

## **INDUSTRY DEVELOPMENT**

### **Full paper**

## **A REFLEXIVE CAPABILITY MODEL FOR SUSTAINABLE E-BUSINESS ENVIRONMENTS IN CONSTRUCTION SUPPLY CHAIN**

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### **ABSTRACT**

Despite the increasing significance of e-business worldwide and construction market leaders developing innovative e-business applications, the widespread uptake in the Australian construction industry is lagging. There has been considerable literature related to e-business adoption focusing on drivers and barriers to adoption. However, there has not been an investigation that has applied fundamental supply chain theory concepts. In this paper a reflexive capability model for the individual firm in relation to e-business is developed which relies upon merging economic and social practices through an industrial organization economic theoretical lens and social science theories of communication. The reflexive capability model proposed within this paper describes a framework for theorization of the different degrees of e-business adoption exhibited by individual firm's and accounts for social-cultural, organisational-structural, communicative and economic (market and supply chain) barriers, influences and pressures to adopt e-business. The model is proposed for the construction supply chain to enable awareness, engagement and realization of e-business technology and achieve long term construction e-business sustainability.

**Keywords:** reflexive capability, sustainable e-business environments, supply chain industrial organization economics, innovative diffusion

## **1.0 BACKGROUND/INTRODUCTION**

Despite the increasing significance of e-business worldwide and construction market leaders developing innovative e-business applications, the industry appears to be not taking advantage of potential e-business efficiencies and benefits. 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. This is problematic because of the critical role that the construction industry plays in the overall Australian economy, the flow on effects it has on other sectors and the future environment the market leaders wish to take the industry as a whole.

There has been much literature related to e-business adoption focusing on drivers and barriers to adoption. However, there has not been an investigation that has explicitly applied fundamental supply chain thinking to the problem of e-business uptake. The interdependency between different firm's no doubt impacts upon the uptake not only of e-business technologies but indeed in relation to *any* new technologies. The nature of firm behaviour is driven by the structural characteristics of the market they are located within and the influence that upstream clients and downstream supplies can have on the whole market. Therefore the industrial organisation economic concepts of structure, behaviour and performance are clearly useful in considering the problem of e-business uptake (London, 2005)

This research is concerned with developing a reflexive capability model of long term sustainable e-business usage that relies upon a deeper understanding of the underlying structural and behavioral characteristics of the manner in which firm's behave within their individual sectoral supply chains. 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. Reflexive capability refers to theories central to the social sciences that highlight the historical development in modern society of the conscious ability to identify, understand and evaluate the self in terms of processes and behaviours in a changing environment (Giddens 1990, 1991; Bourdieu 1990, 1992).

The Reflexive Capability model (London, Chen and Bavinton, 2005) is a conceptual framework that provides a means of identifying descriptors and characteristics of the different firm's positioned within a spectrum of implicit – explicit adoption of e-business technology. The model was developed by the authors for a research project into the internationalisation of construction and design firm's and proved valuable in identifying the underlying forces that influence changes in processes and practices. We propose to apply a reflexive capability model to the problem of e-business adoption in order to develop an adoption profile specifically for the construction industry supply chain that accounts for social-cultural, organisational-structural, communicative and economic (market and supply chain) barriers, influences and pressures to adopt e-business.

The reflexive capability model proposes a framework that describes the continuum of e-business adoption by individual firm's within their competitive and collaborative networks. This industry model for e-business sustainability requires a consideration of both the economic and social practices of the firm. The model is proposed for the construction supply chain to enable awareness, engagement and realization of e-business technology and achieve long term construction e-business sustainability.

## **2.0 BARRIERS TO E-BUSINESS UPTAKE**

It has been well discussed in the literature for more than a decade that a key to productivity improvements for the construction industry relies upon more efficient and effective

information management (Davidson, C. 2004, McGeorge, Chen and London 1994; McGeorge and Palmer, 1997). This has more recently been translated into electronic management of information in the form of web-based project management systems to manage consultant document coordination during the design phase. Coupled with this is the high level of contracts which occur on a project which again makes the construction industry ideally suited for e-business technology.

Therefore the main claims of the benefits of e-business technology are that it will provide commercial efficiencies through more effective design and construction information management and procurement and contract management. This is in addition to obvious increases in efficiency regarding information communication technologies in general as well as industry specific applications in high demand such as e-bidding. While the overall merits of all these technologies require further and prolonged investigation as to their eventual impact on the construction industry economic and cultural situation, the fact remains that after the initial adoption by innovative firm's, e-business has not dispersed throughout the industry.

