ECONOMIC, SOCIAL AND CULTURAL IMPEDIMENTS AND DRIVERS FOR ADOPTION OF EBUSINESS INNOVATIONS WITHIN THE INDUSTRIAL STRUCTURE OF THE CONSTRUCTION SECTOR

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ABSTRACT

The importance of the influence of economic, social and cultural characteristics underpinned by the unique supply chain industrial structure of the construction sector for the diffusion of e-business technologies in the construction industry is investigated. This is reported on through a detailed analysis of twelve firm case studies in a supply cluster around a state government agency responsible for development and implementation of eBusiness policy and infrastructure procurement. A theoretical model was developed which relies upon understanding the core upstream and downstream relationships which firms locate themselves within which are codependent with their market economic structure and firm and individual behaviour. Five key impediments and five key drivers were identified in this study which account for and are hierarchically subordinate to inconsistent adoption patterns and perceptions of advantage. Within these primary impediments and drivers over thirty interrelated secondary drivers and impediments were identified and these interrelationships are described. It is the complex inter-relationships between and across the primary and secondary impediments and drivers and the strong influence that the supply chain industrial structure plays in many of these relationships that is the major contribution of this research. The study forms part of a national project which involves three major supply clusters around a large client which are contributing to the development of an adoption profile. The profile is dependent upon defining the firms and market and structural behavioural characteristics and the trigger points for impediments becoming drivers. The outcome of the research are recommendations aimed at government agencies' and industry market leaders' policy, process and practice towards creating sustainable eBusiness environments of the future and the impact is the response by these organisations to the pathways to adoption strategies.

Keywords: sustainable e-business environments, construction industrial structure, impediments, drivers, causal links

1 BACKGROUND

The main claims of the benefits of eBusiness technology are that it will provide commercial efficiencies through more effective design and construction information management and procurement and contract management. However after the initial adoption by innovative firms eBusiness has not diffused throughout the large majority of the industry. This paper reports on partial results of a study aimed at informing decision makers towards more effective strategies for preparation of future widespread industry uptake.

The adoption of this technology by the Australian building and construction industry lags that of other Australian industries and industries in the USA and Europe (NOIE, 2001*).* Australian statistics (ABS, 2004) comparing construction to all other industries indicates that the construction industry ranks last on all four key performance indicators in relation to e-business uptake. It *could be challenged th*at the indicators may not reflect the real behaviours of the industry. However, at this stage it is proposed that the slow adoption rate is due to the impediments or the drivers related to adoption peculiar to the construction industrial structure rather than the technology itself.

Many elements of a technical solution have been solved and are available; therefore the research has sought to address the significant changes in business practices and consider strategies that will address social, economic and cultural issues at an industry and organisational level to prepare for sectoral widespread eBusiness technology adoption or adoption, which appears to be imminent, over the next decade.

The empirical study described in this paper has involved three detailed case studies which were conducted clustered around three major industry players; a state government infrastructure agency, the largest local government infrastructure agency and a large contractor. The general research question that the project addressed has been:

What is the nature of eBusiness adoption for SME's in the Australian construction industry?

The specific research objectives of the overall research project have been to:

- investigate impediments and drivers to eBusiness adoption by SME's in the Australian construction and building industry, through theory and practice;
- identify strategies and techniques to raise awareness and increase adoption diffusion by SME's in the Australian construction and building industry
- develop an SME eBusiness technology adoption profile specifically for construction industry players

The aim of this paper is to report on the findings of the impediments and drivers to eBusiness adoption for the state government infrastructure agency case study. The paper is outlined as follows:

- Brief outline and discussion on impediments and drivers to eBusiness uptake based upon the existing literature
- Description of the conceptual framework
- Impediments and drivers results and discussion of the complex interrelationships
- Conclusions and implications for industry performance improvement

2 IMPEDIMENTS AND DRIVERS TO E-BUSINESS UPTAKE

A comprehensive review of the academic literature was undertaken in the study to provide the necessary theoretical context to achieve the research objectives. For the purpose of this research project eBusiness was defined as any business process or practice that takes advantage of or that relies upon the collection, transmission and storage of digital information through technology systems. Of particular interest to this project are specific eBusiness technologies and applications that facilitate web-based project management and

dissemination of accurate design data, online tendering and procurement processes and efficient contract management.

Literature was reviewed from the construction management and construction economics disciplines and also selected studies on eBusiness adoption from mainstream management literature were considered. A consistent theme throughout the literature was the concern for identifying the impediment (s) or the driver (s) for adoption. This is obviously not a new research problem and there is a substantial body of knowledge to build upon. This paper briefly summarises the impediments and the drivers for eBusiness adoption which have been identified and identifies a research gap.

2.1 Impediments to eBusiness Adoption

Examination of the academic literature has identified the following commonly recognised impediments affecting eBusiness adoption. It should be noted that these impediments are not industry specific in that they are not directly inferred from research conducted into the construction industry. Nonetheless, these impediments are useful in identifying patterns affecting the uptake of new technologies by within the commercial and governmental sectors.

- The lack of awareness of what eBusiness is and what it involves and further to this a lack of awareness or reluctance to see potential business benefits (Ingirige, 2002; NOEI, 2001; Parish 2002);
- Informed resistance to innovation based on values and attitudes (Frank Zhao and Borman, 2004);
- The lack of security and the perception of an insecure environment; the need for a regulatory and legal framework; lack of systems (Bennett, 2003);
- Market incentive, pressures and rewards and uncertainty regarding of the financial returns from investments in various resources versus economic benefits. (Tetteh, 2001; Veeramani, 2002).

1.1 Drivers assisting eBusiness Adoption

As with the impediments to eBusiness adoption outlined previously, the following discussion of factors exerting positive influence on the adoption and integration of eBusiness technologies is not construction industry specific, but accurately portrays wider forces influencing the general patterns of eBusiness adoption. A review of the academic literature has revealed the following factors which assist in the process of eBusiness adoption:

- Rewards, incentives and initiatives by governments including seeding programs, investment incentives and tax rebates etc (NOIE 2001).
- Managerial characteristics or philosophy of the firms (Gray et al, 2002)
- Culture of the organisation (Elliman et al, 2000; Gray et al, 2000)
- SME's characteristics related to flexible specialisation (de Berranger et al, 2000). (Malone, 1985; Montazemi, 1988; Storey et al, 1995). It is the flexibility of SME's that can make adoption of information communication technologies easier, compared to larger more bureaucratic and inflexible organisations (de Berranger et al, 2000) and some commentators claim that SME's could be expected to adopt technology faster than large organisations.
- Production related factors assisting eBusiness adoption; for example eBusiness technologies have the potential to transfer complex design information accurately (Elliman et al, 2000), thereby eliminating data transfer error (NOIE, 2001), as well as minimising delays as information is conveyed along the supply chain.
- Reduction in transaction costs; small vendors and suppliers can bid on jobs using standardised forms on the site making bidding on jobs relatively inexpensive; costs in transferring information during the tender process is reduced. The website is also

beneficial to large manufacturers as it creates an electronic auction market enabling organisations to receive a wide range of competitive quotations from vendors (Wenninger, 1999).

1.2 Implications for research

Consideration of the previous listed impediments and drivers influencing eBusiness adoption suggests implications related to government intervention, communication including informal networks and formal information dissemination channels; and economic “space”. These issues can be subsumed by a consideration of construction industrial structure. These are now discussed in more detail.

First, government based incentives are aimed at improving the attractiveness of adoption to firms by offering financial support and thus addressing a key issue of financial risk. That government intervention is aimed at a phase of the adoption-decision process; in particular towards the development of an attitude and appreciation of the potential benefits of eBusiness. It is significant in identifying this phase as crucial to the overall process. The pertinence of this factor is highlighted further when it is acknowledged that resistance to eBusiness adoption is commonly based on values, attitudes and perceptions – including the perception of eBusiness as a potentially insecure economic environment – as outlined previously in the impediments to eBusiness adoption section.

Secondly, among the impediments discussed previously, are factors such as the lack of awareness of the potential benefits. Hence, the adoption-decision process undertaken by firm managers is inhibited by such non-economic factors as the lack of accurate information and importance of organisational culture and the social meanings and values that influence decision making in the form of management practice or managerial philosophy. Indeed, as stated previously, managerial philosophy and organisational culture are attributed a key status as drivers in non-construction industry specific research into eBusiness adoption.

The managerial decision to engage in eBusiness relies upon an informed awareness of benefits, an acceptance of the advantages versus disadvantages and also a practical organisational capacity to then move the firm in that direction. The managerial philosophy can also reflect the position that manager’s may take in relation to the perceived risk versus value in relation to e-business contributing to a firm’s operational profitability. Communication plays a significant role in informed decision making and it is both the informal networks and the formal information dissemination channels which are particularly crucial to the construction industry that are important to understand.

Thus, thirdly, closely intertwined with social and cultural values and management philosophies is the economic space that the firm is located within; if managers do not perceive an economic imperative to make change then there is little incentive to undertake the restructuring of business practices and processes of the firm generally implicated in eBusiness adoption. Significant economic imperatives may include the opportunity for new markets and/or new clients, improved internal and external efficiencies, existing clients and/or suppliers demanding change and current competitors adopting new approaches to e-business.

Furthermore, listed among potential drivers positively influencing eBusiness adoption are the supposed advantages of SME organisational characteristics as related to flexible specialisation. Allegedly this supposed driver exerts its influence in the implementation phase, in that the characteristics of these firm’s such as smaller size and greater organisational flexibility make restructuring implicated in the adoption of eBusiness less costly and time consuming.

Given that 93% of upstream project construction firms are SME’s, their organisational characteristics are a factor that should assist them in adopting e-business technologies. Given also that the Australian construction industry displays significantly lower levels of

eBusiness adoption than other industries, it would seem that advantages bestowed by organisational characteristics alone are insufficient to assure the positive interpretation of the values of adopting eBusiness technologies and practices.

