THE STRATEGY OF INFORMATION AND COMMUNICATION TECHNOLOGY DIFFUSION

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We reveal the ICT adoption strategic focus and implementation processes undertaken by six significant Australian construction companies and we also examine the nature of the supply chain relationships associated with their ICT adoption. We present a model to categorise and provide a profile of innovation diffusion adoption based upon an innovator to laggard normal distribution curve. Our findings indicate commitment to a strategic ICT adoption vision and the importance of both a *top-down* and *bottom-up* implementation strategy to manage organisational change and supply chain relationships through ICT adoption for the six companies.

Keywords: information and communication technologies, innovation diffusion, strategy, supply chain management

INTRODUCTION

The Australian construction industry procurement process is complex and requires significant levels of information exchange. The production process also typically utilises a fragmented, often casual network of disparate, independent organisations adding to this complexity. The emergence and development of useful information and communication technologies (ICT) can provide the industry with increases in efficiencies in information exchange processes through the use of both electronic data applications and digital networks. This improved efficiency can deliver productivity gains and subsequent accrued benefits for all stakeholders, and facilitate increased supply-chain relationships integration. E-collaboration (people meeting via electronic forums) and the creation of a 'virtual' (that is people meeting via an internet space rather than physically being together in a shared space) productive environment is a progressive consequence of the capacity of ICT applications to facilitate efficient project supply chain management by effectively binding together the participants of quasi-firms (Eccles 1981)[3], and enabling more effective coordination of project teams. The fragmented and highly competitive nature of the industry may however provide barriers to the effective adoption by construction enterprises of ICT.

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[3] A quasi-firm is a form of organisation through which general contractors (or builders) who retain the services of specialist subcontractors, execute construction projects.

CRC CI industry partners. This study is part of a wider ICT diffusion research project in which a theoretical framework of ICT diffusion, change management and knowledge management literature, was drawn upon to better understand ICT innovation in the construction industry.

In this paper we examine both the intra and extra-organisational adoption of ICT by the Australian construction industry. This examination focuses on six significant contractors, and extends previously reported research undertaken by this CRC CI research group (Goldsmith et al 2002). The construction contractors reported upon in the research lead the construction industry with annual turnovers of AUD$1billion or more. This stratification of the Australian construction industry can facilitate the maturation of its innovation environment through the leadership of significant enterprises. Construction organisations may strive for innovation leadership to foster or maintain a competitive advantage within their marketplace. Along with strategic, evaluative, planning and financial attributes, leadership in ICT innovation reflects the effectiveness of the diffusion of ICT innovation within the organisation and its supply chain. Leadership in innovation may also reflect a corporate culture of proactive change and change management, enhancing strategic planning, process design and implementation, and productivity outcomes.

Analysis of major forces of change (intense competition, demanding customers and shareholders, and technology) that are currently driving businesses provide a rich understanding of how and why they impact on an organisation's business strategy (Topping 2002, p27). This research focuses on the change enabler of ICT adoption by each of these construction companies, and investigates their strategic focus and the implementation processes undertaken. Through the examination of the level and nature of ICT adoption by these cohort group members we determine an adoption profile for each with respect to the cohort as a whole and, by extension, through their innovation leadership profile, the industry as a whole.

This research provides a framework for understanding and evaluating ICT diffusion processes, enterprise change culture and innovation leadership within the Australian construction industry. Using the analytical framework of the (Galbraith 2002) 'star' change model to reveal the nature of the ICT diffusion processes within these organisations we propose an ICT adoption model, developed from Rogers (1995).