General speculation on the reasons for slow adoption of innovative technology, such as those afforded by information and communication technology (ICT) has occurred in other industries and has been attributed to such factors as:

- lack of awareness of what e-business is and what it involves and further to this a lack of awareness or reluctance to see potential business benefits (Ingirige and Aouad, 2002; NOEI, 2001; Parish et al, 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, Cobbold and Phillips, 2003);
- market incentive, pressures, rewards and uncertainty regarding the financial returns from investments in various resources versus economic benefits (Tetteh, 2001; Veeramani et al, 2002).

A review of these factors identified as potential barriers to the adoption of ICT in various industries reinforces the notion that further research must begin to take into account social and cultural issues at supply chain, organisation and individual level. This is particularly evident when it is acknowledged that while the capabilities of the technology itself are rarely in question, it is the perception of the technology, and uncertainty regarding benefits and advantages of adoption that are the underlying reasons behind the above barriers. While it is true that the 'lack of security' in e-business environments is mentioned above as a factor inhibiting the uptake and diffusion of e-business in the wider industry, preliminary results from our research suggest this notion needs to be carefully examined. Predominantly those organisations who espouse lack of e-security as an issue *are not using* those particular e-business applications such as electronic fund transfer or electronic signature. While at first this may seem to be the whole point, upon consideration it becomes evident that these organisations are largely in no position to comment on security of e-business other than through word-of-mouth or hearsay – modes of communication based not in personal direct experience but, rather, precisely the arena in which perceptions of value and interpretations of risk can exert serious influence. For those organisations readily using e-banking and electronic signatures there is little concern displayed over the security of the internet environment – certainly no more than exists for standard forms of information delivery and financial transaction.

The importance of explicitly recognising perception and interpretation of value as key underlying barriers to e-business adoption is that these social and cultural meanings are dynamic and flexible. Preconceptions can be challenged, perceptions altered, values and attitudes toward innovation adjusted, uncertainties reassured and, eventually, different decisions can be made (Frank, Zhao and Borman, 2004). In this respect communication emerges as an important concept in understanding the barriers to adoption and the development of any strategies designed to overcome those barriers.

Although communication is important in understanding the barriers to adoption, the other key barrier is largely the economic imperative that underpins decisions within firm's that determines whether they will adopt e-business or not. The value to an organisation can be measured in real economic terms in many ways. However, sometimes this "real" economic value is elusive to measure; for example, firm efficiencies internally and externally and changes demanded by clients upstream forcing changes to competition are not as easy to measure but are considerations that are largely economically driven. Therefore, the interaction between economics, socio-cultural, organisational – structural communication and supply chain economic factors are crucial in understanding the barriers to e-business uptake. The reflexive capability model explores issues around these concepts in regard to developing an e-business adoption profile. It incorporates these aspects of economics and communication which are barriers to adoption and acknowledges the different scales (supply chain, firm, and individual) which influence adoption processes and diffusion of e-business across supply chains.

### **3.0 SUPPLY CHAIN THEORY**

A brief consideration of the supply chain concept serves as a useful theoretical framework for the development of the reflexive capability model discussed later in the paper. 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).

Firm behaviour in relation to the adoption of innovative technology (in this instance, e-business technology) relies upon; the individual firm's 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 then the social 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 firm's for e-business to be successful. Although it is important to be aware of the structural drivers and barriers 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.

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 firm's towards technological innovations can have significant influence on the acceptance and ultimately the dispersion of e-business 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. The next section describes the diffusion process of how technological innovations are communicated, adopted or rejected and finally implemented and diffused.

## **4.0 DIFFUSION THEORY**

Rogers (1962; 1995) has considered the diffusion of new technology in his text *Diffusion of Innovations*. Whilst not referring specifically to the diffusion of e-business as innovation, Roger's 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 Roger's 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 rate of adoption within a social system. Adopters are categorised into innovators, early adopters, early majority, late majority and 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. For example, according to Roger's, communication channels vary in importance according to the type of adopter; for example, mass media and expert knowledge has more influence on innovators, whereas personal networks are more important for late-adopters. Given this premise then depending on the level of adoption, a construction firm will either be influenced to adopt e-business by outside expert knowledge or personal networks.

