A CASE STUDY OF THE EFFECTS OF ATTITUDE, BEHAVIOUR, AND PROJECT TEAM CULTURE ON BUILDING INFORMATION MODEL USE IN A TEMPORARY PROJECT ORGANISATION

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ABSTRACT
Maximal benefit from Information and Communication Technology (ICT) investments can best be achieved in the construction industry where they are used collaboratively, in a project setting, using business processes that span the boundaries of individual firms. This has its ultimate expression in the Building Information Model (BIM) when it is utilised from the earliest stages of project feasibility, through the design and construction into the operational phase, yet this rarely eventuates. This state of affairs has as much to do with sociological and psychological influences as it has with technology issues. Recently completed PhD research found evidence that diverse influences on the formation of individual attitudes result in boundedly rational decision-making behaviour, which has a significant effect on the likelihood of ICT integration. Parallel doctoral research linked the effect of individual attitudes to the formation of project team culture and subsequent receptiveness to ICT integration. This research used both approaches to analyse a Temporary Project Organisation (TPO) revealing links between the individual attitude formation of key project personalities and their subsequent ICT decision-making behaviour. It found these behaviours collectively resulted in the formation of a differentiated project team culture, sub-optimal ICT usage, and minimal utilisation of BIM capabilities. This was attributed to both a lack of client demand for a functional model, and the absence of championing by the architect of the leading edge BIM access that they had provided to the rest of the TPO.

Keywords: BIM, attitudes, behaviours, project team culture, TPO.

1. INTRODUCTION

Building Information Models (BIM) are virtual technology artefacts that capture the form, behaviour and relationships between the parts and assemblies of a building in database form. This enables them to be visualised and their behaviour tracked under different conditions, and over the passage of time. These attributes present the potential to trigger significant changes in the development, design and building process (Weisberg 2000), however the technology has failed to gain widespread acceptance. Significantly the architectural, engineering and construction (AEC) sector lags behind other major industries producing 3D products in this regard.

Much of the research devoted to BIM is focussed on developing technological solutions aimed to standardise and streamline adoption across the design, construction and operational phases of a building. This work is predicated on the notion that increased functionality combined with improvements in usability and interoperability will necessarily increase uptake and integration across the AEC sector, and indeed these are necessary developments. However recently completed research indicates that a range of psychological phenomena found in individuals and across groups of people can be just as important in determining the success or otherwise of BIM adoption.

This study reports the final results of a detailed case study of a medium-sized construction project to extend an educational facility, worth A$30m, which utilised BIM and web-based communications, as well as more common ICT. This is believed to be the first time that individual attitudes and subsequent

behaviours have been tracked to the formation of project team culture, and identified its impact on ICT/BIM usage and effectiveness.

2. LITERATURE REVIEW

In the AEC sector it has sometimes been suggested that the low level of ICT 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 who sanction and dictate their deployment (Venkatesh, Morris, Davis, & Davis, 2003) 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. Until recently no research had been undertaken to comprehensively map the attitudinal profile of innovators in the construction industry.

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 Attitude and Behaviour (A&B) map within which ICT/BIM decision-makers for TPOs operate (Brewer, 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 consequently 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)

Previous research identified five critical success factors for integration of ICT (Gajendran, Brewer and Chen, 2005): 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. 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.

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 expressions) 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 claimed beliefs, and underlying beliefs made manifest in actions and decisions.

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 and Brewer (2007) maps the actual cultural characteristics of the environment into which ICT is deployed, comparing it to cultural stereotypes.

3. RESEARCH METHOD

Building upon the theoretical basis outlined in the previous section this research was designed to achieve three objectives: firstly, to identify a TPO's members' espoused values using a Critical Success Factor (CSF) framework; secondly, to identify their underlying beliefs through their attitudes and subsequent decision-making behaviours, and; thirdly, to identify the impact that individual attitudes/behaviours had on the development of the TPO culture, specifically in relation to ICT/BIM.

The case study TPO met the twin criteria of suitability and accessibility. In particular it employed sufficient high-level ICT including BIM and web-based communications, and was also accessible in terms of location and participant cooperation with researchers. Participants were chosen in terms of their centrality to the project throughout the design and construction phases, and would all be considered to populate the first tier of the project supply chain.

Representatives from the chosen firms in the TPO were interviewed on two separate occasions, at the first of which each was asked about both their firm’s stance in relation to five critical success factors for ICT integration, 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. The interviewees were also assisted to sketch a diagram of the TPO supply chain as viewed from their perspective, indicating both the nature of the relationships they had with their trading partners, and the nature of the ICT mediated interactions with each. On the second occasion 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.

The case study 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. 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, supported by a research assistant.

