloquially, this part of the study identified the extent to which each project participant "walked the walk" as opposed to "talking the talk". The results are presented in Table 1.

4.3 Cultural Analysis Model

Using the CRC-CI CSF framework (Gajendran et al, 2005) as a point of departure it is possible to identify seventeen traits necessary as precursors to ICT integration across a TPO (Gajendran & Brewer, 2007). However Schein (2004) indicates that the prevailing group culture is best decoded through analysis of the underlying cultural beliefs of individuals within the TPO. By this process it is possible to identify any individual disparity between initial claims that certain traits for ICT integration are essential, and their true attitudes and subsequent behaviours.

The complexity and uniqueness of each individual project environment, together with the constantly changing mix of project participants results in an equally complex mix of attitudes and beliefs across the TPO members. The extent to which they are congruent in large part determines the extent to which the eventual project team culture is integrated, differentiated or fragmented. The cultural analysis framework developed by Gajendran & Brewer (2007) allows these attitudes and beliefs to be decoded on an individual basis, allowing their aggregation to reveal the net impact upon project team culture in relation to ICT/BIM integration. Table 2 details outcomes in the case study project.

5. DISCUSSION

Echoing Porter (2005) in terms of competitive collaboration, and therefore their espoused values in relation to ICT-mediated collaboration the members of the case study TPO generally proclaimed the adoption of ICT to be a positive business innovation, and were guardedly optimistic about its use in the future. However their feelings about BIM were more varied, and clearly reflected an absence of confidence in the technology to deliver Schmpeter's increased profitability through innovation as a result of its use (Heertje, 2006). The reticence or inability of some participants to fully engage with the BIM capabilities provided on the project prevented the co-construction of collaborative work practices, leading to isolated incidents of innovation as a solo activity (Manly and McFallon, 2003), therefore negating Gallon's expected opportunity for sustainable value generation (Gallon, Stillman, and Coates, 1995).

TABLE 1: Attitude and Behaviour matrix for the case study project. (Brewer & Gajendran, 2010)

Domain	Technological			Human			Business process			Personal		
Participant	Intra	Inter	Term	Intra	Inter	Term	Intra	Inter	Term	Intra	Inter	Term
Client	Accepting of, and happy with low level ICT/ protocols across organisation.			Questions practicality of up-skilling FM function to utilise BIM capabilities – majority of facilities are over 20 years old	Sees little benefit		Sees no benefit in requiring BIM for projects when compared to costs	Tends to be bureaucratic	Committed to particular products and services from particular services contractors	Reactive: largely determined by corporate information policy	Reactive: largely determined by corporate information policy	
Architect	High end technology, at introductory stage. Appreciates distinction between BIM and CAD	Various, depending on capabilities of trading partners	Strategic, long-term commitment Seeks similar from other consultants. Hopes they understand BIM/CAD distinction	Recognises enormity of BIM/ICT investment in terms of human capital and development			Utterly committed	Experimental Not committed to driving adoption across the current TPO			Risk averse in sense of not pushing a still-experimental protocol on others	Complex. Sees current FTP arrangement as optional, but intends to be an industry leader in the future
Head Contractor	Standard business applications, would like to automate inventory and invoicing. No BIM.	Largely reactive. Frustrated by confusing lines of communications	BIM (non) engagement is a short term issue		Appreciates potential to incur costs to comply with multiple trading partners, for little reward except for winning job			Keen sense of potential for ICT/BIM to present opportunity, but more so as a threat.		Strong sense of purpose/loyalty to firm's business objectives.	Mediate, conciliate & facilitate solutions. Not positive about web-sharing of project info.	Long term benefit in maintaining reputation
Quantity Surveyor/ Project Manager	Standard business applications, as well as state of the art QS application	Largely reactive. Frustrated by confusing lines of communications	Strategic, long-term commitment Arguably waiting for the industry to catch up.	High levels of commitment to staff development and R & D			High levels of commitment to R & D, but not sure that industry is ready to engage,	Sees client risk as the driver/ barrier to BIM and other high end ICT	Ultimately strategic, but a follower.	Reactive: largely determined by corporate information policy	Reactive: largely determined by industry-wide changes	
Sub-contractor	Standard business applications, as well as state of the art CAD application		Product driven, information intensive, global (lift manufacturer		Sees the firm as autonomous within the project, largely avoiding interaction		Highly ICT-driven	Process driven	In a position to dictate business protocols		Bemoans the loss of face to face contact with supply chain (up and down stream)	
Structural Engineer	Adaptable, using all technologies from drawing board up to CAD. Uses work-arounds to deal with system conflicts	Recognises system compatability issues as serious impediment to wider use		High levels of commitment to staff development and R & D				Would prefer to work with a strategic group of consultants.		Driven by achievement and pride in finished projects.	Risk averse in terms of losing control of intellectual property. "Genie in the bottle". However is sanguine about paper-based IP loss.	