Roger's theory of diffusion is a good starting point for measuring levels of e-business adoption. As Australian statistics (ABS, 2004) show that the construction industry ranks last on all four key performance indicators in relation to e-business uptake compared to all other industries it is conceivable that large percentages of SME's and firm's within the construction industry can be classified under the category of late to non-adopters. Certainly Roger's (1995) theory of a spectrum of different adoption rates is present in any industry (and indeed in the general population) and therefore the construction industry also has its share of innovators and early adopters. It is important to note that the measurement and categorisation of organisations as a particular rate of adopter does little to assist in understanding why innovators and early adopters have the marginal influence they do in the

overall adoption rate of an entire industry. These are the questions that have led to the examination of e-business diffusion through the supply chain through the means of a reflexive capability model that examines the socio-cultural and organisational contexts alongside communicative and economic concerns. Thus providing a framework that locates a context for understanding the spread of ideas and technologies *between* organisations. Therefore inter-personal social networks both within the supply chain and outside the supply chain in the form of expert knowledge and interconnection with other social networks (such as family, community and interest based groups) are significant for increased e-business diffusion. More precisely, this status identifies the importance 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 firm's of both collaboration and competition.

Whilst Roger's 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. Mode refers to the form that the adoption of the innovation takes. It is how the innovation actually works in practice. Of relevance to this point is recognition of the different functions of firm's in the supply chain, and accordingly their substantially diverse organisational structures. For example, organisations within the supply chain may only use aspects of e-business that they perceive to be of use to them.

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 suppliers, downstream clients 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 firm's. The diffusion of an innovation through a firm is not simply a managerial decision carried out by the firm's employee's, but rather individuals have a certain capacity to determine to what extent the innovation (e-business 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 firm's, and also alternative (and often creative) modes of adoption. Again though it is not simply an individual's capacity to adopt e-business as various strategic frameworks are required to support an individual's access to the innovation. At times managerial decisions drive change within an organisation as individuals have no choice in adoption of certain levels of the innovation.

Our spectrum of adoption, which will be demonstrated in our reflexive capability model in Section 5: A Reflexive Capability for e-Business adoption incorporates *mode* as well as *time* which allows for a degree of differentiation between the adoption of an innovation by an individual user and at an organisational level. This 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), that is, an innovation is considered to be an innovation respective to the organisation's level of adoption.

#### **4.1. THE ELEMENTS OF THE INNOVATION**

While Roger's diffusion theory acknowledges that different innovations will have different attributes dependent on their form and function, we argue that the consideration of the innovation as a unified and singular entity contributes to a reductionist and simplified perspective on diffusion. Roger's definition of the innovation consists simply of an idea, practice or object that is new. There appears to be little consideration of the component elements of the innovation, nor is there recognition that frequently an innovation consists

simultaneously of a new idea, facilitating objects (technologies) and associated practices (also new ideas) – which is the case with e-business.

To address this deficiency we have developed a model of the innovation complex. An innovation is composed of three primary elements: concept, material form and operating knowledge (refer to Fig. 1.0). The concept refers to the idea of the innovation, which includes an understanding of the advantages that it offers and involves an understanding of the concept in relation to a network of other concepts. The material form exists in the physical form of the innovation, which could be a piece of hardware or software. The operating knowledge is the set of ideas that explain the correct use of the material form or concept. These three elements together make up the innovation complex.