Thus, although the key impediments and drivers drawn from the general academic literature are quite extensive and clearly relevant to the present research, it is also apparent that non-construction industry specific research has not significantly integrated key industrial structure characteristics of the sector that will influence the conduct of research into industry specific impediments, drivers and adoption characteristics. Key aspects of the construction industrial structure include:

- attributes of construction industry SME's related to flexible specialisation and clustering;
- the integration of business processes along the supply chain; particularly that offered by construction portals
- the project-based nature of the industry and therefore contractual relationships are constantly forming and reforming as firms respond to projects.
- Underpinning the project culture in upstream linkages is a non project based manufacturing sector in downstream linkage – which provides an interesting intersection as the supply chain is nowhere more important than in the construction industry
- Further to this the role of different supply chains and competitive behaviour in a substantially project based demand industry pulling a non project based supply industry

A significant gap in the literature is that there has not been an investigation that has considered the organisational behaviour of participants within various construction industry supply chains in both the positive and normative sense (ie industrial structure of chains and strong network relationships within chains) and the role that this plays on eBusiness adoption. Past research (Gray and Lawless, 2002; Elliman and Orange, 2000) has been reductionist in its approach and assumed adoption is dependent upon individual variables and that adoption relates to an individual firm's choice as an entity that does not operate within a wider social and economic system.

The creation of the supply chain is impacted by the location of the individual firm within its competitive market; which has unique economic, structural and behavioural characteristics. The upstream and downstream linkages are affected by the nature of these markets and the countervailing power, which occurs between market tiers in the chain (London, 2005). It is speculated that within the construction industry new technologies and eBusiness practices are commonly diffused through various operational clusters because of their business linkages and interdependence.

It is a premise of this research project that for eBusiness to be successful, eBusiness adoption and the diffusion of ideas concerning more efficient practices and more effective technologies must happen from business to business within the supply chain as well as within the individual businesses. This is due to the nature of key potential eBusiness benefits in reducing production and transaction costs associated with supply chain organisation and contract management. Firm behaviour in relation to the adoption of innovative eBusiness technology relies upon the economic pressures confronting individual firm's as a result of market competition (the behaviour of their immediate competitors), as well as the upstream and downstream linkages that they typically find themselves located within including the business practices of their upstream and downstream suppliers and/or clients.

In the discussion of the impediments and drivers to e-business adoption identified in the literature the point has been to acknowledge that e-business adoption is a complex and multi-phase process that is heavily reliant on the provision of information and communication between individuals and groups. In doing so it is clear that research into eBusiness adoption in the construction industry needs to examine the process in a cultural and social context

that takes into account the complexities of the wider social system in which individuals and firms are embedded as well as the economic context within which these operational decisions and organisational processes take place and are contextualised.

Thus, while it is important to be aware of the structural drivers and impediments to e-business, our research focuses on the importance of diffusion within and between businesses and the interdependencies between upstream and downstream markets along the supply chain for the adoption of e-business. Therefore a deeper and more detailed consideration of the nature of structural impediments and drivers their relationships and then more importantly the relationship between an impediment and a driver: that is, when and how does a driver become a driver, as this is the real trigger point for adoption and thus widespread diffusion of technologies.

There is a body of theory referred to as diffusion theory. The following section outlines diffusion theory as a basis for developing a conceptual framework designed specifically for investigation of the construction industry as a social, cultural and economic system. Diffusion theory is the starting point as we critique diffusion theory and also overlay considerations from supply chain theory as this helps us to understand the importance of industrial structure on the performance of the industry as a whole towards the development of a conceptual model and interpretive framework for the study.

3 DIFFUSION THEORY

Rogers (1995) has considered the diffusion of new technology in his text *Diffusion of Innovations*. Whilst not referring specifically to the diffusion of eBusiness as innovation, Rogers' work does provide an initial framework through which examination of the diffusion of e-business through supply chains can be examined. Rogers defines the diffusion of innovations as the process by which knowledge of an innovation is transmitted through communication channels, over time, among the members of a social system. Therefore, the four key elements comprising Rogers' diffusion theory are defined as:

- The innovation: an idea, practice or object that's perceived as new;
- Communication channel: can be mass media and/or interpersonal networks and is the means by which messages about the innovation gets from one individual to another;
- Time: comprising a) the innovation-decision process, b) relative time with which an innovation is adopted by an individual or group - an innovation's rate of adoption.
- The social system: a set of interrelated units that are engaged in joint problem solving to accomplish a goal.

Within this framework diffusion is largely measured through the degree of adoption within a social system. Adopters are categorised by Roger's as innovators, early adopters, early majority, late majority or laggards. These adopter categorisations are differentiated primarily in relation to diffusion as a temporal process – diffusion happens in time, whilst the other key elements of innovation, communication channels and social system exert variable influence upon the temporal diffusion process depending on their specific qualities. According to Rogers for example, communication channels vary in importance according to the type of adopter; mass media and expert knowledge has more influence on innovators, whereas personal networks are more important for late-adopters (Roger's 1995). Which is to say, the type of communication channel has influenced the *rate* of adoption, for the difference between an innovator and a late-adopter, according to Rogers is simply the relative time in which the diffusion process has occurred. The key processes in Rogers diffusion theory are, thus, the adoption-decision process and the rate of adoption - comprising multiple phases, and influenced by various factors. As noted earlier in relation to a discussion of the impediments and drivers for eBusiness, the adoption-decision process is a key phase through which an individual (or group) passes from:

- first knowledge of the innovation;
- to forming an attitude to the innovation;
- to making the decision to adopt or reject the innovation;
- to implementing the innovation; and confirming the decision taken.

This transition from first knowledge of the innovation to its implementation *measured as a temporal process* encompasses the innovations rate of adoption. This may be affected by various factors relating to the key elements of Rogers' theory, including; the specific attributes of the innovation in question - its relative advantage, compatibility, complexity, trialability and observability (Rogers, 1995). Also influential is the type of innovation decision being made including optional/individual, collective/organisational, and authoritarian/hierarchical. This factor parallels the recognition of organisational culture and managerial philosophy as a driver to e-business adoption.

The basic significance of Rogers' theories of innovation diffusion can be found in his acknowledgement of the complexity of the process. Rogers' unravelling of this complexity displayed considerable insight (considering the inception of the original theory in the early 1960's and thus preceding recognition of the importance of culture in organisational and social theory) in identifying the nature of the social system – its social and cultural norms, beliefs, values and attitudes, as being influential factors in the rate of adoption.

4 Conceptual Model

In this section the conceptual model research project is described. This model emerges from the examination of impediments and drivers to eBusiness adoption discussed in the previous sections, and takes as its starting point Rogers' diffusion theory. Deficiencies in innovation diffusion theory are identified and the conceptual model adjusted to take into account the unique characteristics of the construction industry and also to address eBusiness technology as a specific form of innovation that bears relevance to the approach taken to research patterns of adoption. These key aspects are concentrated on in order to build a conceptual interpretive framework designed specifically for investigation of the contexts surrounding eBusiness adoption within a construction industry interpreted as a complex and interconnected social, cultural and economic system.

A more detailed discussion on the chosen research design of case study methodology and the specific design of the research project including the industry and government partners who have assisted in the process of data collection is not included in this . The data collection and analysis processes and the relationships between the conceptual model, the key themes investigated and the types of questions asked of interview subjects are outlined in detail in the research reports for this study which can be obtained from the CRC_Construction Innovation.

1.3 Conceptual Framework

The conceptual model and interpretive framework underpinning this study takes account of the industrial structure of the industry, and typically the economic system as a whole and also of the organisational, managerial, and cultural characteristics of the firms integrated into supply chain structures that comprise the social system of the construction industry. The business and social system for the construction industry can be related to the following key players: upstream clients, downstream suppliers and market competitors. This project addresses the wider contexts that influence organisational decisions as to whether or not to adopt innovations and assesses the above-mentioned impediments and drivers through a combined economic, social and cultural conceptual model. The following sections discuss these ideas in more detail.

1.4 Critique of Diffusion Theory

Rogers' diffusion model is a useful starting point for analysing the processes involved in diffusion, and is particularly relevant to the present study due to its explicit recognition of the importance of social and cultural factors on the adoption and diffusion of innovations. However, aspects of the theory must be extended and modified before it can be applied to IT (Bayer and Melone, 1989) and more specifically to eBusiness within the construction industry. Particularly significant to this discussion on diffusion theory is the need to introduce networked information technology itself as a primary communication channel with particular qualities, which will considerably influence both the innovation-decision process and the rate of adoption.

Alongside these extensions and modifications of diffusion theory in order to make it applicable as a framework for investigations into the adoption of e-business in the construction industry, there are other limitations to Rogers' diffusion model. Bayer and Malone (1989) argue that Rogers' theory of diffusion is oversimplified in terms of a binary dualism of 'adopt' or 'not adopt'. There is no means for the analysis of cases where innovations are partially adopted or explanation offered as to why innovations are adopted in some form other than the one intended by the developers of the innovation. Alongside this main methodological deficiency Bayer and Malone (1989) also identify the lack of differentiation between adopting an innovation at a firm level and at an individual user level, and also the failure to consider adoption and diffusion as a function of interactions between various social and economic systems.

Rogers' tendency towards a simplified binary conceptualization of the adoption process is considerably problematic in that it does not address the complex interconnected nature of the construction industry, nor takes into account the intrinsic flexibility and multi-functionality of information technology and e-business. It is proposed that in the construction industry it is difficult to place firms into one definite category because adoption is not simply an either/or situation. The diversity of e-business applications and also the competitive nature and fragmented and/or specialised structure of the industry - grounded simultaneously in project-based relationships of close collaboration with limited time frames - introduces the notion of discontinuance. Collaborative relationships between firms within supply chains are not permanent, but both dynamic and transient. However as London (2005) clearly identified even this is a simplistic expression of the patterns that exist in the industry. Long term formal and informal relationships exist in the industry along the supply chain and firms act as strategically as the environment will allow them to – that they exercise as much power as they can to manoeuvre themselves into the best possible efficient and effective customer-supplier relationships as this dynamic and cyclic industry can support. In considering adoption and diffusion within supply chains, our research model acknowledges that adoption of e-business for one project and in collaboration with a particular group of firms to form a supply chain does not necessarily translate to the utilisation of e-business methods permanently. Rather, each supply chain exerts its own pressures on collaborating or competitor firms, and these pressures are unique to the supply chain in question as a product of the specific project requirements and the organisational and communicative practices of participating firms.