Schein's precepts (2004) indicate that the case study participants questionnaire responses could be regarded as a public espousal of the broadly ideal, and largely mirrored the national CSF survey. However, when the interview transcripts were analysed from the perspective of each respondent as a decision maker for their firm/organisation, mapping the effect of their personal attitude to the adoption of ICT in general and BIM in particular, it became apparent that the group encompassed a wide range of underlying beliefs, leading to the creation of a disparate collection of cultures (Schein, 2004;

Rousseau, 1990). Reflecting the findings of Hinks et al (1997) the lack of cohesion could in many ways be attributed to a corresponding lack of leadership within the TPO.

TABLE 2: Cultural Analysis for the case study project. (Brewer & Gajendran, 2010)

ICT Integration Trait *Successful ICT implementation requires:*	Organisational trait *For a firm to successfully integrate ICT within a TPO:*	Observed Culture *In this case it was found to be:*
The commitment of a firm's senior management.	Senior management should embrace ICT and commit to implement ICT in their organisation/when there is potential for ICT to support operations.	Differentiated
The commitment of an organisation's employees	Employees need to commit to engage with ICT tools those support/enhance their personal work environment	Differentiated
Transparency and trust among project team participants	Members of the team should develop trust and transparency within the project environment	Integrated
The identification and sensitive handling of the ownership of the intellectual property generated during a project	Contractual arrangements should encompass safeguard on intellectual property rights.	Integrated
The project team members to acknowledge the sensitivity and confidentiality of other participants' information	Members are guided by explicit codes of practice and informally held ethics and moral values. The source of these value codes may come from the organisation's procedures, personal upbringing or by education.	Integrated
A powerful ICT "champion" to support the technologically weaker organisations in project teams	Powerful member should support the weaker members through leadership, collaboration or as a result of their positional power.	Fragmented
An organisation's continuous and conspicuous investment in staff development and training	Should continuously invest in their staff ICT development programs and training	Differentiated
A "powerful organisation" within the team to impose ICT adoption	Could impose 'power positions' within the project to encourage appropriate level of ICT use in a project environment	Fragmented
A "champion" to support all new technology that is to be used across a project team within a firm/Project.	Leadership structure should engage in giving proactive direction in the use of new ICT tools and techniques	Fragmented
Standard conditions of contracts that specifically accommodate the issues raised by the use of ICT	Need to maintain contractual clarity in ICT employment through stipulating conditions of contract and adherence to the conditions. This also could be viewed as an industry regulators role.	Differentiated
An organisation to be prepared to engage in long-term collaborative relationships	Preparedness to engage long-term relationships with trading partners.	Differentiated
Organisations to commit to ICT as a long-term strategic decision.	Commitment to engage in long term strategic relationships with trading partners to foster return on large ICT investments	Integrated
Organisations to commit to ICT as a project-based tactical decision.	Commitment to engage with ICT in project to project basis in short run in small ICT investments	Differentiated
The organisations to monitor competitor's ICT adoption.	Need monitor the competitors to gain potential competitive advantage	N/A
Addressing the fragmentation issues of the project team for improved performance of ICT-enabled operations.	Must engage in procurement methods that minimises fragmentation of project teams.	Fragmented
Organisations try to limit their use of multiple online systems promoted by different project participants.	This factor can be viewed purely as a technical (interoperability) issue, outside of cultural considerations. However, one can relate the espoused values to Item 12 above	Fragmented
The security of information is vital in an ICT-enabled project environment.	This can also relate to the espoused values relating to the level of acceptance of ICT security	Differentiated