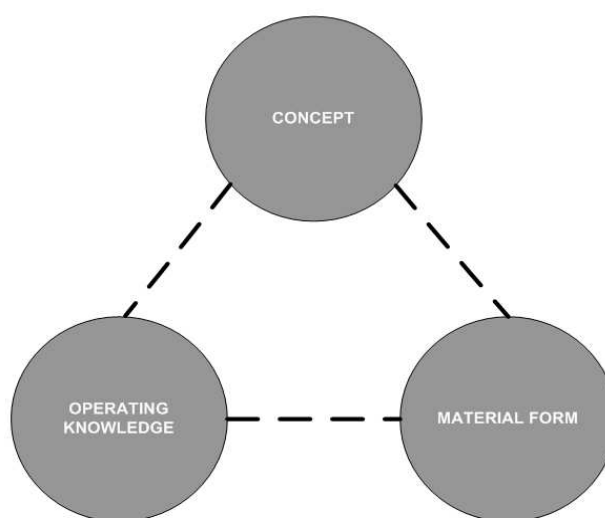


Figure 1: The elements of the Innovation

However, the inter-relationships between the elements are not stable or secure but must be maintained for the effective diffusion of an innovation. This potential for the inter-relationships to be severed is called detachment, whereby total detachment of the elements leads to fragmentation. It is proposed that different elements of the innovation complex are of differing levels of interest relevant to individuals due to their specific roles in firm's, and also each element is affected separately by individualised barriers relating to the circulation of meanings, values, perceptions and attitudes within the social system. Therefore diffusion of the innovation complex through the firm or supply chain may potentially exhibit a tendency towards detachment of its component parts simply due to its communicative passage through individuals with differing interests and interpretations.

#### **4.2 MODES OF COMMUNICATION**

Modes of communication are particularly important for analyzing the role of diffusion in e-business adoption. Diffusion of any type of knowledge can be considered to involve two distinct modes of communication. Drawing on Roger's (1995), these can be described as 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.

Most communication is more effective when it is homophilic; where people share common beliefs, meanings and have mutual understanding of one another as communicating with those of a different social status requires more effort to make communication effective. We suggest that the construction industry will be based in predominantly homophilic communication as a social system that shares the same general attitudes and perspectives due to roughly similar work needs and organisational requirements. Indeed, most diffusion networks are homophilous, and in this sense there should be, according to Roger's descriptions of homophilic communication and diffusion, rapid dissemination and adoption of innovations within the industry. The case remains, however, that the construction industry lags considerably in taking up e-business. In this regard, it is important to note that while homophily 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.

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, interpersonal network or business cluster. The importance of heterophilous communication for diffusion is that it can often connect two cliques, thus spanning two sets of socially/economically dissimilar individuals in a system. This is especially important in spreading information about innovations. Although homophilic communication may be frequent and easy, it is not as crucial to the diffusion process as less frequent heterophilous communication.

The diversity and fragmented nature of the construction industry and the project-based relationships of collaboration/competition that form most readily within a supply chain do however act to encourage dissimilar firm's and individuals into contact with one another. Thus while acknowledging the homophilic communication prevalent in the construction industry as a whole; the supply chain can act to promote heterophily. It is in this sense that the present research proposes that adoption of e-business within the supply chain can act to promote the adoption of e-business within the construction industry. It is noted that it can act to promote the adoption however it is suspected that many firm's in the construction industry work within a fairly well established business cluster – that is, a common group of clients, a common group downstream suppliers and the same competitors. Even if individual contractual relationships change from project to project and it is seemingly fragmented – over time many of the same firm's are working together or competing against each other. Therefore it is the characteristics of the cluster that might prove to aid adoption – thus the role that the industrial organisation economic supply chain concept plays on e-business adoption.

Both homophilous and heterophilous communication networks within firm's and between firm's within the supply chain are vital for successful diffusion of e-business in the construction industry. Homophilic communication enables these ideas to spread more quickly yet can also act as an invisible barrier to the diffusion of e-business. Encouraging heterophilic communication means that ideas about e-business can spread between organisations and to all levels within an organisation. Understanding these forms of communication is an important aspect of the reflexive capability model.

## **5.0 A REFLEXIVE CAPABILITY FOR E-BUSINESS ADOPTION**

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. In acknowledging the different scales (supply chain, firm, and individual) which influence adoption processes and diffusion of e-business within the construction industry, this research model sees adoption and diffusion of e-business as a function of the complex and potentially contradictory interactions of members of the business system. This is the case at both the level of the firm within the supply chain and also of the

individual within the firm. Reflexive capability refers to the conscious ability to identify, understand and measure processes and behaviours in a changing environment. The conceptual framework outlined above demonstrates that the diffusion of innovations is about change, and that the context for diffusion is a series of scaled dynamic environments.

It is based upon the premise that the behaviour and attitudes of firm's towards technological innovations can have significant influence on the acceptance and ultimately the dispersion of e-business by other firm's within the supply chain. Although it is important to be aware of the structural drivers and barriers 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 doesn't adopt we are suggesting that adoption and ultimate dissemination across the industry is based upon firm's being along a continuum of "reflexivity" relying upon e-business awareness, responsiveness and adaptability attributes. The application of a reflexive capability model forms part of a wider study whereby we are developing an e-Business Adoption Profile that articulates these attributes and characteristics of firm's identified as adopting e-business technologies and practices more readily and adapting to the demands of e-business environments more effectively.