1.5 Conceptual Model and Interpretive Framework

In overcoming the constraints of both time and space IT changes the nature of decision-making, making vast amounts of information available for perusal, consideration and comparison. The diffusion of ideas is no longer bound by its passage from individual to individual in a linear and often hierarchical (in the form of management to employee, or from expert to lay-person) chain of communication but is essentially free to move directly and immediately among members of an organisation or social system. The time-space compression (Harvey, 1989), and the lateral networked system functions (Castells, 1996) that information technology provides, and which are central to the coming information

society, are crucial to understanding the organisational and financial benefits of adopting e-business. Indeed, the web portal is a primary focus of e-business adoption within the construction industry. Thus, a central aspect of the model being developed in the current research is the acknowledgement of the capacity for e-business to improve supply chain integration, and vice versa, supply chain integration to assist in the adoption of e-business.

It is also important to acknowledge the nature of the construction industry supply chain as a social and economic system with particular characteristics. A large percentage of SME's and firms within the construction industry can be classified under the category of late to non-adopters, which exemplifies the significance of inter-personal social networks within the supply chain for increased e-business diffusion. More precisely, this status identifies the complexity of social networks and the variety of relationships based in trust and social capital currently in existence within the Australian construction industry. These social networks are both fragmented and dynamic – consisting of relationships between firms of both collaboration and competition.

Additionally, there are a range of trust-based relationships at play within supply chains and the wider construction industry. For example, relationships of trust grounded in personal (professional or informal relationships) differ substantially from relationships of trust based in the credibility or reputation of a competitor or collaborator. The credibility of a competitor or collaborator significantly alters how a manager of a firm approaches the adoption-decision making process; as their first thoughts are *"I trust and value their business decisions even at times without hard evidence"* and therefore place faith in what economic advantages the competitor or collaborator has achieved or potentially seeks to achieve.

Similarly, supply chain relationships of trust and collaboration are often created between otherwise disconnected firms that both share a more direct relationship with a mutual party; for example we typically work with similar clients or suppliers. Acknowledgment of this diversity of relationships and shifting scenarios calls for the development of a research model that addresses the complex issue of development of social capital in an environment marked primarily by short-term project based relationships and a competitive ethos but one where everyone is cognisant of the possibility of future linkages within a cluster of customers and suppliers.

Whilst Rogers' five adopter categories provide a spectrum of adoption *rates* from innovator to laggard, these are a function of *time* and do not accommodate differential *modes* of adoption. Of relevance to this point is recognition of the different functions of firms in the supply chain, and accordingly their substantially diverse organisational structures. Associated with this point are also various different interests and perspectives that occur at different levels within both a firm and within the tiers of the supply chain - upstream clients, downstream suppliers and market competitors. Related to this flexibility in mode of e-business application at the level of organisation is also the need to recognise the relative autonomy of individuals within firms. The diffusion of an innovation through a firm is not simply a managerial decision carried out by the firm's employees, but rather individuals have a certain capacity to determine to what extent the innovation (eBusiness application) is used efficiently and effectively in relation to their specific role within the firm (Frank, Zhao and Borman, 2004). In this sense, it is possible to account for both partial adoptions within firms, and also alternative (and often creative) modes of adoption.

This more complex reading of the adoption and diffusion decision process overcomes simultaneously Rogers simplistic binary of adoption/non-adoption, and his emphasis on the temporal rate of adoption in the categorisation of adopter types. This is achieved while maintaining his insights into the influence of the social system in both the form of operating and structural and economic pressures from the supply chain, and also in the circulation of social and cultural meanings and values that influence the development of positive or negative attitudes towards e-business applications.

Furthermore, the present research allows a degree of differentiation between the adoption of an innovation by an individual user and at an organisational level and thus facilitates the analysis of cases where innovations are partially adopted or are adopted in some form other than that proposed by the developers of the innovation. The individualised interpretation of a given innovation is relative to both the social and cultural meanings prevalent in the firm, but also to the particular requirements of the role of that individual within the firm and of the firm within the supply chain.

In this sense, we suggest a more sophisticated conceptualisation of the nature of the innovation is needed, alongside a more individualised analysis of the diffusion of the innovation throughout the social system that acknowledges that the innovation can be changed each time it is communicated or diffused, and that eBusiness lends itself particularly to diversified modes of application.

1.6 SUPPLY CHAIN THEORY

Ultimately the success of the diffusion of e-business is reliant upon the firms' economic and social "space" or environment and then the capacity to achieve change. Although it is important to be aware of the structural drivers and impediments to e-business, our research focuses on the importance of diffusion within and between businesses and the interdependencies between upstream and downstream markets along the supply chain for the adoption of e-business. Rather than taking the approach that a firm either adopts or does not adopt we are suggesting that adoption and ultimate dispersion across the industry is based upon firms being along a continuum of "reflexivity" relying upon e-business awareness, responsiveness and adaptability attributes and that reflexivity capability is underpinned by firms and individuals within firms who are within an industrial structure particularly influenced by supply chain relationships.

There are numerous interpretations of what the supply chain is and at what level a supply chain is considered (London 2001). For the purposes of this study the following interpretation is assumed. "The supply chain is the firm's that are involved through upstream and downstream contractual relationships who deliver a commodity (product and/or service) related to the core business of a construction project. The supply chain once formed creates a flow of commodities, cash and information. The creation of the supply chain is impacted by the location of the individual firm within its competitive market; which has unique economic structural and behavioural characteristics. The upstream and downstream linkages are affected by the nature of these markets and then the countervailing power which occurs between subsequent markets at adjacent levels in the chain" (London, 2005).

The reflexive capability model focuses on the importance of communication, social networks and social, cultural and economic capital for increased awareness and diffusion of e-business within supply chains. It is based upon the premise that the behaviour and attitudes of firms towards technological innovations can have significant influence on the acceptance and ultimately the dispersion of e-business by other firms within the supply chain. The conceptual model and interpretive framework of supply chain influenced diffusion suggests that people change perceptions about the value of an innovation through communication and it is these perceptions that then drive implementation.

Firm behaviour in relation to the adoption of innovative technology (in this instance, e-business technology) relies upon; the individual firms' attitude towards risk which is driven by economic pressures as a result of market competition (the behaviour of their immediate competitors), the upstream and downstream linkages that they typically find themselves located within and the business practices of their upstream suppliers and downstream clients.

For e-business to be successful, diffusion must happen from business to business within the supply chain as well as within the individual businesses. The economic and social system for the supply chain in the construction industry is related to the following key players: upstream

clients, downstream suppliers and market competitors. Therefore diffusion must take place between firm's and just as significantly within the firms for eBusiness to be successful. Although it is important to be aware of the structural drivers and impediments to eBusiness, our research focuses on the importance of diffusion within and between businesses and the interdependencies between upstream and downstream markets along the supply chain. The reflexive capability model focuses on the importance of communication, social networks and social, cultural and economic capital for increased awareness and diffusion of eBusiness within supply chains. It is based upon the premise that the behaviour and attitudes of firms towards technological innovations can have significant influence on the acceptance and ultimately the dispersion of e-business by the individual firm and then also by other firm's within the supply chain. This model of diffusion suggests that people may change perceptions about the value of an innovation through communication and it is these perceptions that then drive implementation. Change may also occur through changed market conditions. The next section describes the results of the empirical study of a cluster of twelve firms organised around a large government agency. For this study the existing industrial structure of the supply chain and the inherent tenuous countervailing relationships between markets along the chain that this brings with it in the construction industry is taken as a "given" within which the impediments and drivers which were found in the industry are embedded.

5 RESULTS AND DISCUSSION

A case study methodology was undertaken where each firm represents a case and collectively this represents the "case" surrounding the large client of which these firms are clustered around.

An important part of case study methodology is the establishment of constructs that organise the research methodology and provide a framework for the data analysis. Three areas of investigation relating to different aspects of the adoption of e-business within the construction industry were focused upon in order to achieve the research objectives:

1. Impediments and Drivers
2. Processes and Practices
3. Strategies and Techniques

Impediments and drivers are obviously of central importance to the research project. This construct is construction-industry specific and refers to the relationship between the eBusiness innovation and the adopting organisation. More specifically it encompasses factors and forces that prevent or hinder the adoption of e-business (impediments) and also factors and forces that facilitate and encourage adoption of e-business (drivers). These impediments and drivers can originate internally or externally to the organisation.

Practices and processes refers to the way things are *organised*; formally and structurally (processes) and the way things are *done*; informally and practically (practices). There will be substantial correlation between these two as the goal of process is to organise practice in a consistent manner. However this relationship is not deterministic or unidirectional. People do not always do things according to the guidelines, and the individualised, contradictory ways that people do things (practices) can exert influence on the way that formal processes are organised.

Strategies and techniques refer to the ways in which the organisation relates to the innovation relative to the firms goals. Primarily this will concern the ways of thinking (strategies) and ways of acting (techniques) by which the organisation will overcome impediments and thereby facilitate the achievement of goals.

Twelve cases were considered and data was collected through a minimum of a one-hour interview and follow up telephone discussions to confirm details. The data analysis involves a two-phase process of open and axial coding of transcripts and both within case and cross

case analysis. Data gathered in relation to the three key areas of investigation was then subjected to thematic analysis based upon individual analysis of datasets investigating for textual indicators of both social/cultural and economic factors in play. The following table summarises the cases discussed in this paper and each of these are suppliers to at least the state government agency; at times they supply to the other two major clients involved in this study.

