INNOVATION DIFFUSION IN DIGITAL AGE AT THE IMPLEMENTATION STAGE OF A CONSTRUCTION PROJECT IN NIGERIA

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ABSTRACT

With the significant advancement in communication technologies in the last two decades, there has been a renewed interest in information and communication technologies (ICTs) as a sign for modern development. There is a strong belief in the potential of ICTs to bring social and economic development to developing countries. This paper therefore focuses on construction industry (CI) innovation, particularly with the rate at which Information Communication Technology (ICT), has been growing steadily with the advent and widespread use of the Internet. However, despite its potential for delivering competitive advantage, many companies have failed to effectively realize promised benefits from ICT due to misunderstanding relationship between factors and processes influencing ICT implementation. Results from recent in-depth quantitative ICT implementation research on three construction contractors provides useful insights and practical experience of lessons learned that can be more broadly disseminated. These research results about how it may be applied to improve ICT adoption at different implementation stages for the CI. They suggest that strategic ICT implementation planning needs to consider issues of critical management support, technical support, supportive workplace, environment and ICT user's individual-characteristics so that the framework processes offered can be effectively applied.

Keywords: *Innovation, Diffusion, Digital Age, Construction Project.*

INTRODUCTION

Since the end of the 1980s, a new era of possibilities concerning information and communication technologies (ICTs) has begun in Africa. Satellite technology, which permits instantaneous transmission of images, has brought the continent into international information circuits. The popularity of other information and communication technologies such as the Internet in the 1990s came at the same time as other monumental trends such as globalization, economic crisis, and democratic change (Vittin, 2000). Recent advances in ICTs have begun to change radically the ways in which people can both work and learn, such as life-long and distance education (Manji et al, 2000). Information and Communication Technology (ICT) facilitates communication and improves integration (Bjork, 1999) enhancing productivity and service delivery. Skibuiewski and Abduh (2000) reviewed the development of Internet application for specific Construction Industry (CI) and showed that such technology provides information services, communications and computing management benefits. In similar vein, this paper is making case for how ICTs can also be adopted to enhance activities at construction sites in developing society like Nigeria. In view of this, the following points should be noted when construction organisation attempts to gain ICT use benefits (a) These may be limited when few people actually adopt and use ICT because this requires user acceptance (b) Where widespread ICT adoption prevails, users will find it impracticable to communicate electronically with colleagues who avoid using ICT (c) Therefore, organisations can lose potential productivity gains through operating with both hard copy and electronic data (d) Transitioning from a paper-based to a fully electronic environment requires that users readily adopt and accept ICT. At the highest level, innovation has been studied at the national or corporate strategic management level. While this is useful for understanding the value of innovation and why it should be pursued, it does not help explain what is happening after an innovation initiative decision has been made and how it can be effectively implemented. This strongly supports the aim of such innovation study reported upon here to more concretely explain effective innovation deployment from an implementation perspective focusing on a specific type of innovation. This paper was divided into 3 parts; the first aspect begins with a review of literature relating to ICT to support basic ICT diffusion knowledge, the second aspect was on research methodology, while the findings formed the last part. Finally, a conceptual model of ICT diffusion and framework across critical implementation phases complemented the work.

Research on Technological Innovation Diffusion

Innovation diffusion is defined as the process in which a new idea, concept or technology has been introduced throughout a social system over a time period (Roger 2003). The term "ICT diffusion" is defined in this paper as the process by which an ICT application is adopted and implemented by an organisation until its expected users accept and transfer knowledge of how to use these ICT applications throughout the organisation. However, this explain what happens at the macro level and it is of little use to those interested in how to facilitate innovation to make a positive and lasting impact at the work groups or individual level. The extent to which innovation results from demand-pull or product-push forces was presented in the works of Rothwell and Robertson (1973) and Movery and Rosenberg (1979). It was argued that 'continuous charges are often related to progress along a technological trajectory defined by a technological paradigm (Dosi, 1982). A close integration will lead users forming a network of people that enjoys testing and validating better versions of innovation (Von Hippel 1999). This process can lead to a new way of fulfilling that innovation's need. For example, Radical innovation can 'invade' a stable business through offering better value by solving a problem in an entirely different way.

Utter back (1994) describes how document processing by typewriters was first overwhelmed by word processors in the 1980s then overwhelmed by word processing software. These examples exhibits technology-push where producers convince users to adopt their innovations, but there is also evidence of strong demand-pull through users actively seeking innovation solutions. However, ICT strategic implementation in the CI could be seen as being defensive and reactive because clients and supply chain partners increasingly rely upon these tools – thus, failing to use these 'tools' make a firm unattractive. Innovation diffusion plays an important role in theories describing information technology (IT) implementation (Rogers, 2003). It can be studied using both 'factor' and 'process' approaches (Fichman 1992).

To make valid comparisons, researchers must clearly address:
- Which of the various streams of innovation research is relevant to a research question;
- The stage(s) of the innovation process upon which a study focuses;
- The types of organisation included a study;
- How a study's outcome variable (e.g. adoption, innovation, implementation) is conceptualized; and
- The attributes of the innovation(s) being investigated.