### 5.1. REFELXIVE CAPABIILITY MODEL MEASURES

The reflexive capability model measures the performance of an organisation or business against a set of characteristics that represent the *degree* of adoption. In order to account for deficiencies in previous conceptual models that were grounded only in diffusion as a temporal process we have developed *degree* of adoption as a conglomerate indicator that comprises the *rate*, *mode* and *level* of adoption against the key attributes of reflexivity. Rate, mode and level are defined as:

- *rate* of adoption (the time in which the firm adopts the innovation relative to the firm's first awareness of the innovation),
- *mode* of adoption (the variable form in which the innovation is adopted and interpreted – the way the innovation is used in practice),
- *level* of adoption (the extent to which adoption of the innovation transforms the processes and practices of the firm).

While certainly more complex than a simple paradigm of adopter/non-adopter, we argue that the above indicator model permits a more accurate investigation into the way that organisations of substantially different type and size consider and implement innovations. A brief example will demonstrate both the complex nature of adoption classification and also the benefits gained by the use of a multivariable indicator such as *degree* of adoption that comprises *rate*, *mode* and *level*. This example is drawn from preliminary research undertaken as part of the project into e-business adoption in the construction industry.

Consider the case of a new piece of intranet-based software designed to store and organise design documentation. One organisation is a multinational architectural firm; another is a small family owned and operated building contractor.

The architectural firm may well adopt the software as soon as it comes onto the market, their IT budget for purchases and training allows this expenditure and by all measures they are justly described as innovators in regard to adoption of this technology.

The contractor, not having the budget or time to purchase either the innovation technology (software) or the operating knowledge (training courses) does not adopt at this time. Measured simply by *rate*, and relative to the architectural firm, the contractor is thus a non-adopter.

At some time in the future the particular software has become more commonplace in the industry and the contractor must now consider adopting the innovation in order to work with the other members in the contractor's supply chain. The contractor does so, and would be considered a late-adopter – except the software is no longer considered an innovation, but rather the industry standard. However when the contractor adopts they find that the document management software substantially reorganises the way they conduct business, having previously stored design documents in hardcopy on a shelf in a spare room or in a box under the desk.

In this instance a piece of software (that is technically not an innovation) is adopted by a small end operator and produces dramatic change on the *level* of e-business in his business processes. This scenario could barely be measured in Roger's simplistic model of diffusion adoption.

At the same time, the architectural firm, now using the software as standard procedure has found that it hasn't really changed their business processes all that much. They merely switched from one document management program to another. An innovator measured by *rate* but not by *level*.

However, one day some of their designers are frustrated by their inability to simultaneously collaborate while in different cities. They find that the document manager provides them with the ability to all work on the same document in a way that substantially mirrors the face-to-face collaborative process necessary for effective group-context design. The benefit is in the software's ability to update real time changes to the central document and transmit throughout the network, or rather, to allow multiple remote access to a real-time dynamic document.

This is a use of the software neither envisaged nor recommended as a function of the program. This new idea does substantially change the way they do business by allowing the construction of interstate design teams and specific expertise on required projects regardless of the designer's location.

However the innovation here is not the software, which was already in place, but a new way of thinking about how it can be useful. The designers have developed a new *mode* of adoption, and this in turn has affected the organisations *level* of innovation adoption

The identification of the degree to which a given business has adopted a specific e-business technology alone does not provide the required detail for an adoption profile specific to construction industry SME's. What is needed is the identification of the characteristics of businesses who readily and effectively adopt new e-business technology and techniques as compared to the characteristics of businesses that resist new forms of organisation and technology.