Case	Firm Type	Size Indicator	Respondent
1	Residential and commercial building and Construction Managers	100 staff AUS$110M Turnover	State Manager and Director
2	Project Management Consultants	4 staff	Project Manager
3	Commercial Construction Contractors	20-25 staff AUS$10M Turnover	Manager and Director
4	Commercial Construction Contractors	No Indicator Given	Document Control Manager
5	Commercial Architectural Firm	No Indicator Given	Office Manager
6	Residential Building Subcontractor	6 staff	Owner Operator
7	Development Consultancy	120 staff	Manager and Director
8	Quantity Surveyor consultants	5 staff	Director and Quality Control Manager
9	Contractor -Shopfitting	25 staff	Owner and Director
10	Project Management Consultancy	No Indicator Given	Division Manager
11	Contractor -Commercial Building	15 staff AUS $0.8M average job	Owner Operator
12	Architectural Firm	1 staff	Owner Operator

Table 1 Summary of Case Firm details

The following sections are a result of the first stage of open coding followed by the second stage of axial coding and are organised as follows:

- Impediments
- Drivers
- Impediments and Drivers

The analysis is presented graphically in three causal link diagrams. The diagrams represent part of the data displays used in this study, various within case and cross matrices were developed to summarise and compare and contrast the emerging key themes.

1.7 Impediments

The overarching impediment to adoption of ebusiness in the construction industry is the inconsistent adoption patterns. We can then break down this impediment into four interrelated subordinate impediments; including perceptions and attitudes; compability of the innovation, market incentives (uncertainty regarding returns) and heterophilic and homophilic communication. These are all discussed in detail in the following sections and supporting quotes are used to illustrated the key points.

1.8 Inconsistent Adoption Patterns

The inconsistent adoption of eBusiness across the industry has been highlighted as a key barrier to further adoption. It is a direct cause of problems such as software incompatibility,

but in addition to that a firm's experience with eBusiness also influences their approach towards further adoption, and is linked in with most of the other key themes:

Inconsistent adoption patterns are mostly a result of inconsistent approaches to business management, such as IT investment strategies. Consistency of approach is difficult to attain across the industry, whereas for eBusiness adoption consistency is an important factor for the sake of compatibility. Firm 2 discusses the issue:

> *You're dealing with … the likes of MXXXX …and you're dealing with … the local builder who's a two man business who wouldn't know a computer if he fell over one. so you've got this enormous range of abilities of people and types of organisations, some of whom you will find already are very highly IT orientated down to … people that do their paperwork on the back of a matchbox, … and it's hard enough getting them to actually put something in writing let alone do it on a computer … it's very difficult to get a common approach to any bloody thing (Firm 2)*

Firms with a higher level of experience with eBusiness technologies recognise the need for continual IT skill advancement; a greater IT skill level results in a greater understanding of the possibilities of eBusiness, which then results in a positive business approach towards further adoption. Firms with a lower level of exposure to eBusiness don't participate in IT skill advancement, which hinders their understanding of the technology, the possibilities of eBusiness and thus their level of adoption. This knowledge gap continually widens as those at the front move forward at a greater rate than those at the back.

> *It's a constant process…because we don't use all the facets of the intranet, we lose the skills, we don't use them and IT is very quick. So what we do is we call everybody who in the office once every three months or so and we sit down and go through everything…So it's a constant process of training, the resources that we have how do we use them best (Firm 10)*

The previous quote demonstrates that the more eBusiness "savvy" firms recognise the potential for a tendency toward differentiation between IT technology and the required operating knowledge. For firms such as these the recognition of the potential problem and the economic capacity to engage in regular staff training and formal processes of internal knowledge dissemination is frequently enough to promote a strategic attitude toward management of the problem. But as is made clear by the previous quote from Firm 2, the nature of the construction industry as both fragmented, specialised and diverse means that management policies internal to a firm that are designed to promote consistency between technology and operating knowledge can only extend so far:

> *IT moved a bit faster than people's IT skills and that question of IT skills and individuals and particularly in the construction industry. See a lot of these people are you know well physical workers a lot of these subcontractors. It's the biggest impediment is the end users being comfortable with that, the end user IT awareness. If we can get over that hurdle it would be very easy (Firm 10)*

The larger operators within the industry commonly hold the attitude that the problems of inconsistent patterns of adoption lie predominantly with the smaller operators. The nature of the subcontractors within the industry as physical workers is perceived as an impediment to increasing 'end user IT awareness', and one that is readily identified by these firms:

> *How do you expect a person whose working laying bricks and mortar and keep thinking about how it looks on the computer, he still deals with that and creating that and when he goes back home and all his muscles are sore and he's not going to sit on the computer, if he sits on the computer probably he's going to play games." (Firm 10)*

A potential incompatibility between the basic demands of the subcontractor to engage in physical construction work and the desire of larger operators to improve their profit margins via increased eBusiness efficiencies is recognised as a key impediment to consistent patterns of adoption. However this recognition does not tend to ameliorate any assumptions that it is the subcontractor level that is the cause of inconsistent patterns of adoption that are holding back the 'real efficiencies' associated with eBusiness adoption:

To me the biggest problem at the moment in the construction industry is getting acceptance at the subcontractor level. It's OK … from a client, consultant (and) contractor level … but we've got to capture the subcontractors and the suppliers in it too because (then we'll) get the real efficiencies with it ... and then E-business will really take off I think." (Firm 1)

Firms with a higher degree of adoption prefer to do business with others with similar capabilities. This exclusionary behaviour further limits the opportunity for eBusiness exposure of the less-capable firms. Those firms with a higher capability recognise the competitive advantage of having a more advanced degree of adoption. As such, these firms have an interest in maintaining the status quo, which is in conflict with their desire for the greater efficiencies achievable with a higher degree of industry-wide adoption. Firm 1 demonstrates this conflict very clearly in the following quote as compared to their quote previously:

What differentiates us against a lot of our competitors (is) that we've got systems in place which are as good as a lot of the major builders so we're trying to give a service of a larger company in a smaller sector of the market. (Firm 1)

Inconsistent patterns of adoption are often expressed and experienced as the relatively innocuous problems of software incompatibility between organisations. This has a negative effect on business outcomes for those who have a relatively low experience with eBusiness technologies. Businesses with a higher degree of adoption (and thus more experience) tend to find incompatibility little more than a hindrance.

We have a graphic artist who does letterhead or brochures for us. Her level of software was not compatible with the printer's level of software, they're obviously the latest and greatest…so it led to a mistake in the print that, it was a big print run and of course the printing company didn't want to take any responsibility and the graphic artist said that she told them it was Version blah, blah and so we were left in the middle receiving a product that wasn't a hundred percent. I just had to wear it, just had to grin and bear it (Firm 9)

With AutoCAD they have a requirement for AutoCAD 2000, I think it's 2004, my subcontractor uses 2000, my other contractors use 13 and 14 which are pre 97 and 98, I've got other people who're using 2004, another person using (Archi)CAD and another person's RBT. … The translation is supposed to be easy … but it's never simple and you lose, you lose aspects of drawing (Firm 12)

We have some sub consultants in the other disciplines whether it's structural, mechanical or electrical that might be using different packages or might not be on the same version of AutoCAD, so that can become a hindrance, not necessarily a problem (Firm 5)

The inconvenience of incompatible software platforms can certainly have an economic impact on smaller operators, and one that can contribute to increased perceptions of eBusiness adoption as unnecessary and economically prohibitive. Inconsistent patterns of eBusiness adoption is a complex issue and one that is fed by numerous other social/cultural and economic processes that themselves can be considered manifestations of the underlying issue frequently discussed as the fragmentation of the construction industry. Inconsistent patterns of adoption are themselves an expression of this fragmentation and are at the same time causal to increasing fragmentation.

Standardisation is perhaps in theory a good thing but I think in practice it's almost impossible." (Firm 7)

The problem is that none of the parties in that chain actually has a commercial interest in changing the culture individually... it's still too bloody competitive ... nobody trusts anybody else of course so it makes it harder to get them to deal with each other and it shouldn't be the case. (Firm 2)

Also what is happening is at the moment the nature of the industry the competition, commercial advantage and all that is not very conducive at the moment…that would be an impediment to bringing

any standardisation, it's a bit complex issue because I mean you should notice that any of these major contractors…only a handful of in the country, they like to keep their competitive advantage." (Firm 10)

The previous quotes highlight this perception of an industry that is fragmented, and this is all the more problematic because the adoption of eBusiness is frequently touted as a means to overcoming an endemic fragmentation and integrating the industry through more effective and efficient communication flows.

1.9 Subordinate impediments

There are four key subordinate impediments including perceptions and attitudes, compatability of the innovation, market incentives and communication and these are now discussed in detail. The research findings provide a much deeper explanation of each of these types of impediments and also their interrelationships; further to this is a much deeper appreciation of how to develop strategies to account for these impediments and then to develop strategies to move from non adoption to adoption of some appropriate form.

5.1.1 Perceptions and Attitudes

Barriers to diffusion as an outcome of perceptions can be reduced down to two key forms of individual perception on the limits of an innovation. The first is a perception of IT environments as insecure. The second is a perception of an innovation as being overly complex or causing difficulty.

The perception of IT environments as insecure is a commonly held assumption prevalent through out the construction industry and has been identified in numerous other research studies as a key problem. The finding of this perception as an impediment allows us to confirm the findings of these other projects but does not offer anything specifically new. The following quotes demonstrate the pervasiveness of this assumption through all strata of the industry:

We still resist the E-banking because of security problems. We've had two meetings with the Commonwealth Bank here and there were several issues that the girls had with the bank for security. We've had customers who have…put one digit out and he lost about $30,000 and it took him months to try and retrieve that. (Firm 9).

