

## **Information and Communication Technology: Organisational and Supply Chain Adoption and Diffusion - An Australian Case Study**

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### **Abstract**

The complex, competitive nature of the Australian construction industry's production processes presents problems for the effective adoption and diffusion of emerging Information and Communication Technologies (ICT) by its participant stakeholders.

This paper reports on research that examined the adoption and diffusion of ICT groupware by six significant Australian construction contractors and a large construction subcontractor. The research utilised a methodological instrument adapted from Galbraith's 'star model' of change and Rogers technology diffusion model to investigate the strategies and processes undertaken to affect ICT adoption and diffusion. The research also investigated the maturity of the organisations' ICT adoption, relative to the industry group studied, utilising a technology adoption profiling process.

The research revealed that the ICT diffusion activities undertaken by these enterprises reflected various levels of technology adoption maturity. The diffusion processes and outcomes also indicated that effective ICT adoption and diffusion, both from an organisational-specific and supply chain context, occurs through *top-down* and *bottom-up* strategic processes within organisations and as collaborative or independent initiatives both *upstream* and *downstream* of the supply chain.

### **Key Words**

Information and Communication Technology, Technology Adoption and Diffusion, Supply Chain

### **1. Introduction**

The emergence of Information and Communication Technologies (ICT) can provide the Australian construction industry with improved information exchange process efficiencies. This improved efficiency can deliver stakeholder productivity gains and facilitate increased supply-chain integration. The fragmented and highly competitive nature of the industry may however provide barriers to the effective adoption by construction enterprises of ICT.

This paper reports on a Cooperative Research Centre in Construction Innovation (CRC CI) research project undertaken by RMIT University Australia that examines the adoption and diffusion of ICT by the

Australian construction industry. This examination focuses on 6 significant contractors and a large subcontractor, and follows-up previously reported research undertaken by this CRC CI research group (Goldsmith et al 2002, Wilson and Walker 2004).

The contractors utilised for the research are part of a distinct cohort of 20 or so significant enterprises that lead industry output with annual turnovers of at least AUD\$1billion. This stratification of the Australian construction industry can facilitate the maturation of its innovation environment through the leadership of significant enterprises. Through the examination of the level and nature of ICT adoption and diffusion by these cohort group members we determine an adoption profile for each with respect to the cohort as a whole. The seventh case study examines the adoption and diffusion of ICT by a large construction subcontractor to reveal not only the strategies and processes utilised but also the nature of the supply chain relationships associated with the ICT adoption. The nature of the supply-chain diffusion of ICT by the construction contractors is similarly reviewed.

This research provides a framework for understanding and evaluating the relationship between the nature and level of the ICT diffusion processes and innovation leadership within the Australian construction industry. To facilitate its research objectives, we use the analytical framework of the 'star' model of change (Galbraith 2002) to reveal the nature and level of the organisations' ICT diffusion processes. We also propose an ICT adoption model, developed with reference to Rogers (1995), that indicates innovation leadership as determined by the nature of ICT diffusion resolved by the Galbraith model analysis.

## 2. Analytical Framework

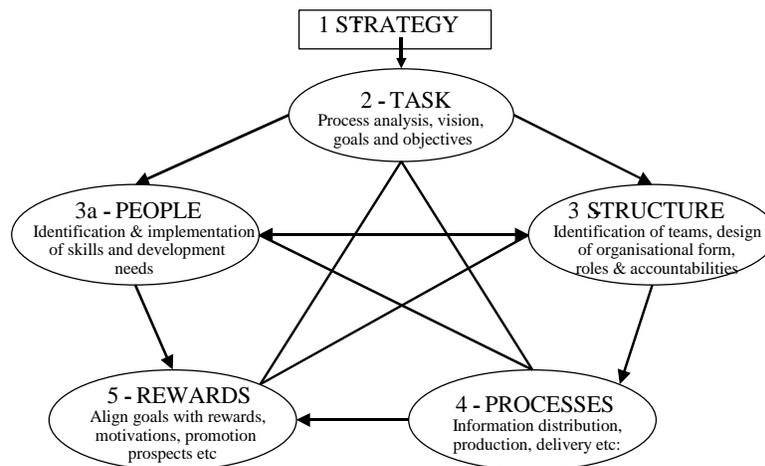
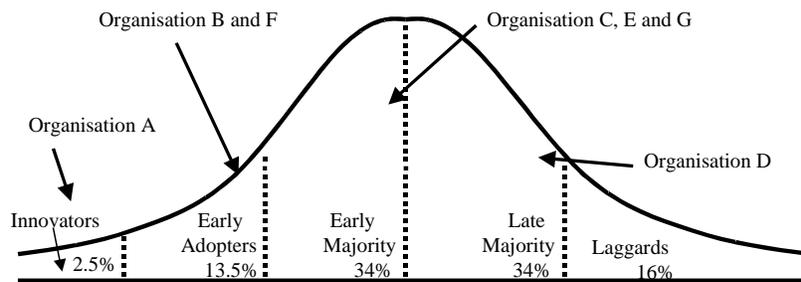