THE ANALYTICAL FRAMEWORK

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. Next, a *Structure* is 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—these include protocols or rules and regulations, communication means and coordination mechanisms. *People*, their skills and willingness, make change possible. The *Reward* system motivates people to ensure that the required action takes place.
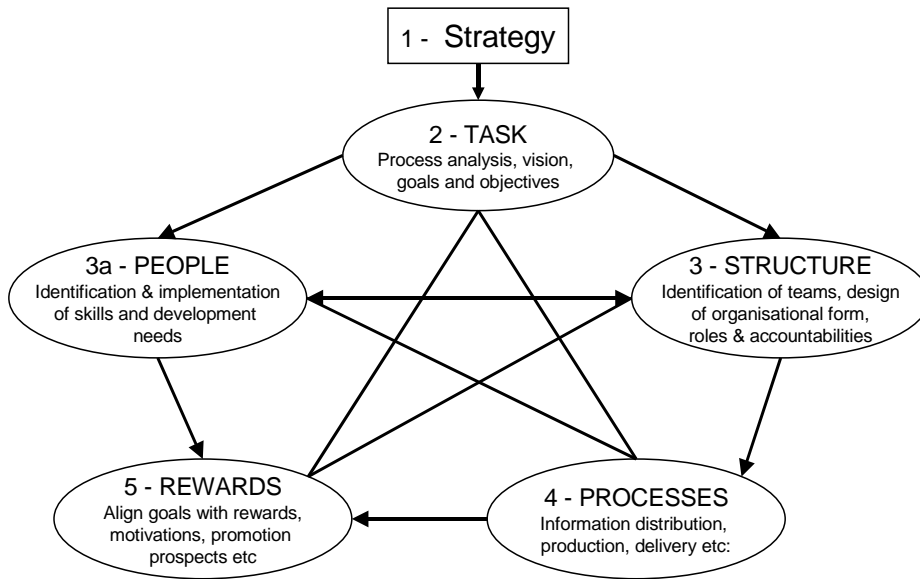
Figure 1- The Galbraith 'Star' Model of Change Management: Source Galbraith (2002, p10)

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).
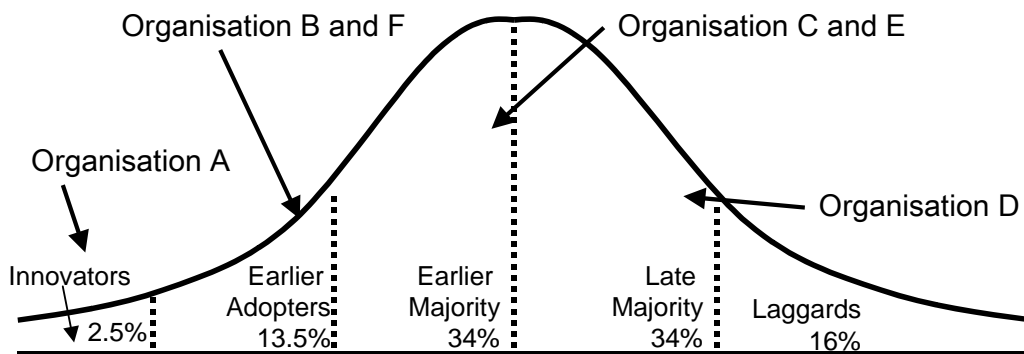

Figure 2 - Innovation Diffusion Model: Source Rogers (1995, p262)

The Rogers (1995, p262) model defines innovation leadership according to adopter categories and gives indicators of 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. They generally have control of substantial financial resources, the ability to understand and apply complex technical knowledge and cope with a high degree of uncertainty about an innovation at the time of adoption. *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. Because early adopters are not too far ahead of the average individual in innovativeness, they serve as a role model for many other members of a social system. The early adopter is respected by their peers, and is the embodiment of successful, discrete use of new ideas. The *early majority*, comprising the 34% percent to the left of the population mean, adopts new ideas just before the average member of a system and seldom hold opinion leadership positions in a system. The early majority's unique

position between very early and relatively late innovation adopters makes them an important link in the diffusion process. The *late majority* comprise the next 34% of the population in a system to adopt an innovation. The late majority adopt new ideas just after the average member of a system. Like the early majority, the late majority make up one-third of all members in a system. Their adoption may be the result of increasing network pressures from peers. *Laggards* comprise the last 16% of the individuals in a system to adopt an innovation. They possess almost no opinion leadership. The point of reference for the laggard is the past. Decisions are often made in terms of what has been done previously. Laggards tend to be suspicious of innovations and change agents. Resistance to innovations on the part of laggards may be entirely rational from the laggard's viewpoint, as their resources are limited and they must be certain that a new idea will not fail before they can adopt it.

The usefulness of the application of these two constructs in our research is that the Rogers' model provides indicator markers of ICT diffusion stages for the case study contractors and the Galbraith Star Model determines the ICT diffusion stage.