(The risk involved with not having an actual signature on documents) would be a concern if it's … a document that requires a signature. If I'm signing … on behalf of the company then I'm obliged to either have a director's signature on it or two directors' signatures on it… for it to be a legal document (Firm 1)

We have heard a story, not us were involved but of a firm which issued electronic documents and on the system we use you can lock the quantities in other words it cannot be doctored when they're calling for tenders and we understand that one of the tenderers got to the formula. Now we don't know how he could break into the computer, the program system we don't know. So you know the old days of printing out a hard copy you can see if somebody's changed that, it's bloody obvious." (Firm 8)

A significant twist on this finding however is the degree to which perceptions of IT as an insecure environment have insinuated itself into lower levels of organisational trust, in which firms deploy stringent intranet security measures designed to protect sensitive information and presumably defend against loss of commercial advantage via leakage of sensitive information. It is difficult to imagine a cultural shift towards greater transparency of process and ease of information availability and file sharing taking place amongst an industry supply chain composed of firms that do not trust their own employees.

Different offices can't look at the different projects. Like I can't look in on (other office's) projects, their servers are separate to the main server and have … password protection on those and similarly up here we've got password protection to the project managers only for their particular project so they can't see … any other projects, or … get in and do anything to anyone else's projects. (Firm 1)

The perception of eBusiness as 'difficult and complex' is an interesting finding that demonstrates the power of attitudes and perceptions in influencing patterns of adoption. Our research made use of a hyphenated concept indicator: "perceptions of complexity-difficulty" and found this useful precisely because it shows the relationship between the perception of complexity, which is usually a marker of the conceptual distance between required operating knowledge and previously held ideas and available skill sets, and an interpretation of that complexity as 'difficult'.

> *I wouldn't say I could see any advantage really I mean we certainly wouldn't have any problem with getting involved with it or looking at tendering on a web site. Personally it might just make it another hurdle for small contractors to get involved, just another bloody whiz-bang thing you know. (Firm 11)*

An interesting outcome of this finding is the general tendency for this perception of 'complexity as difficult' to occur at the lower ends of the construction industry spectrum as arrayed by Roger's (1995) diffusion categories. The previous quote reveals that the firm in question professes no 'problems' with the idea of adopting a particular eBusiness application – an attitude seemingly at odds with both the failure of the firm to currently be utilising that application, a failure to see any advantage, and, the use of the 'personal' position in framing the objection to the innovation on the grounds of complexity-difficulty. Interestingly the perception of complexity as difficult is associated with the economic and cultural characteristics of the lower-end subcontractors who so frequently are focused upon as the impediment to complete and effective adoption patterns. This is the case even in this example of a mid-level consultancy firm who in this instance is itself a non-adopter.

There is little doubt that for firms and small-operators with little experience with IT technologies and eBusiness processes that there is a greater tendency for something new to be perceived as a difficulty. In this sense 'difficult' becomes understandable as a euphemism for unavailable resources in terms of manpower or capital to invest in understanding the complexity in order to turn that greater (more complex) capacity into advantage. These themes are discussed in a following section regarding Market Incentives for Adoption.

Not surprisingly, these smaller end operators who occupy the lower end of Roger's spectrum have a very low degree of adoption. Their processes remain impervious to any perceived IT benefits largely on the basis of these perceptions and attitudes. Thus their perceptions of complexity and difficulty are frequently not the product of personal exposure and usage of the eBusiness application in question, but rather the product of 'myths' and second hand knowledge passed on through informal networks. Consequently the firms at the lower end can be considered to belong to primarily homophilic communication networks, on the basis that their perceptions of 'complexity as difficult' are rarely challenged.

Therefore there is a demonstrable relationship between holding perceptions of IT as complex and difficult, and resistance to adoption based on attitudes. A position in a homophilic social network is likely to produce a culturally indoctrinated set of attitudes that forms the basis for an easy dismissal of potential benefits of IT adoption on the basis of many justifications.

> *E-technology does have to get more intuitive and … I reckon the keyboard in that system is the wrong system. … it's not a human way of doing things, it's a bit like writing with typewriters … in the 19th century .. . But all the same … we still have to work within a context and that's the context in which we work and I still just have to struggle but I certainly don't see it as a panacea or a great thing, I think it's a tool that's got it's limitations (Firm 12)*

> *I know a subcontractor … and he sits in the office … all day and he's got the email going ding, ding, ding and … he only does one thing … (Firm 6)*

> *I held out getting a fax machine as long as I could. I used to trot across the road or up the road, same with photocopying and then obviously got one and realised well we should have got one a long time ago (Firm 9)*

We still resist the E-banking because of security problems. We've had two meetings with the Commonwealth Bank here and there were several issues that the girls had with the bank for security. We've had customers who have…put one digit out and he lost about $30,000 and it took him months to try and retrieve that. (Firm 9)

For many of these firms the resistance to IT adoption on the basis of attitudes is interesting because the attitude can remain in parallel with positive attitudes that have developed through exposure to eBusiness. Some of these firms displayed an aversion to IT in general references, but when discussion delved into the different aspects of eBusiness applications at use in their enterprise their antipathy was markedly reduced. For example Firm 9 who above expressed an attitude of resistance to new technologies in the form of fax machines, and who also holds a perception of internet-based business as an insecure financial environment makes the following quote concerning experienced advantages of eBusiness:

Very precise, so much quicker…More accurate, we can probably push the envelope a bit further. (Firm 9)

This dimension of the problem, in which attitudes of difficulty and perceptions of aversion are eventually and primarily overcome by positive experiences of adoption, demonstrates that what is generally required for the increasing of 'end-user IT awareness' and subcontractor familiarity that are generally recognised as key hurdles to consistent patterns of adoption is that innovations present themselves as compatible with pre-existing business processes.

5.1.2 Compatibility of the Innovation

An outcome of inconsistent adoption patterns is the financial problems caused by different organisations utilising different software programs, or frequently different editions or versions of the same software. Issues of inter-organisational (supply chain) compatibility being the impediment to eBusiness adoption demonstrated by the following passage:

We have a graphic artist who does letterhead or brochures for us. Her level of software was not compatible with the printer's level of software, they're obviously the latest and greatest…so it led to a mistake in the print that, it was a big print run and of course the printing company didn't want to take any responsibility and the graphic artist said that she told them it was Version blah, blah and so we were left in the middle receiving a product that wasn't a hundred percent. I just had to wear it, just had to grin and bear it (Case 9)

Examples such as this are prevalent in the datasets with almost all respondents mentioning some experience of a lack of accurate information transfer due to differing operating systems.

However incompatibility of the innovation based on disparate software platforms is the not the sole expression of innovation incompatibility. Another recurring theme was that IT applications are also frequently incompatible with pre-existing process and operating systems within a firm.

This can cause delays in processes and outcomes with the inevitable financial consequences. Equally importantly such occurrences can add markedly to the perception of adoption as complex and thus difficult. This idea of complexity and difficulty is discussed again in the section 5.5.1 Compatability with innovation pathway. The outcome of this impdiment is that the potential eBusiness applications of an innovation are never simply evaluated and considered for adoption just on the basis of its own attributes, but also on the basis of a whole range of pre-existing organisational-structural conditions that largely determine the relative ease of the adoption process. Consider these quotes that demonstrate an incompatibility on the basis of entrenched business processes that reflect current needs of various elements of the industry:

You've gotta work from the people that use it ... the subcontractors out there that are doing the work ... are 95% of the people and they're the people that want the information, they want it correct, accurate, quick, now, ... and they need to be able to get it easily and you know they're not geniuses when it comes to IT but they're good at what they do, so you've gotta design a system that allows them easy quick access to that information whether it's drawings, specification pages, site instructions, whatever it is. (Firm 2)

It's all handwritten, all the prices, it's all written by hand, … old blokes they can't type, they don't want to sit there for hours writing something. Hand it to the office girl and say fax it or send it by email and they go bang, bang, bang and it's done, put it in the fax and send it over, so it's all just done once." (Firm 6)

Thus compatibility of the innovation with pre-existing practices & processes can be seen as a key contributor to the barrier discussed above as inconsistent adoption patterns and also below as lack of market incentives. Potential gains in efficiency claimed by a given eBusiness application must be considered relative to the overall cost of adoption which can mean substantial changes to pre-existing systems and processes. Thus the price tag of a new piece of IT should not be confused with its total cost.

5.1.3 Market Incentives: Uncertainty Regarding Returns

There is little doubt that IT adoption has a considerable economic outlay and that frequently economic benefits are not felt immediately but can often take some time to accrue. It was a key theme in our research that smaller operators keenly felt the financial pinch of outlay on IT equipment & related software. Thus the lack of market incentive in terms of a prohibitive cost intersected frequently with an attitude that the status quo is a workable proposition. In many cases this was enough to convince the smaller operators that a given adoption was unnecessary and thus improvements to business processes offered by innovations are not pursued. Consider the following quote that demonstrates the relative significance of an objectively minor business cost in the context of a small-end industry operator's decision-making processes when evaluating financial outlay versus potential benefits relating to an eBusiness innovation:

Broadband it's going to cost me bloody I don't know I think it might be forty bucks a month, …and I'm paying fifty bucks for two months (for dial-up) so you know difference there isn't there? And I hardly use the thing now. (Firm 6)

This degree of uncertainty regarding returns on investments held by the smaller-end operators is an outcome of their perception on the value of the innovation, which can also perhaps be considered as a lack or awareness of the potential benefits an eBusiness application can offer. An important point emerging from the analysis is that these attitudes are common across individuals of comparable strata within the industry and hence related to their position in an economic structure and a specific market dynamic as much as their participation in an industry culture. The following quote from the same subcontractor highlights that occupation of a stable and favourable market can act as an effective justification for the status quo when intersecting with a conservative attitude toward technological innovation adoption:

No (I don't feel competitive pressure to adopt). There's only about four or five builders who do stuff I do anyhow. And we're all spread out and we're all doing stuff … it's not as if no one's working." (Firm 6)

It is certainly the case that firm's of considerably larger economic capacity hold an assumption that entrenched attitudes regarding the satisfactoriness of current business processes are a factor in preventing small operators from examining potential benefits of eBusiness applications:

They do have to change their way of thinking. It's the attitude of "No I like doing it this way, so why should I look at something else?" "This way has worked for me", and I hear it all the time "But this is the way we've done it for so many years, why should we change?" (Firm 4)

For those firms with a greater economic capacity and thus a substantially different attitude toward evaluating the risks of expenditure versus returns this entrenched attitude as an impediment is frustrating for two reasons. The first is that it obviously increases the trend toward inconsistent patterns of adoption that bears a flow on affect on their own ability to streamline process and thus influences their profit margins. The second reason is that an entrenched attitude that prevents an open-minded evaluation of potential benefits of adopting eBusiness applications is self-fulfilling. Quite simply, without ever trying a new technological application or refined process it is impossible to evaluate from a position of experience whether or not an eBusiness adoption will turn out to provide financial benefits. For those firms with the economic capacity to survive the time lag between investment and return a common belief is that if the smaller operators did try a given application that would experience real financial benefits:

> *(Those smaller operators are) fairly set in their ways of doing business and some are just not interested I think in (the) IT side of things and the biggest thing is finding people that you know are prepared to give it a go because once they do I think they'll see the benefit of it." (Firm 1)*

Yet, as pointed out in the above quote from firm 6, there are very real concerns about minor outlays for those operators running on relatively small profit margins. It is difficult for the bigger players in the construction industry to truly appreciate the experience of operating a successful small business on extremely tight margins. Prohibitive cost is also not restricted to the purchase price of new technology or software alone.