The technology adoption decision within organisation requires change management to facilities and encourages people to adopt ICT initiatives. Organisations can do this through (a) motivating staff, (b) providing appropriate training and technical support; and (c) ensuring supervisor support for an open-discussion sharing environment (Senge, et al, 1999). Eleven factors influencing ICT use and adoption were identified. These factors were clustered into management (M), individual (I) and technology (T) groups that impact upon ICT diffusion with each of these being influenced by the impact of the workplace environment (E). Individual and environment group factors generating had a high impact upon ICT diffusion with slightly above moderate impact.

RESEARCH METHOD

As a preamble to this study, quantitative data was gathered to identify factors influencing ICT diffusion within three large scale construction organisations comprising a major construction contractor, a government public works department and a leading global engineering consultant that were experienced and sophisticated ICT users to explain how they influence the ICT diffusion processes for details (Peansupop 2004). Case study through qualitative research can be grouped into three broad categories such as (i) exploratory; (ii) descriptive; and (iii) explanatory. A descriptive case study approach was chosen to obtain rich qualitative data from the participant's viewpoint using multiple sources of data for unearthing what was happening as well as how and why it followed a particular trajectory (Yin, 1994). Three ICT-experienced construction companies that have been using ICT application for several years were targeted. This research investigated ICT adoption and diffusion practices of three top-tier of Nigerian construction contractors and the opportunity to conduct interviews with them was available. The study focused upon internet and ICT groupware used by organisation that had been experienced with diffusing IT and general-purpose office management software tools.

Table 1 presents interviewees grouped into five levels: It strategists (senior level management champion and initiative driver) – implementation (given the task of encouraging diffusion of the ICT groupware initiative), project managers (responsible for construction teams on projects using this technology), site engineers, and site foremen (both direct users of the technology in coordinating the physical and administrative work being undertaken on site).

Table 1: Categories of Interview in the Three Case Studies

Interview	Case Study		
	CSA	CSB	CSC
IT Strategist	1	1	1
Implementer (L1)	1	1	1
Project/Engineering Manager (L2)	4	1	1
Site Engineer (L3)	1	3	2
Foreman (L4)	1	1	1

CASE STUDY RESEARCH FINDINGS

Each contractor aimed to gain competitive advantage through investigating in ICT groupware communication and co-ordination applications for processing requests for information (RFI), and document management that allowed users to access, exchange and search information from anywhere at any time. Each organisation had a different trajectory in positioning themselves to adopt and implement the ICT applications. While objectives for ICT adoption in all three cases were similar, their adoption processes were different. The summary of our findings of their (Construction Contractors) ICT adoption study are as follows:

- CA and CB chose to embrace a proactive strategy that is acting in anticipation of future problems and changes, of ICT adoption whereas CC selected a reactive strategy of ICT adoption.
- ICT adoption in CA and CB was influenced by both demand-pull and technology-push while this in CC was more influenced by technology-push than demand-pull.
- The adoption decision in CA and CB was centralized (top-down direction) whereas the adoption decision in CC was decentralized (top-down and bottom-up).
- The adoption of ICT in all three was supported by group of top business managers and senior IT managers.
- The adoption approach in CA was defined as in-house development, CB development was based on in-house development plus IT consultancy and CC relied on outsourcing (the external web-based service).

- In the time cases, it was difficult quantifying ICT adoption benefits and use, however, users expected to gain benefit from adopting ICT in terms of improving team communication, information exchange, document repository, and a project register of past events.

Although the nature of ICT adoption for the three cases was quite different for 'proactive' and 'reactive' strategic adoptions, the implementation of the ICT application was similar for supporting management technology and supporting individual users. While most of the three cases' participants believed that collegial and knowledge-sharing ICT environments are the main factors influencing the actual implementation, these were informally valued as being essential elements of organisational implementation. Case studies conclusions and quantitative study indicates that the main implementation process focused on training and technical support, senior management support, user characteristics and ICT characteristics. Training and technical support and ICT characteristics were formally managed but support from senior management or project manager, characteristics of users, and a sharing and open discussion environment was informally managed.

Framework of ICT Innovation Diffusion

The ICT diffusion framework for managing technology adoption and diffusion is being subsumed in a model. The model has two stages: initial adoption and actual implementation. It illustrates key relationship categories: management (M), individual (I), technology (T) and environment (E) that influence diffusion processes. Thick-lined numbered elements highlight organisation ICT diffusion processes. M (management) focuses on the influence of management and organisational support. I (individual) focuses on the influence of personal/individual characteristics such IT skill, capability to learn, and previous experience of IT. T (technology) focuses on the influence of technology characteristics such as functionality, speed and accessibility. E (environment) focuses on the influence of the workplace environment such as open discussion and sharing knowledge and ICT. It can be deduced that: (thick-lined elements) wide acceptance distribution (diffusion) of ICT can be achieved through six key ICT distribution (diffusion) processes:

Developing New Business Practices/Processes: Senior managers recognize that the potential ICT application may provide strategic improved core business competences through cost leadership and differentiation by improving productivity through reducing time and cost to transfer, store

and search for information and/or delivering a differentiation competitive advantage. CA used ICT as part of its knowledge management system differentiating it from the approach adopted by CB or CC. ICT innovation persuasion can be carried out by convincing senior executives and managers that adopting a potential ICT application is of organisation strategic importance to support business requirements by proposing scenarios and benefits of adopting it.