The literature is replete with references to successful ICT/BIM implementation requiring active "championing", both in terms of the business-technology interface (e.g. Angeles et al, 2001), and the initial demand for its adoption (e.g. NSW Government, 2002). Very often this role is associated with an "informed client", who has a pre-existing understanding of its potential to deliver increased value to them over the lifetime of the building. Public sector clients are often cited as the most likely source of this kind of leadership. In this particular case the client's representative was a slave to a highly complex bureaucracy, having to reconcile and coordinate input from multiple institutional stakeholders, as can be seen from Figure 2. Throughout the transcript it was apparent that the client's representative was well aware of the capabilities that BIM offered, both in terms of technological outcomes and the University's business processes. Angeles et al (2001) suggest that for project champions to dismiss their consideration on the basis of existing institutional policy required them to see no personal benefit in championing their adoption.

By comparison the architectural practice engaged on the project could be thought of as being an industry leader, both in terms of technology and its intra-firm integration into business processes. The architect's representative in the TPO largely shared this vision, but tempered it by echoing Green et al (2001) with the realisation that being a leading edge BIM adopter could be fraught with risk particularly in terms of integrating -- or rather failing to integrate with the majority of trading partners through their lack of capability.

The architectural practice had demonstrated proof-of-principal through limited BIM and on-line integration with other design consultants, but had developed quite convoluted online analogues of paper-based information sharing processes in order to communicate with the rest of the TPO, indicative of Schein's (2004) pervasive fragmentation. Clearly this was both inconvenient and costly, and as a consequence it was evident that the architect's representative was committed to backpedalling on future projects in terms of business process integration with trading partners (Green et al, 2001).

The head contractor's representative was aware of the existence of both the BIM outputs and their accessibility via the project FTP site provided by the architect, but was clearly sceptical about their value to him as a tool for assisting in project completion. However, as Archer (2004) indicated, of far more immediate concern was the lack of clear communication channels across the TPO, irrespective of the technology used to facilitate them.

For the other TPO participants interviewed in this study the issue of ICT/BIM was on a practical level a matter of intra-firm investment and policy, reflecting Irani, Hlupic, Baldwin & Love (2000), rather than the strategic commitment to implementation on this and future projects implied by Ford (1997). Thus it can be seen that the project was characterised by clusters of collaboration rather than seamless integration, arising from a lack of clear leadership and vision for the TPO in terms of ICT/BIM adoption and integration. Yet in spite of this several of the people interviewed spoke of the project in positive terms, hinting at issues of "team spirit" and informal leadership. It turned out that this could be explained from a team culture perspective

When the individual transcripts were analysed in the context of the cultural integration framework it was found that out of 17 espoused conditions for ICT integration only four actually reflected a culture of integration. Seven aspects were differenced and four were wholly fragmented. Although the ICT environment was a mixture of 'integration', 'differentiation' and 'fragmentation' (Schein, 2004), it was the last of these conditions that characterised the project.

Detailed analysis revealed that a lack of technological alignment combined with the absence of leadership were the main causes of this outcome, with the situation being compounded by those provided with a leadership position failing to fulfil their obligations. Paradoxically those aspects of the integration framework that were integrated in practice, whilst not leading to ICT integration, did nevertheless play a major role in mitigating what would otherwise have been a very dysfunctional set of TPO relationships. In particular the high levels of trust and respect that were fostered and maintained throughout the project enabled the head contractor's representative to overcome fragmented communication and information sharing, allowing project completion to the general satisfaction of all stakeholders.