For many small operators the initial outlay was only of minor significance, the problem was the continual need to update and renew technology to stay abreast of industry levels – that is, to maintain a consistent pattern of adoption as dictated by firms with far greater economic capacity. Many respondents doubted the need for this continual updating of technology. Consider this quote:

> *The only thing that probably pisses me off greatly is that every year they tell you that what you just bought is now old news and obsolete. I still can't come to grips with that if they're so clever at designing computers and packages, why can't they design something that will last at least five years. I think it's a big conspiracy. (Firm 9)*

The fast moving pace of technological advancement is also productive of a second barrier that is mostly keenly felt in relation to supply chain interactions: The disparate levels of technology and degrees of operating knowledge that can lead to inconsistent adoption patterns. Inconsistency in eBusiness potentials across the supply chain can be an outcome of differentiated levels of technology and software platforms and this is most frequently a reflection of the rapid patterns of adoption demonstrated by innovative highly capitalised firm's as much as the above discussed lack of market incentives held by smaller operators. However, inconsistency in eBusiness potentials is also related to disparate levels of operating knowledge. The possession of the technology itself is often not the sole problem, but also the knowledge required to effectively operate the technology is a key requirement and one that bears a somewhat hidden cost that easily contributes to smaller operators uncertainty regarding returns on investments.

This often-cited barrier relates to the required operating knowledge inevitably accompanying any purchase and integration of a new IT application into a business process. Associated with the need for training is the consequent loss of productivity that goes along with it. Thus, while Staff Training emerges as a driver to innovation adoption in terms of developing a degree of dissemination of necessary 'operating knowledge', it is also evaluated as an additional (and negative) cost associated with IT outlay.

This relationship of staff training to loss of productivity exasperates the perception of IT expenditure as prohibitive for small operators such as Firm 12. This perception becomes even more acute when it is factored in that the technology and software may very well be effectively obsolete in a very short time and thus the outlay on staff training and knowledge

dissemination and associated losses of core-business productivity may have to be repeated, perhaps indefinitely. This dilemma is not restricted to small operators functioning on a small margin. Large highly capitalised firms also expressed concern at the potential loss of productivity associated with developing and maintaining effective operating knowledge to ensure that eBusiness applications do contribute to improved business processes and thus do provide return on initial outlay.

5.1.4 Heterophilic and Homophilic Communication

The notion is emerging that heterophilic communication within an organisation is a complex issue that can simultaneously be both an impediment and a driver to eBusiness adoption and innovation diffusion. Differences between vertically integrated groups of employees can exasperate problems in communication, or indeed communication between areas of niche expertise within the larger firms produce the same outcomes: Many people attempting to communicate without sharing some common point of shared understanding can lead to minimal effective communication. Examples of this problem are:

- Generational discrepancies in attitudes and perceptions to the value of IT,
- Disparate levels of operating knowledge

These notions also tie in with the idea that an eBusiness innovation's incompatibility with previously understood beliefs is most likely to occur along generational lines.

> *We've got a really wide spectrum of employees from students through to senior older architects that aren't say as versed with the E-environment. Generally trying to get that senior person to understand the benefits of the process. A lot of them are still quite orientated towards the drafting and the pen and pencil so that's been an interesting process. (Firm 5)*

On the other hand, for those firms large enough to appreciate a degree of heterophilia and diverse employee groups (in terms of organisational function) in their structure, there seems to be a massive benefit from the organisation of formal processes designed to foster and manage heterophilic communications. Heterophilia is discussed in more detail in section 5.5.3 The Heterophilic Communication Pathway.

Figure 1 Causal links between impediments to eBusiness adoption summarises the key interrelationships discussed in this section.

1.10 Drivers

In a manner similar to the primary impediment discussed above of inconsistent adoption patterns, it is relatively easy to identify from the analysis a perception of advantage as being the key driver for eBusiness adoption. There are, however, obviously numerous processes of both a social/cultural and economic nature involved in generating the prevailing conditions for a perception of eBusiness adoption that interprets it as a pathway to competitive advantage. Accordingly, analysis has identified a series of 'nested' or hierarchically related factors that intersect and co-influence one another in order to produce the complex conceptual and financial terrain in which innovation-adoption decisions are taken. The following is a brief description of the nature of each driver but the complexity of these relationships is best illustrated below in Figure 3. The following sections summarise the key drivers.

5.1.5 Primary driver: Perceptions of Advantage

Most organisations view their level of adoption in terms of competitive advantage, whether that meant having a point of differentiation from their direct competitors, or needing to adopt to remain competitive within their particular market, i.e. nullifying others competitive advantage. The key significance of this finding is the emphasis it places on the nature of the relationship between social/cultural processes and economic outcomes. It is the way that various managers think; the values and meanings they draw on when interpreting new situations and potential benefits that mark this key driver as uniquely malleable. Perceptions of advantage are developed in response to the market conditions and structural economic forces, but are equally influenced by the prevailing social codes, limitations and justifications at play within the social/cultural spaces of construction industry relationships. The following section outlines the various other drivers and their interrelationships.

5.1.6 Subordinate drivers

As indicated by the above discussion the characteristics of firm management play a large part in determining an organisational approach to eBusiness adoption. The firms with more experience in eBusiness were found to view innovation as integral to their way of doing business and have incorporated processes that support this into their culture. This is driven by a desire to improve the efficiency of their business processes, for which they view IT as a tool for the job. The key point here is that it is those firms that have experience with eBusiness that are most likely to develop management level perceptions of eBusiness as delivering competitive advantage.

Thus while management characteristics as broadly conceived play a large part in producing functional decision-making processes and improved capacity for organisational implementation it is those characteristics of managerial practice that bear direct relationship to the adoption-diffusion process that bear inordinate influence upon wider levels of industry adoption. The following sub-themes emerge as component factors within managerial characteristics of the firm analysed:

The general attitude taken towards innovation can be quite easily arrayed along the common continuum of conservative to progressive. In relation to the specific nature of the innovation in question as an eBusiness application there was a fair amount of resistance to innovations based upon generational discrepancy. That is, older individuals were more likely to be uncomfortable with taking rapid steps towards eBusiness adoption. At the same time, younger individuals were more likely to embrace a 'cutting edge' application bringing with it the concomitant risk associated with returns on investments and perpetual upgrading cycles. It was found that the most effective attitude towards eBusiness applications was those individuals who interpret IT as a tool. These individuals are not enamoured with the cutting

edge simply because of its novelty, but rather display a keen eye for potential advantage in combination with a measured level of restraint.

The process by which innovations are evaluated thus emerges as another key intersection of economic and social/cultural factors. Risk management decisions within the construction industry are made predominantly within a framework of economic rationalism and therefore the framework for interpreting potential benefits related to eBusiness applications is made primarily on the basis of delivery of organisational and economic efficiencies and hence greater profit margins. These management decisions are not made in a vacuum, however, with respondents citing numerous sources that exert influence over their interpretation and evaluation of a new technology.

As discussed in the previous section regarding key impediments to eBusiness adoption the actual cost for firms of adopting a new technology can often well exceed the strict outlay required to purchase the eBusiness application. The need for relevant operating knowledge to functionalise a given technology is a key influence in improving the potential for an adoption to produce economic and organisational advantages. The loss of productivity associated with sending staff on training programs is a hindrance toward developing an advantageous attitude toward the investment. Those firms that actively encourage staff training and have in place formal process for wider dissemination of knowledge's gained through training display remarkably more adaptive potential.

The organisational culture of a firm refers to both the processes and practices that make up a particular organisation as well as the forms of understanding and interpretation that makes those behaviours effective as an organisational unit. Firm Culture is a key driver for the firms of a size large enough to be able to reflect upon their organisational culture as embodied in the collectively held perceptions and attitudes and the general and strategic philosophy of management. A firm culture conducive to adoption and diffusion was generally described through terms such as 'continuous improvement' and 'openness to change'. An industry wide culture exerts a degree of pervasive influence upon individual firms within the construction industry, and this is more prominent with smaller end operators with lower staff numbers.

A culture of innovation emerged as perhaps the key differentiator between firms that drove industry eBusiness levels, and those firms that attempted to maintain those levels. Innovation as a culture can emerge from strategic management initiatives but must predominantly become entrenched in the commercial operations of the firm at the level of the individual staff. Aspects of innovative cultures include official processes designed to encourage and capture staff ideas about process improvement.

Engagement with wider industry associations and related networks is both a means of generating a firm culture and the product of an effective firm culture. The wider industry culture is often on display at these association meetings, and it is in comparison to a cultural forum such as this that representatives from a firm can recognise and evaluate their own internal organisational culture as either advantageous or deficient. Industry associations and other professional networks also figured as key sources of information about new technologies potentially of benefit to the industry as well as space for the circulation of experience and advice regarding technologies.