Organisational Adoption of the ICT Decision: By exploring ICT applications' adoption, this influences existing business processes. Existing ICT software that delivers the identified benefits will influence the selection process of that particular ICT application. The adoption here is based on matching an available ICT application to construct processes after undertaking a cost/benefit analysis (including non-financial benefits).

Preparing for the Initial Use of ICT Application: This process prepares expected users to learn and understand the ICT application at the group/individual level. The organisation should facilitate groups and individuals to develop a background understanding of the ICT application's key features an how these can benefit them. Facilitating ICT background understanding requires an 'implementer'. Implementation may be similar to promoting knowledge awareness but it is more focused on capability and benefits of ICT use issues to facilitate user feed-back on the ICT application. Knowledge awareness is a two-way process in which knowledge is transferred from the initiating group to targeted users and targeted users provide feedback for possible improved preparation and ideas on how to best deploy the ICT application. In the event of preparing for the initial use of ICT application, it will be necessary to (a) Provide practical examples (b) Deploy targeted skills assessment and needs analysis (c) Apply trials; and (d) Provide adequate reference materials.

Reinforcing the Actual Use of the ICT Application: Actual continued Information and Communication Technologies (ICTs) application usage occurs when users routinely accept and engage the ICT innovation with adaptation occurring to suit work process constraints. It will therefore be necessary for the staff to adjust their behaviour and procedures to accommodate ICT use and requires overcoming problems with ICT functions, resources, and other technical problems. The actual-use phase requires active communication and feedback between users and ICT initiative and actual ICT use. Transition to this stage involves support at four levels: (1) Management, (2) Individual, (3) Technology, and (4) the environment. 'Individual category' within the context of the group factor indicates that personal learning capability has a strong

influence on the actual use of an ICT application. Most users, who may encounter problems will try (as long as they had sufficient time) to learn how to solve the ICT application problems by themselves.

Clarifying Benefits of ICT Application Use: This will occur when members have understood the positive outcome of using a technological innovation (and limitations that they may face) and have accepted it to the extent that they embed its use into their work routines. A two-way communication between ICT users and senior manager/project managers will promote a clear understanding of how the ICT application assists or inhibits users' work. ICT users' commitment is essential because they have to change procedures causing temporary discomfort and inconvenience. It is of paramount importance that the ICT application's characteristics should support and maintain system reliability. Also, the system should be designed to cater for increased member of users. Therefore, the organisation should make sure that the ICT application performance retains its functionality, reliability, and speed so that it is not degraded.

Developing a Positive Perception towards ICT and ICT Diffusion

A positive perception towards ICT and its diffusion reaches a stage where users adopt the ICT application as a part of their work processes moving to a stage of infusion whereby a continual cycle of fine-turning, improvement and evaluation takes place. Adopters should convince others of their positive experience thereby becoming a 'knowledge activist'. These people will effectively transfer knowledge about an innovation as well as motivating others, often through using role-model behaviour for adopting and adopting the knowledge in question. At this stage, management support should focus on issue of facilitating the creation and maintenance of conditions that enhance the ICT users' experience of benefits of the ICT application's use.

DISCUSSION AND CONCLUSION

Innovation theory was discussed with clear focus on the actual implementation stage. A supportive model of ICT diffusion was presented to explain ICT diffusion and two-stage (initial adoption and actual implementation) six process framework to effectively implement ICT innovations was explained. The case study work focused upon IT-experienced construction contractors, so the framework's general applicability limitations must be acknowledged. However, the literature reveals that the CI is increasingly becoming more It-literate so the

framework presented may be tested more broadly and could be found to offer a practical approach to ICT diffusion within the described context. Senior management was shown to be in a pivotal position to strongly influence the initiation and implementation stage of ICT diffusion.

- They mould the initial organisational adoption phase by waking resources available and demonstrating their high level of commitment.

- The next diffusion stage shows that they encourage potential users to adopt and use ICT in their daily job through adaptation of application and its acceptance, routinization and infusion into normal workplace practices.

- Infusion of the ICT application can take place if ICT-use benefits are accepted and routinized.

- If the benefits of ICT use are unclear or rejected, then improvement in the management, technology or workplace environment needs to be instigated.

The contribution that this paper offers is that it clearly illustrates the dynamics of ICT diffusion within the case study organisations then has been shown in the literature. Also, ICT as emerging innovation diffusion at the implementation stage of construction will be enhanced by applying the framework processes offered for speedy development and widespread use of ICT in Nigeria our (Nigerian) construction industries.

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