Figure 1-The Galbraith 'Star' Model of Change Management: Source Galbraith (2002, p10)

Figure 1 plots the relationship between the key factors that facilitate innovation diffusion as proposed and developed by Galbraith (2002). These key factors, numbered according to their hierarchical and derivative relationships, are: *Strategy*, *Tasks*, *Structure*, *People*, *Processes* and *Rewards*. In the Star Model, *Strategy* imposes the *Task* of developing a vision and objectives, which are then prioritised. A *Structure* is then developed that involves *People* who implement the change using defined accountabilities, roles and responsibilities. This activity is undertaken in conjunction with the identification and implementation of the

skills and development needs of the *People*. *Processes* are undertaken to enable the development of change processes to take place. The *Reward* system motivates people to ensure that the required action takes place. The Star Model is dynamic, with each element self-adjusting with the dynamic forces of implementation and diffusion shaping each response. We use the Star Model in this paper as an analytical tool to better understand the ICT innovation process and categorise innovation leadership based upon the model developed by Rogers (1995).

The Rogers model, as illustrated in Figure 2, defines innovation leadership according to innovation adopter categories and gives an indication of their likely distribution within a particular population. According to the Rogers model, *Innovators* are venturesome and the first 2.5% of the population in a system to adopt an innovation. *Early Adopters* comprise the next 13.5% of the population to adopt an innovation and are a more integrated part of the local system than are innovators. The *Early Majority*, comprising the 34% to the left of the population mean, adopt new ideas just before the average member of a system and seldom hold opinion leadership positions in a system. The *Late Majority* comprise the next 34% of the population in a system to adopt an innovation. *Laggards* comprise the last 16% of the individuals in a system to adopt an innovation.



**Figure 2 - Innovation Diffusion Model: Source Rogers (1995)**

The usefulness of the application of these two constructs in our research is that the Rogers' model illustrates the ICT adoption maturity of the case study enterprises that reflects the nature of the adoption and diffusion of ICT by these organisations as revealed through structured analysis utilising the elements and relationships of the Galbraith Star Model.

### 3. Methodology

The research investigated the ICT diffusion practices of 6 top-tier Australian construction contractors and a large construction subcontractor that were selected on the basis of availability and the opportunity to conduct interviews utilising an instrument designed with reference to the components of Galbraith's Star model. Semi-structured, face-to-face interviews were conducted with a key ICT innovation champion supplemented with numerous less formal conversations with employees at various levels to validate the impressions and data provided. Interviewees were requested to respond to the questionnaire by specifically addressing the diffusion process of an ICT collaborative application with extensive organisational-wide usage. The supply-chain diffusion of this technology was also questioned.

## 4. Case Studies

Organisation A revealed a proactive corporate strategy of ICT innovation and its diffusion. Strategy and associated tasks were formulated using a best practice focus provided through a purpose-designed strategic and technical advisory cell structured for the active collaboration with, and encouragement of enterprise representatives and contributors as internal innovation resources. Internal innovation resources were supplemented through research using information gathered from numerous external sources, all in the pursuit of best practice. Organisation A had undertaken an extensive rollout of an enterprise wide electronic document sharing application utilising its internal network. Organisation A used a team of internal trainers to facilitate its implementation strategy and program with support from external providers of these services. Extensive skills audits of staff were undertaken to determine existing skills levels and capacities, and training was designed in consultation with the outcomes of this process. Ongoing training and helpdesk facilities were established as support services and for new employee induction purposes. The diffusion process was actively monitored. Individual rewards for participating in the ICT diffusion process were intrinsic. Organisation A had proactively undertaken the engagement of its supply chain in the adoption of its groupware application. Organisation A can be classified as an Innovator