Non-industry relationships were also uncovered as playing a significant role in how an organisation goes about implementing an eBusiness application. This is particularly the case for individuals that expressed a degree of resistance to change based upon generational discrepancy. Family, community and social relationships outside work were identified as playing a central role in both enforcing and changing entrenched attitudes towards innovations. Alongside industry associations the family was identified as a key source of ideas about new technologies, in addition, children of staff members were identified as exerting inordinate capacity to positively influence attitudes towards IT technologies.

This factor concerns the possibility of integration between a technology and the organisational processes of a firm. Identified as a key impediment to eBusiness adoption, the compatibility of the innovation becomes a driver when that issue of compatibility is addressed. When an innovation that is marketed on its ability to deliver a particular business advantage is trialled by staff and fails to deliver due to its complexity this is a major cause of negative attitudes towards adoption. However, when an innovation is intuitively useable, functionally simple and delivers a recognisable advantage then the nature of the innovation as compatible with both users needs and clients needs is the key factor in delivering organisational efficiencies and economic benefits that are the foundation elements for a perception of the innovation as offering competitive advantage.

The most frequently mentioned factor driving further adoption of eBusiness was the experience of improved organisational efficiencies form previous adoptions. Inevitably the positive interpretation of efficiencies gained, indeed the capacity to measure them at all, is due to the tendency for improved efficiency to manifest as economic benefit. As mentioned above it is organisational efficiencies and economic benefits that comprise the two key parameters for evaluating the success of an innovations adoption. In the analysis of the dataset for this case study there were four main notable types of improved efficiency.

Reduced production costs predominantly extend from improved organisational capacity within the supply chain. The complex interrelating processes involved in construction from both the management side and the organisational roles of subcontractors and their workers can easily be the cause of financial impacts due to mismanagement or unforeseen circumstances – particularly with the ever-decreasing timeframes being proposed in the industry. The effective usage of eBusiness applications can reduce these potentials for wastage through streamlined production processes.

Reduced communication relates to two aspects. The first dimension of reduced communication costs refers to the greater capacity for intra and inter-organisational communication between firms. The second involves measurable improvements in process time and output quality related to increased potential to transfer complex design information rapidly and accurately. Every single respondent discussed this as a key perceived benefit of eBusiness in general or a realised advantage of adoption of a given innovation. Given that design documentation is a central dimension of the construction industry it is perhaps not surprising that the capacity of eBusiness to greatly increase the rate and accuracy of documentation transfer is identifiable as a predominant driver.

For those firms with a culture of continuous improvement entrenched working practices include such self-reflexive measures as revision of processes & practices as well as periodical evaluation of technologies with the aim of increasing efficiency & lowering costs. Organisational efficiencies are frequently an outcome of improved communicative capacity, such as increased mobility and decentralised flexibility. Other frequently discussed organisational efficiencies are related to staff reductions and role consolidation.

Increased empowerment of individual staff via the increased capability provided by eBusiness applications has the affect of improving an organisations usage of its human resources. This is in the sense of a better ability to identify those resources through more effective document management systems, and also, and more importantly, allowing individual staff more access to other staff through the flattening o f the information channels. Thus organisational efficiencies produce greater flexibility allowing less rigid working patterns and the increased potential for staff creativity and ingenuity.

Figure 2 Causal links between drivers for eBusiness adoption

1.11 Pathways to adoption from Impediments and Drivers

Of keen significance to understanding the forces exerting variable influence upon processes of eBusiness adoption within the construction industry has been the finding that numerous barriers and impediments can easily transform into drivers for further adoption and innovation dissemination once they are re-evaluated and perhaps approached with new strategies or techniques.

The tendency for impediments to transform into drivers is demonstrated by the corresponding presence of two key themes described by respondents as simultaneously barriers hindering and factors positively influencing eBusiness adoption. These two key themes are Perceptions and Attitudes and Compatibility with the Innovation. In addition, a third impediment, described as Heterophilic and Homophilic Communication, is also interpreted as an impediment to adoption in an unmanaged state that quickly becomes a key driver toward innovation when it is addressed as a component of strategic management. In Figure 4 the relationships between these impediments and drivers is outlined in terms of pathways to adoption.

Figure 4 outlines a set of interrelated pathways that define the transformative relationships between the key themes discussed by respondents. Pathways are conceptualised in the following discussions as being the processes and strategic re-evaluations discussed by respondents as means of overcoming social/cultural and economic barriers to adoption by transforming the same structural conditions and organisational practices into resources for further innovation and adoption.

The following discussion should be prefaced with a qualification stating that in reality all of these processes are coterminous and intersecting. In the actual lived circumstances of organisational practice it is not so easy to identify a clearly defined starting point in a complex circulation of causal factors. The decision to begin the discussion with the theme of Compatibility of the Innovation is therefore made on the basis of integration with the preceding sections that clearly outline compatibility of the innovation as the prime cause of organisational efficiency and economic benefit. It would be possible to begin the outline of pathways to adoption from any impediment described by the respondent as befitting the diverse circumstances of construction industry organisations.

5.1.7 The Compatibility Pathway

A dominant issue described by respondents as contributing to the key impediment of Inconsistent Adoption Patterns is the incompatibility of adopted technology. This incompatibility can be experienced with either external organisations or internal practices and processes. In the first instance the form of incompatibility with external organisations manifests as different firm's utilising disparate software platforms or frequently different editions or versions of the same software. As a general theme the incompatibility of eBusiness technologies and operating software platforms is predominantly felt as a nuisance and does not prevent adoption. Indeed, as an impediment it logically follows the decision to adopt and exerts its influence within the implementation phases of the adoption process.

Almost all respondents mentioned some experience of a lack of accurate information transfer resulting from software incompatibility and this can easily prove frustrating as the capacity to improve transmission of design documentation accurately is a key claim of eBusiness. This form of incompatibility of the innovation can lead to the development of negative attitudes towards adoption and contribute to the perception of innovation complexity as synonymous with difficulty. However, the economic ramifications of this form of compatibility are relatively minor.

The second form of incompatibility with the innovation concerns the possibility of integration between a technology and the organisational processes of a firm. Failure of an adopted

innovation to deliver a particular business advantage is frequently caused by a mismatch between either the operating knowledge or technological requirements of an innovation and the processes and practices entrenched within the organisation prior to adoption of the innovation. In a fashion similar to the first form of incompatibility this mismatch can be a cause of negative attitudes and perceptions towards innovations and indeed towards the broader processes of adoption. It presents a greater potential for economic consequences, however, because it forces organisational restructure and adaptation in order to make the innovation functional. Thus, the situation is either to write of the initial investment on the adoption, or to invest further in the more expensive process of organisational restructure.

As discussed in the section on drivers to adoption, compatibility of the innovation with organisational processes means taking into account both the user's needs and the client's needs. When an innovation is intuitively useable, functionally simple and delivers a recognisable advantage in terms of efficiency of process or improved quality of outcomes and deliverables then the organisational efficiencies and economic benefits gained via utilisation of the innovation are deemed in accordance with broader company objectives. Addressing the practicalities of integration of an innovation with the objectives of an organisation in terms of the needs and desires of the users (staff) and the clients permits the transcendence of the impediment caused by incompatibility. Accordingly a pathway to adoption is opened as higher levels of compatibility continue to produce positive experiences of adoption. The flow on effect, as expressed in Figure 4, is an impetus given to improving perceptions and attitudes, as well as the recognition of organisational end economic benefits resulting from streamlined processes and improved outputs.

5.1.8 The Perceptions and Attitudes Pathway

It is recognisable from the discussion of the compatibility pathway that positive employee experiences of adoption and recognisable competitive advantage bestowed by adoption of an innovation are key factors in shaping the perceptions and attitudes held toward eBusiness adoption. A further implication of the compatibility pathway is the requirement that the adoption-decision process as undertaken by management must acknowledge and strategically manage the wider contexts of adoption. Adoption can not occur as a decision made in isolation from either the organisational processes, cultural practices or the strategic objectives of a firm. Hence, the improved perceptions and attitudes towards eBusiness adoption produced by increasing compatibilities between innovations and firm processes include an improvement of perspectives upon the internal operations of the company. Specifically, positive experiences of adoption produce a more strategic and reflexively conscious awareness of the importance of developing firm culture and beneficial management characteristics.

The improvement in perceptions and attitudes produced via this strategic awareness is identified as a key technique for alleviating problems associated with the perception of complexity as difficulty. As mentioned in the section on impediments this relationship between complexity and difficulty is problematic because it represents the gap between the present organisational practices and the required operating knowledge necessary to make an adoption functional. Complexity alone is not necessarily an impediment to implementation if the adopting organisation has recognised the need to effectively engage complexity before negative end-user experiences translate into a perception of difficulty. Inevitable those firms that displayed capacity to break the conceptual linkage between complexity and difficulty were those firms who had developed internal processes for technology problem solving. It is the broader perspective gained by management understanding innovation adoption as being primarily an organisational and cultural change rather than a technological purchase that allows formal systems and procedures to be put in place to address inevitable teething problems associated with eBusiness adoption.

Figure 4 demonstrates how changes in perception and attitude toward innovations and the adoption process produces a pathway to further adoption by generating positive flow on affects to the key drivers of management characteristics and firm culture. As discussed in the section outlining the key drivers, the management characteristics of an organisation as expressed in such factors as attitudes to staff training and processes of evaluating risks and potential advantages play a large role in determining the degree of adoption for a given firm. Likewise, firm culture was identified as a key context in determining the extent to which implementation of an adoption moves forward smoothly and also to what extent the capabilities of an innovation are integrated into the organisational capacity of the firm by employee practices. Invariably the most adaptive and innovative firms spoke of their own firm culture as being 'open to change', 'continually seeking improvement', and able to take 'advantage of opportunities'. It is these characteristics that feature prominently in a further flow on affect. Figure 4 also outlines how improvements in the two drivers of management characteristics and firm culture create a further pathway to adoption by influencing the organisational approach to homophilic and heterophilic communication.