Overall it was possible to identify that cultural development in the TPO was hampered from the outset by legacies from the base building project -- changes of structural engineering consultant, and the uncertainty this introduced for the new engineer – a situation that pre-existing relationships couldn't fully overcome. Thereafter major changes in the TPO composition -- participants and changes in their role/scope of responsibility -- ensured

that no opportunity existed for an integrative culture to develop. Islands of cooperation did develop, often where a previous history of successful collaboration existed, and a positive attitude from the contractor drove the project through tough times. Surprisingly the client organisation, which had a reputation for developing sophisticated and standardised IT protocols for its core business, appeared unwilling to mandate or champion any significant level of ICT use across the TPO. This style of risk minimisation extended to the procurement mechanisms, which many TPO participants identified as a barrier to better e-business engagement. The client's representative was reticent about encouraging the use of ICT, either with his employers, or with others in the TPO.

These behaviours could be considered to be transmissible cultural traits, which Geertz (1966) would appear to suggest 'infected' the rest of the TPO, contributing to the overall project culture. Certain traits could, through comparison of individuals' espoused values with their observed attitudes and behaviours, be seen to have been 'imported' into the TPO as cultural artefacts developed elsewhere. They too could be considered to be 'infectious', though the extent to which they took hold depended upon the receptiveness of the current TPO culture. Thus it was evident that the creation of the best possible initial cultural conditions at the inception of the TPO was a critical consideration in ensuring the likelihood of maintaining the good cultural 'health' of the TPO throughout its life.

6. CONCLUSIONS

The case presented in this paper was chosen because of the presence of high-level ICT and particularly BIM to facilitate the TPO's e-business. This research has suggested that despite this the TPO has failed to embrace its widespread use. When initially quizzed about their espoused position in relation to technology all of the senior decision-makers in the organisations displayed similar beliefs to their colleagues elsewhere in the industry, leading to the expectation of positive outcomes from their engagement with technology. However, when probed deeply on the subject many revealed disparate understanding of the term BIM -- with many viewing it as a vague 3-D CAD model of interest to others in the TPO, but not to them -- and the general reluctance to wholeheartedly invest in success.

Few members of the TPO recognised the project ICT as a venue for deep and complex collaborative interaction, and none expressed the view that this should be synchronous or involve shared access to a common model. In general their attitudes were at odds with their espoused values, revealing them to be sceptical about the benefits and disinclined to engage. Their consequent behaviours, particularly during the formation of the TPO, resulted in an overall state of ICT fragmentation. Nevertheless pockets of technology-mediated collaboration were evident in parts of the TPO supply chain, leading to an overall project team culture that was clearly differentiated.

Cultural analysis of team performance is notoriously complex. However in this case two particular factors are clear. Firstly, although the architectural practice provided both the BIM and the FTP site for data exchange, it conspicuously failed to champion the use of either. This was partly as a consequence of their private concerns about the advisability of their use across the TPO, and also because their contractual obligations didn't require the provision of either technology. Secondly, although the client's representative was aware of the capabilities of both technologies, the highly bureaucratic organisation they represented had not recognised the potential benefit presented by their use – particularly BIM – both during the design/construction phase of the project, and more particularly during the operation of the building.

Whilst the individual frameworks of analysis used in this research have been derived from previous studies (Brewer, 2009; Gajendran, 2010) this is the first time they have been used in conjunction with each other. In doing so it provides an integrated process of investigation encompassing personal attitudes, leading to observable individual behaviours, resulting in the creation of project team culture. This can thereafter be deciphered in a systematic and reliable way, using the tools and frameworks utilised in this research. Its application to this case reveals the importance of the establishment phase of a project team both in terms of the technology itself, and the cultural environment within which it is to be used.

This is a single case study, and it is acknowledged that further confirmatory research is required. However there is nevertheless one last observation that can be made: the presence of clusters of integrated firms (culturally

differentiated) that have the ability to work together in a BIM environment suggests that it might be advantageous for them to continue to do so, on subsequent projects. On the other hand the structure and culture of the industry, and the consequent procurement mechanisms it employs do not encourage this approach. If classical economists are correct that the key to innovation is to generate sustainable competitive advantage then the challenge facing leading edge BIM adopters is to develop a business model that capitalises on collaborative working arrangements to create increased sustainable profitability. This in turn would appear to be dependent upon them developing demonstrably positive cultural traits that are sufficiently 'infectious' as to allow integration to occur with profitable regularity.

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