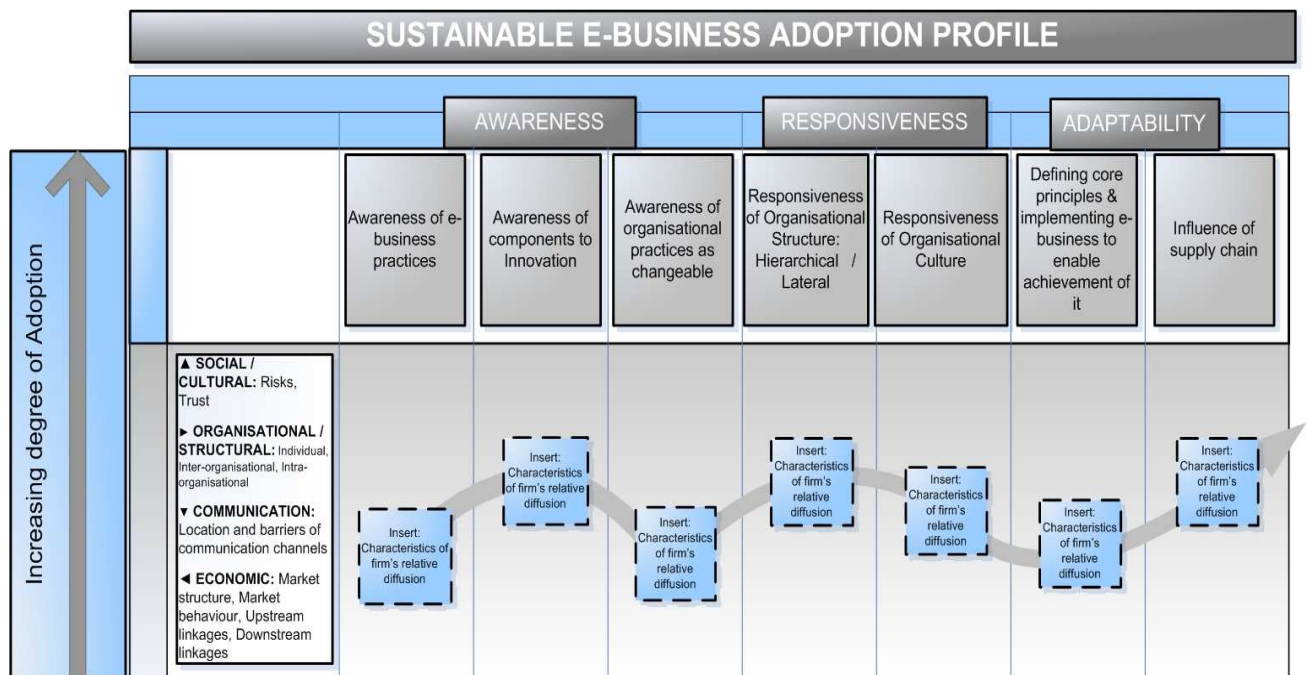
Figure 2 illustrates the e-Business Adoption Profile model. The matrix identifies two key dimensions – organisational attributes across four key areas and then characteristics in relation to the organisation's approach to change.

On the left hand side of the reflexive capability adoption profile model for e-business adoption are four attributes through which organisations will be investigated in order to ascertain the characteristics of firm's at different degrees of adoption. These different attributes are;

- social-cultural factors (the social system, meanings, values and attitudes),
- organisational-structural factors (qualities of both the firm and the supply chain that influence process and practice),
- communication factors (including both the type of communication channel and the mode of communication as heterophilic or homophilic or a combination) and

- economic factors (market structure, market behaviour and upstream/downstream linkages and associated pressures and relationships).

Across the top of the adoptive profile model is a series of key attributes in reflexive capability comprising awareness, responsiveness and adaptability. The variable field created by the cross referencing of these sets of attributes allows the plotting of the firm's position relative to a dynamic context and thus produces the adoption profile specific to firm's within the construction industry. The curve thus defined is the adoption profile – unique to the firm in question, and providing a description of the extent of e-business adoption and diffusion that is relative to the strategic objectives and goals of the firm.



. Figure 2: E-Business Adoption Profile Model

Characteristics of particular firm's will be analysed to produce a set of general attributes that reflect a particular degree of adoptive capability. Until a time when we have completed the analysis, the attribute boxes have been left as general themes. However, in order to provide an example it is possible, based on preliminary analysis, to predict a pair of attributes for each dimension that would reflect the high and low ends of the reflexive adoptive capability spectrum. For the following diagram the statement following each triangle indicates a common dimension in both the high and low characteristics.