5.1.9 The Heterophilic Communication Pathway

Diffusion of any type of knowledge involves two forms of communication. These can either be *heterophilic*, where two or more individuals interacting have different attributes, beliefs, education and social status, or *homophilic,* where two or more individuals are similar in their attributes and social status. Generally speaking, most communication is more effective when it is homophilic, where people share common beliefs, meanings and have mutual understanding of one another. Individuals who attempt to communicate with others who are different from them often face frustration and ineffective communication. In this regard, it is important to note that while homophilic communication offers 'smooth' diffusion of ideas, it does not necessarily denote acceptance of new ideas or practices – instead homophilic communication can act as an invisible barrier to the diffusion of innovations.

Although homophilic communication may be frequent and easy, it is not as crucial to the diffusion process as less frequent heterophilic communication. Homophilic communication may accelerate the diffusion process but it limits the spread of an innovation to those individuals who are already connected within the same strata of the social system or interpersonal network. The importance of heterophilic communication for diffusion lies in its potential to connect two cliques; thus spanning two sets of socially dissimilar individuals in a system and bringing into contact diverse ideas. This is especially important in spreading information about innovations, as by definition the innovation involves a new way of thinking or behaving.

For small firms analysed in the case study, homophilic communication (and monocultural groupings) was found to be typically advantageous because it reduces confusion in informational transfer. However, this perception of benefit is relative to a scenario of 'unmanaged' heterophilic communication. On the other hand, for those firms large enough to appreciate a degree of heterophilia and diverse employee groups (in terms of organisational function) in their structure, there seems to be a massive benefit from the organisation of formal processes designed to foster and manage heterophilic communications. The key point here is the *management* of heterophilic communications.

When heterophilic communication is identified as a potential resource and management decisions develop specific processes designed to control that potential towards strategic objectives the outcome is a degree of employee empowerment and involvement in diffusion that is a key measure of an organisations status as an innovator. Primarily we see this in "Innovation Groups" operating within firms that seek to generate new ideas by exposing individuals to different ways of thinking and encouraging a degree of empowerment and employee engagement with processes of innovation and diffusion.

The outcomes of firm's management and cultural characteristics that are intentionally designed to implement and foster heterophilic communication are an inevitable movement toward flexibility of practice. When difference of opinion between individuals is valued as a means to producing further creative solutions it becomes close to impossible not to acknowledge that there are more than one way to achieve objectives. The consequences of this seemingly banal revelation is that firm organisational practices become recognisable as malleable and adaptable, and creative vision is permitted to see beyond the status quo. New ways of doing things are sought after and produce a mentality that is demonstrated by the analysis to be closely integrated with 'openness to change', 'continually seeking improvement', and the ability to take 'advantage of opportunities' that are the key characteristics of innovative firms.

Perhaps the key finding from this discussion of the interrelation of influencing factors to produce identifiable pathways to adoption is the understanding of the circularity of causation. The privileging of heterophilic modes of communication is a key driver by itself, as it promotes an openness to new ideas that is an essential social/cultural precursor to effective adoption. When these modes of communication are intentionally embedded in organisational policy and processes then individuals within the culture begin to be indoctrinated toward a culture of innovation. The flexibility of practice enabled by such a culture turns out to be of central importance.

An understanding of the cultural context and organisational structure of the firm as flexible and adaptable enables the risk-evaluation of innovations and adoption-decision process to occur under circumstances far more favourable to the possibility of engaging in adoption. This is because the new technology or practice is evaluated in terms of a flexible organisational context. Rather than an adoption being sought that must fit precisely into pre-existing organisational requirements the potential of an innovation can be evaluated in relation to the potential of the organisation. Thus a culture of innovation grounded in effective management of heterophilic communication means that the likelihood of an innovation being found to be incompatible is much less likely. Accordingly the opportunities for positive experiences of adoption by staff, and the organisational efficiencies and economic benefits flowing from increased compatibility are also increased.

Figure 3 Pathways to adoption from impediments to drivers

6 CONCLUSION FUTURE RESEARCH

This important contribution of this chapter to the current literature surrounding eBusiness technologies and in particular the adoption of eBusiness is the particular focus taken on the complex interrelationships between the various impediments and drivers. This then allows market leaders in the industry, whether they be government setting policy and directly engaging the industry on projects or larger contracting firms, to develop and refine strategies to improve the environment for adoption in particularly specific targeted ways. The key to adoption and widespread diffusion is understanding at a deeper level the decision making processes that are taking place specifically across our industry. The pathways to adoption is a particularly important way forward. The pathways to adoption map provided is merely the starting point and this shall be reflected upon again in light of the other three case studies and is thus a case specific and first "cast" as to what the decision maker behaviours are and the means by which they change their decisions. It is important to know the interrelationships which occur between impediments and when impediments turn in to drivers of adoption and become enabling agents. In this case study three key themes of pathways to adoption were Perceptions and Attitudes, Compatibility with the Innovation and Heterophilic and Homophilic Communication were used as the starting point. Quickly we realised that it is largely irrelevant where the starting point is and that it is a multiphased and multi directional decision making process.

The future research within this study is to conclude the cross case comparisons between all three case studies and confirm the significance of the impediments and drivers identified across these twelve firms. A large cluster of more than twenty firms and associated

The limitation to this study is that it really needs further confirmation and although by a case study methodology standard, detailed information on twenty firms is considered to be quite a large project it still will lack a regional and national verification. The validity and reliability of the model could also be enhanced by exploring sectors within the industry a little more acutely. It would be most constructive to investigate the various types of chains in much more detail than could be achieved in this study. The aim of this study was to try to bring together an interpretation about the complexities of decision making in relation to social, cultural and economic threads of arguments that are pervasive in academia and develop a model for adoption behaviour. One of the most interesting themes in relation to eBusiness technologies which are innovations in the industry is the way in which an innovation culture is perhaps the ultimate aim of the cluster of firms that are working together; that the project and the various contracts on projects which tie them together are the key triggers to enabling adaptation of the particular eBusiness technologies. It is the combination of skills, knowledge and attitudes towards eBusiness technologies within these clusters which requires further examination to take the model forward.

The final conclusion to be drawn is that governments and market leaders have a significant role in understanding the real impediments faced by the groups of firms which supply to them and are highly reliant upon them. It is not only an understanding but an ethical position to develop supportive strategies to enable change in the industry. Further research in ways forward from their perspective is required; particularly in the way that these organisations currently operate internally and with their external interfaces to their suppliers to help or hinder the future adoption of eBusiness technologies and are either creating obstacles or paving the pathway for widespread adoption across the industry.

7 References

ABS (2004) Cat No 8129.0 1999-2000; Business Use of Information Technology

Bayer, J and Melone, N. (1989) A Critique of Diffusion theory as a managerial Framework for Understanding Adoption of Software Engineering Innovations, The Journal of Systems and Software 9, pp 161-166

Bennett, B., Cobbold, T. and Phillips, M. (2003) ICT use and firm performance in Australia: evidence from firm interviews. Eight working paper of the Joint Project on Use of Information and Communications Technologies, Department of Industry, Tourism and Resources and the Productivity Commission: 32

Castells, M. (1997) The Power of Identity. USA: Blackwell Publishers.

De Berranger., P. and Meldrum, M.C.R. (2000) The development of intelligent clusters to increase global competitiveness and local cohesion: The case of small businesses in the creative industries, Urban Studies, 37:10, pp1827-1835

Elliman, T. Orange, G. (2000) Electronic commerce to support construction design and supply-chain management: a research note, International Journal of Physical Distribution & Logistics Management, 30:3/4, pp 345-360.

Frank, A.K., Zhao, Y. & Borman, K. (2004) Social Capital and the Diffusion of innovations Within Organisations: The Case of Computer Technology in Schools, Sociology of Education, 77: 2, pp148-172

Gray, C. and Lawless, N. (2002) Determinants of e-commerce adoption in small firms. Conference paper. http://www.vitalcgi.co.uk/~isbauk/papers/messages/243.html

Harvey, D. (1989b) 'From Managerialism to Entrepreneurialism: The Transformation of Urban Governance in Late Capitalism'. Geografiska Annaler, Vol 71 (B), p3-17.

Inirige, B. and Aouad, G. (2001). Awareness and usage of information standards in the UK construction industry: A survey by the SIENE network. Available at http://itc.scix.net/data/works/robots/w78-2001-8.htm

London, K. (2001), An Industrial organisation economic supply chain approach for the Construction Industry, Journal of Construction Management and Economics, 19: 8, pp 777-789

London, K (2005), Construction Supply Chain Procurement Modelling, unpublished Phd thesis, February 2005, University of Melbourne, Australia.

Malone, S.C. (1985) Computerizing small business information systems, in Journal of Small Business Management, April pp 10-16.

Montazemi, A.R. (1998). Factors affecting information satisfaction in the context of small business environment. MIS Quarterly, 12, pp 239-256.

NOIE (2001). B2b E-Commerce: Capturing Value Online, Available at http://www.noie.gov.au/

Parish, A., Kibblewhite, G., Woodley, M. and Richardson, J. (2002) The UK Electronic Industry E-Commerce Initiative: A study of the adoption of e-commerce Report for the DTI.

Rogers, E. (1995) Diffusion of innovations, fourth edition, The Free Press: New York

Storey D.J. and Cressy R. (1995) Small business risk: A firm and bank perspective. Working Paper, Warwick Business School SME Centre.

Tetteh, E.a.B.J. (2001). Global strategies for SMeBusiness: applying the SMALL framework, Logistics Information Management, 14:1/2, pp 171-180

Veeramani, R., Russell J.S., Chan, C., Cusick, N., Mahle, M. and Van Roo, B (2002) State-of-practice of E-Commerce Application in the Construction Industry, A Report to Construction Industry institute The University of Texas at Austin, University of Wisconsin-Madison

Wenninger, J. (1999) Business-to-business electronic commerce, Current Issues in Economics and Finance