The following protocol was established for the project:

- Multiple analytical passes of the data were used to extract the fullest understanding.
- The first pass consisted of note/memo writing for each piece of data, which was read in isolation. This was a “sense-making”, topic identification exercise, and the notes/memos therefore become a legitimate part of the data to be analysed by the study.
- The second pass interrogated the researchers’ notes/memos themselves in order to identify emergent recurring theme codes, as differentiated from isolated topics.
- The third pass revisited the interviewees transcripts, utilising the code list developed in the previous step to assign particular meaning to text passages. The theme codes were then modified where necessary during this stage, with addition, extension and deletion of codes being permissible.

- Lastly a process of abstraction was undertaken in order to explain the appearance of various theme codes.

4. RESULTS

The client in this case was an educational institution in regional Australia, investigating alternative ways to accommodate a school of Design and IT. A design competition was initiated and the winning design added an extra floor constructed on top of a multi-storey car park that had been completed 18 months earlier.

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. 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, since the project was construct-only. 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.

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 as they perceived 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. The eventual lack of engagement with it was caused in the first instance because its use was not mandated in the conditions of contract, and thereafter by a lack of awareness of its existence across large parts of the TPO. Eventual project team communication processes centred on the use of emails, printed media and telephones. The head contractor did not use an online collaboration platform in its communication with sub-contractors.

Figure 1 illustrates the structural relationships between the various TPO participants.

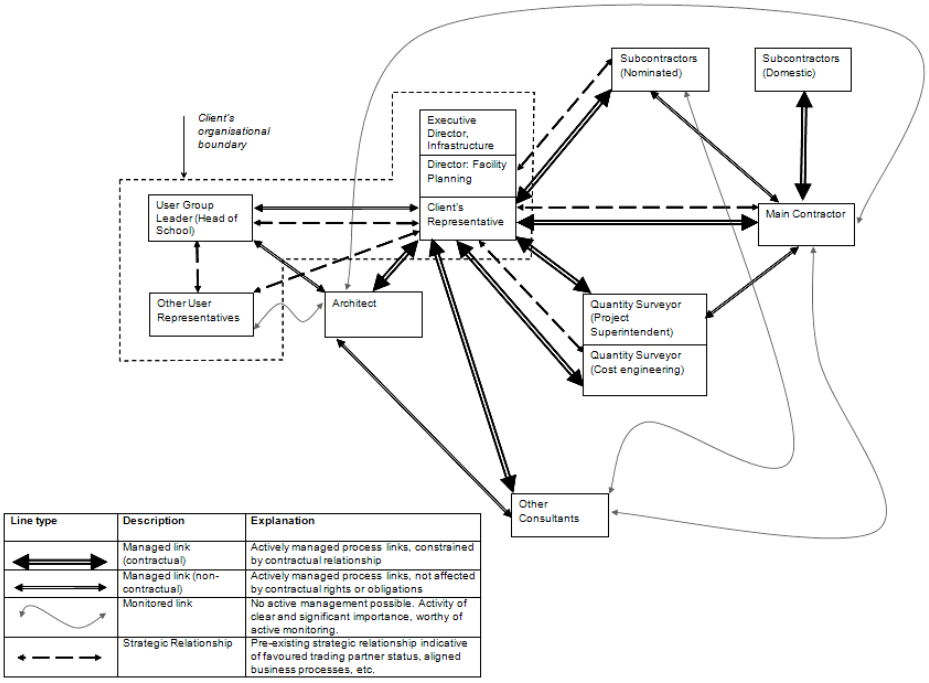

Figure 1. Supply chain map for the case study project.

The following sections report the outcomes of three analyses obtained from the case study: firstly, by reference to the Cooperative Research Centre for Construction Innovation (CRC-CI) CSF model; secondly, by application of the A&B map to interview transcripts, and; thirdly, by analysing the impact of stakeholder attitudes and behaviour on TPO culture development. Each is followed by a brief discussion of the significance of its findings, leading into the next section. By the conclusion they provide a comprehensive explanation of the human impact on the BIM and other ICT deployment in the project.

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 and 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 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.

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.
- Various design consultants were both willing and capable of participating in a limited amount of data exchange using CAD capabilities, though not in a pure BIM fashion (i.e. where all work on the same model), 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.

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 their 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 an integral part of their future, citing it as a significant hurdle to be overcome.

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.

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.

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.

CSF discussion

It can be seen from the foregoing that as a group the members of the case study TPO regarded the adoption of ICT in general as a positive business innovation and were guardedly optimistic about its use in the future. Their feelings about BIM were more varied, and directly related to the extent to which they could recognise the opportunity to increase profitability as a result of its use. However in all regards their statements could be described as a public espousal of the broadly ideal, and similar in many respects to what could be expected from the majority of respondents in the national CSF survey. The following section re-examines the interview transcripts from the perspective of each respondent as a decision maker for their firm/organisation, mapping the effect of their personal attitude in four key areas previously identified as being influential in the successful adoption of ICT in general and BIM in particular.

Attitude & Behaviour Model

The model shown in Figure 2 has been adopted 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 with 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 will thought to have an impact. This approach lends itself to presenting results in matrix form.

Thematic re-analysis of the interview data was conducted with the intention of separating their 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 Figure 3.