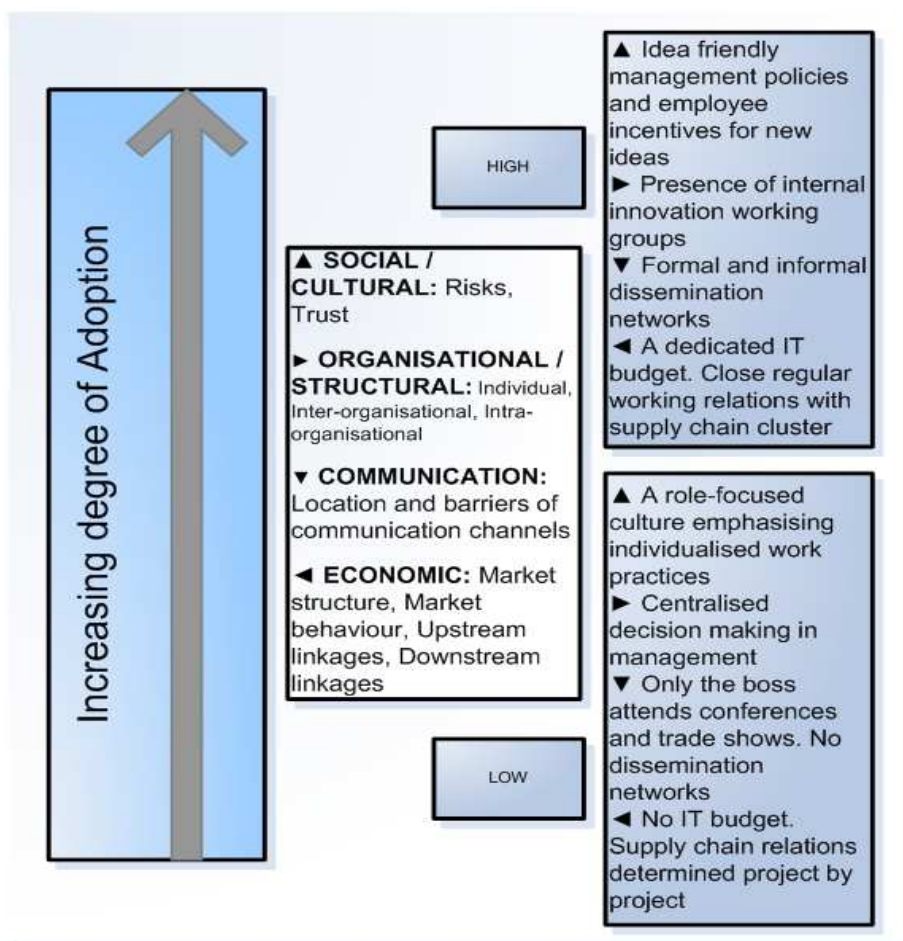


Figure 3: An example of characteristics of businesses at high and low ends of adoptive capability spectrum

Through application of a reflexive capability model the current research seeks to identify the underlying causes that encourage individuals or firm's to move between the different stages of diffusion/adoption. In doing this it will be possible to highlight the characteristics of the different types of construction SMEs in relation to the differential levels, modes and rates of adoption as well as to identify the particular organisational and socio-cultural characteristics of firm's that acts to encourage (or discourage) the innovative diffusion of technology. The emphasis on communication provided by the reflexive capability model will make it possible to identify the dominant types of communication channels operating within firm's and between firm's within the supply chain. Accordingly the current research hopes to be able to ascertain the type of communication, economic structure and organisational culture that best facilitates diffusion within firm's and the supply chain.

## 6.0 SUMMARY

This theoretical paper has examined the relationship between economic, social and cultural aspects of innovation and the capacity to increase the diffusion of e-business in the construction industry supply chain. It has identified the need to not only consider the structural barriers and drivers to innovation but also the significance of diffusion within and between businesses and the supply chain for the adoption of e-business. The research is unique in its acknowledgement of the dynamic, complex and multi-scaled contexts

influencing the adoption of e-business within the construction industry. It is also unique in the development and application of a reflexive capability model that is specifically designed to account for changes in dynamic environments. This research model is a conceptual framework for developing an exploratory qualitative research program into e-business adoption in the construction industry through an examination of economic, socio-cultural, organisational and communicative factors through a ground-up holistic method. It has not been the purpose of this paper to present a set of testable hypotheses that have little usefulness in the accepted field of qualitative research methodology – dealing as it does with interpersonal meaning and the ephemeral nature of perception, interpretation and circulation of shared meanings through a social network. Research into the adoption and diffusion of e-business within the construction industry is both timely and valuable. The present research intends to make a significant contribution to this field of endeavor precisely because it is being undertaken from a less utilised vantage point and therefore promises to contribute a unique voice via a thoroughly broad and unified perspective.

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