Organisation B demonstrated a proactive corporate strategy of ICT innovation and its diffusion with a formal structure established for determining and disseminating innovation within the organisation. This structure facilitated strategy and associated tasks using a best practice focus provided through a purpose-designed strategic and technical advisory cell structured for the active collaboration with, and encouraged of enterprise representatives and contributors as internal innovation resources, drawing also upon outside sources of knowledge. Organisation B had undertaken a limited rollout of an electronic document sharing application on a project specific basis. To facilitate its application rollout, Organisation B used a small team of internal trainers with significant support provided by the application vendors. Staff skills audits were not undertaken with training designed on a generic basis. There was some indication of an expectation of training being provided by colleagues, and to a limited degree, mentoring was informally encouraged. Ongoing support services training and helpdesk facilities were established with supplementary vendor initiatives for new employee induction upon individual application. There was limited monitoring and analysis of the diffusion process effectiveness. Individual rewards for the take-up of ICT through the diffusion process were intrinsic. Organisation B, although not actively engaging its subcontractors and suppliers in the adoption of its ICT applications had nonetheless designed and initiated strategic protocols intended to engage its supply chain within its innovative framework and culture. Organisation B can be classified as an Early Adopter

Organisation C established a strategic focus on ICT innovation but had not yet fully established a structure to support and implement an active strategy. A small Information Technology (IT) department undertook the rollout or upgrading of ICT applications. This group informally provided technical advice to strategists with introductory internal training to users. It also supported ICT diffusion through training and helpdesk services provided by application vendors. A staff skills audit was not undertaken, with a generic training program being designed. There was evidence of Organisation C's ICT diffusion expectation being for informal training provided through colleagues, with an mentoring being encouraged by individual business units to disseminate application training rather than an integrated organisation-wide strategy. There was no monitoring and analysis of application diffusion effectiveness indicating again the immature nature of its strategic ICT innovation program. Individual rewards for adopting ICT through the diffusion process were intrinsic. Although recognising the need for supply chain adoption of its ICT applications over the longer-term, Organisation C was singularly focussed on the internal rollout of its groupware. Organisation B can be classified as an Early Majority Adopter.

Organisation D had no active innovation strategy or associated business structure. This reflected a short-term strategic focus and concentration of the enterprise on business processes efficiency. This organisation, although a significant construction organisation, operated actively to reduce productive infrastructure by outsourcing most undertakings. The ICT focus of this enterprise was directed to improve the operability of internal communication through upgrading the ICT networks technical capacity. Applications were designed or upgraded through vendors who provided most of the required training and helpdesk facilities. Informal training was expected by the organisation with some formal small-scale training initiatives provided by the organisation for new employees being inducted. Adoption of new applications, or new versions of existing applications, was deemed the ultimate responsibility of project managers who were expected to undertake this as part of their commitment to the project's and organisation's performance. There was a strong culture of enterprise commitment and loyalty providing intrinsic rewards for successful new technology adoption. Organisation D had no expressed interest in participation in a virtual productive environment utilising e-collaboration and corporate connectivity integrating supply chain management, project control and organisational administration. It indicated that the organisation would become involved in such ICT innovations only after perceived benefits became tangible and uptake costs were minimised through the learning from mistakes made by other users. Organisation D can be classified as a Late Majority Adopter.

Organisation E was in the early stages of ICT adoption and diffusion. Having determined that a proactive ICT innovation strategy was a necessary and desirable long-term goal for the enterprise, Organisation E had designed and undertaken an implementation strategy for organisational groupware adoption and diffusion. This outcome was directed through a purpose-designed strategic and technical advisory cell structured similar to that utilised by Organisation B. Problems in adoption and diffusion however occurred as a consequence of an apparent lack of resource provision for the undertaking and inadequate planning and process design, particularly in regard to the systematic determination and provision of the particular skills required for system usage, and a lack of a coherent and relevant reward system. There also seemed to be issues arising from a strong resistance to change by the workforce. Despite these implementation problems Organisation E remained committed to their strategic goals and was assiduously undertaking refinements to the processes of adoption and diffusion, as directed through a comprehensive feedback facility. Organisation E, despite the relative immaturity of its organisational groupware diffusion processes, had however undertaken a leadership role in the supply chain adoption and diffusion of ICT through the use of collaborative document sharing applications on various projects, and as such could be considered an early adopter of this particular technology. The Organisation E can be classified as an Early Majority Adopter