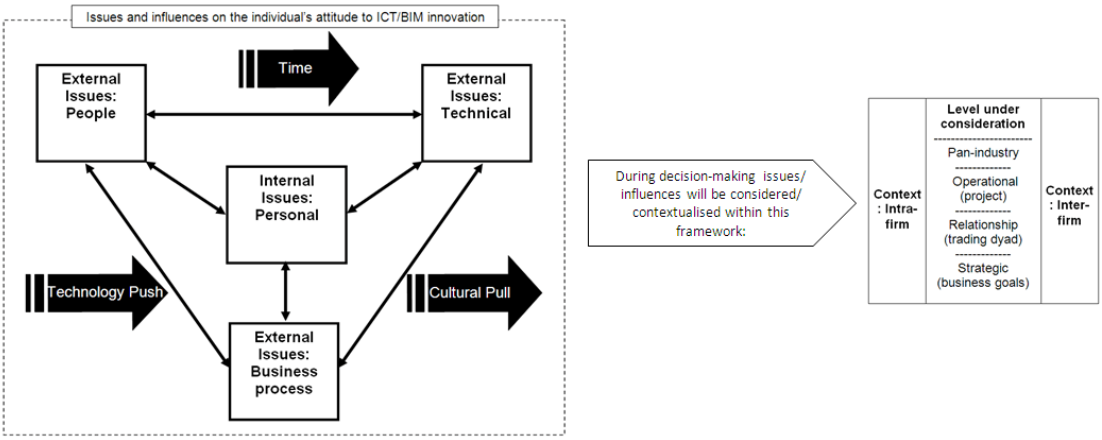

Figure 2. Attitude and Behaviour model for ICT/BIM innovation.

Attitude and behaviour discussion

Successful ICT/BIM implementation requires active "championing", both in terms of the business-technology interface, and the initial demand for its adoption. 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 1. Throughout the transcript it was apparent that the client's representative was well aware of the capabilities that BIM had, both in terms of technological outcomes and the University's business processes, but tended to dismiss their consideration on the basis of existing institutional policy, and certainly saw no personal role 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 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. 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.

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. 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, rather than a strategic commitment to implementation on this and future projects.

It can be seen from the foregoing that the project was characterised by clusters of cooperation 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. This prompted a second round of interviews designed to investigate the cultural aspects of the TPO, the results of which are reported in the following section.

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 communicat-ions	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/loya lty 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 communicat-ions	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 manufactur-er		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 compatabil-ity 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.	

Figure 3. Attitude and Behaviour matrix for the case study project.

Cultural Analysis Model

Using the CRC-CI CSF framework 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 is it possible to identify any disparity between individual 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 of which they are congruent in large part determines the extent of which the

eventual project team culture is integrated, differentiated or fragmented. The cultural analysis framework developed by Gajendran and 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. Figure 4 details the outcomes in the case study project.

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

Figure 4. Cultural Analysis for the case study project.

Cultural analysis discussion

After all the data was analysed it was found that out of 17 espoused aspects of ICT integration only four (25%) were integrated. Seven aspects (44%) were differenced and four (31%) were fragmented.

Although the ICT environment was a mixture of ‘integration’, ‘differentiation’ and ‘fragmentation’, it was the last of these conditions that predominated.

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, 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.

The outcomes of this cultural analysis were confirmed and reinforced in subsequent discussions with TPO members.

5. CONCLUSIONS

The case presented in this paper was chosen because of the presence of high-level ICT communication technology and BIM. This research has shown that despite this the TPO has failed to embrace its widespread use. When 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 one to expect more positive outcomes from their engagement with technology. However, when probed deeply on the subject many revealed attitudes at odds with their espoused values, often rendering them sceptical about the benefits and disinclined to engage. Their consequent behaviours, particularly during the formation of the TPO, resulted in a large measure of ICT fragmentation, with pockets of technology-mediated collaboration 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, the architectural practice that provided both the BIM and the FTP site for data exchange conspicuously failed to champion their use, largely as a consequence of their private concerns about the advisability of their use throughout the TPO, and; secondly, the highly bureaucratic client organisation did not recognize the potential benefit presented by the presence of these technologies, both during the design/construction phase of the project, and more particularly onwards throughout facility management.

Whilst the individual frameworks of analysis used in this research has been derived from major studies this is the first time that they have been used in conjunction with each other. This research reveals the importance of the establishment phase of a project team both in terms of the technology itself, and is the cultural environment within which it is to be used.

This is but a single case study, and further confirmatory research is required to establish the extent to which its findings are generalisable. Nevertheless there is one last observation: the presence of clusters of integrated firms (culturally differentiated) that had 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. However procurement mechanisms, the structure of the industry, and indeed, the culture of the industry itself do not seem conducive to this approach. Nevertheless, if the classical economists are correct, and the secret to innovation is to generate increased profitability, then the challenge facing leading edge BIM adopters is to develop a business model that capitalises upon collaborative working arrangements to create sustainable competitive advantage.

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