Organisation F was an enterprise that, through its relationship with its European parent company – a significant global construction entity – could be categorised as a proactive early adopter of ICT. This profile reflected the strategic goals, resource availability, structures and processes adopted and refined from the experience of the larger and more mature European market as transferred to Organisation F through its corporate association. Organisation F had apparently undertaken a seamless adoption and diffusion of organisational groupware applications. The nature of this adoption seemed to reflect recognition of the key attributes of the Star Model - an overarching strategic focus determining appropriate tasks, matching the people and skills to these tasks, designing processes to realise the tasks and providing a suitable reward system, all within a dynamic system proving information and feedback both from the internal and external environment. Not surprisingly, Organisation F was actively involved with a small consortium of significant Australian construction enterprises in the development, adoption and diffusion of an ICT collaborative electronic supply chain initiative as manifest through a web-based industry portal. Again much of the technology and adoption practice planned to be utilised in this innovative activity reflected the experiences

of the more mature European market where this technology has been in place and utilised for some time. Organisation F can be classified as an Early Adopter.

In addition to investigating the ICT adoption and diffusion practices of six members of the top tier of Australian construction enterprises, this research also examined the ICT adoption and diffusion practices of a construction subcontractor organisation. Organisation G undertook strategic planning for ICT adoption diffusion and adoption with regard to electronic document control applications in consultation with the entire staff. Overall strategic goals were however set by an executive committee directed by a person with responsibility for innovation and change management. Organisation G allocated appropriate resources to obtaining advice and providing training and infrastructure to facilitate the ICT adoption. Although constrained by budgetary considerations, ongoing skill audits were recognised as necessary for an effective adoption process and were accordingly planned for and implemented. Barriers to change however arose particularly in the attitudes of the workforce, which required the determination of appropriate strategies and processes to overcome – this was addressed systematically as work in progress. Despite concerns about limited resource availability, ICT adoption was enforced on Organisation G by its upstream clients, however it in turn enforced ICT adoption downstream to its suppliers. In summary Organisation G was a proactive adopter of ICT within the constraints of its size and resource availability and reflecting its role in the supply chain as a dependant middle layer entity within the production process Organisation G can be classified as an Early Majority Adopter

## **1. Conclusions**

This paper examined the ICT diffusion processes undertaken by six significant Australian construction companies and a large construction subcontractor using the Galbraith 'star' model of innovation diffusion and Rogers' Diffusion of Innovation model. The analysis disclosed a variety of innovation diffusion profiles. Organisation A is an Innovator with established strategies, programs and structures to implement and monitor program outcomes. Organisations B and F also possessed an innovation profile with established structures reflective of their long-term visions and programs, although not to the same extent or maturity as Organisation A. Organisations B and F indicated an Early Adaptor profile supporting the adoption of successful initiatives and new ideas. Organisations C and E were undertaking emerging innovation and diffusion strategy programs and developing appropriate diffusion processes. Both clearly trailed Organisations A, B and F in the maturity of their innovation processes and were described as Early Majority innovators that adopt new ideas just before the average member of a system but seldom hold positions of opinion leadership. Organisation D projected a short-term returns focus with no strategic or structural innovation or diffusion profile. Organisation D was accordingly categorised as an innovation Laggard or at best a Late Majority innovator being suspicious of innovation with its resistance to change however being entirely rational as a consequence of limited resources and the need to be certain that a new idea will not fail before they will adopt.

Case Study G – the Subcontractor - could be considered an Early Majority innovation adopter within the framework of its upstream and downstream supply chain relationships. Having a proactive adoption strategy, and with ICT adoption enforced on it by clients with it in turn enforcing its adoption imperatives on its suppliers, only resource and financial constraints apparently precluded it from a more active and innovative role in ICT adoption.

One element of notable practice evident from the analysis is the substantial commitment to strategy and having a clear vision of ICT adoption and diffusion by innovative enterprises. Another element is the way that technical support and training units can form communities of practice. While motivation appeared to rely upon intrinsic rewards, this element should attract increased future attention. These insights support the top-down and bottom-up approach advocated by Nonaka and Takeuchi (1995).

The analysis described in this paper can contribute to the development and adoption by the industry of an innovation diffusion best practice template and encourage the adoption of ICT innovation that can reduce industry fragmentation and enhance enterprise and industry productivity through the supply chain by streamlining communication and coordination.

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