METHODOLOGY

Our research project investigated the ICT diffusion practices of six top-tier Australian construction contractors from a population of approximately 20 similar companies. This construction industry tier manage projects of AUD$00's millions with annual turnovers exceeding AUD$1billion per annum and all six selected for this study also operate outside Australia on major projects. We selected these six on the basis of availability and the opportunity to conduct interviews utilising an interview instrument designed with reference to the components Galbraith's Star model. Semi-structured, face-to-face interviews were conducted with a key ICT innovation champion from each organisation with the interview being recorded and later transcribed. Our data was supplemented with numerous less formal conversations with employees at various levels to validate the impressions and data provided. Interviewees were requested to respond to a questionnaire based upon the Star model elements 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. We selected this type of initiative because this is the current strategic ICT initiative indicated as being diffused by these organisations. We also conducted workshops with three of these organisations and checked company publicly available reports and web information.

CASE STUDY RESULTS - ORGANISATION A THE INNOVATOR

Organisation A's strategy was facilitated through a corporate culture of market and industry leadership focused upon maintenance of this leadership. Innovation was regarded as a driver of its leadership culture and objectives. Strategy and associated tasks were focussed upon best practices developed though a strategic technical advisory cell that actively collaborated with and encouraged enterprise representatives and contributors to contribute knowledge. Internal innovation resources were supplemented though researching external sources of best practice. Organisation A had undertaken an extensive rollout of an enterprise wide electronic document sharing application utilising its internal ICT network. This rollout formed an implementation strategy and program to develop a virtual e-linked community. This innovation utilises e-collaboration and corporate connectivity that includes its supply chain, with project control and organisational administration utilising extensive internal and external

networks facilitated by a wide range of purpose-built ICT applications. 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. Analysis was undertaken to determine its effectiveness, mindful that the role of this programs role was as a pilot rollout for a wider ICT implementation. Individual rewards for participating in the ICT diffusion process were intrinsic. Remuneration packages were provided to Organisation A's employees at higher levels than normal industry standards. Innovation was perceived to deliver increased profitability to the enterprise and enhance market leadership thus providing subsequent performance premiums to employees. This was an implied rather than an explicit remuneration policy but, nonetheless, it was clearly understood throughout the organisation. Employees also were rewarded intrinsically through their upgraded skills with what were considered state-of-the-art applications, reflective of the enterprise's market leadership. This *up-skilling* enhances individual's career prospects. A strong culture of teamwork and pride resulted in commitment to the organisation's continued prosperity and leadership. Organisation A had proactively undertaken the engagement of its supply chain in the adoption of its groupware application. This was achieved through gradual diffusion with significant resources being allocated to supply applications, supporting infrastructure, training and maintenance. Subcontractors and supplier were encouraged through their recognition as preferred members of the supply chain.

CASE STUDY RESULTS - ORGANISATION B THE EARLY ADOPTER

Organisation B demonstrated a proactive corporate strategy of ICT innovation and its diffusion. This organisation demonstrated innovative organisational processes rather than being an ICT industry leader. Organisation B had a strategic commitment to innovation with strategies and associated programs in place which were not dissimilar in intent and technical delivery to that of Organisation A. The difference in these strategies and programs was with the level and timing. Organisation B followed initiatives already undertaken and implemented by Organisation A. Organisation B had 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 though a strategic and technical advisory cell for active collaboration with, and encouraged of enterprise representatives and contributors as internal innovation resources, drawing also upon outside sources of knowledge.

Organisation B also had undertaken a limited rollout of an electronic document sharing application on a project specific basis. This rollout was part of an active implementation strategy and program to facilitate the introduction of a virtual productive environment utilising e-collaboration and corporate connectivity inclusive of supply chain management, project control and organisational administration. 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. This *informal* focus on training and mentoring

expectations reflected the staged project-by-project rollout of this application and the transference of acquired skills delivered through project and enterprise teams rather than through formal training initiatives. This outcome again reflects the financial limitations associated with diffusion at this level of implementation of pilot programs. 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 indicating the still, at that stage, unconfirmed nature of the enterprise-wide rollout of the next generation e-collaboration and procurement system. Individual rewards for the take-up of ICT through the diffusion process were intrinsic with project managers, as those responsible for project-specific implementation decisions, encouraged adopting the applications based on perceived productivity gains to be made on their projects. Employees were intrinsically rewarded though upgrading their skills with what were considered to be state-of-the-art applications reflective of the innovative, progressive culture of Organisation B's market leadership—enhancing their individual competencies within the industry. Organisation B's strong culture of teamwork and commitment to the enterprise and individual's desire to foster its continued prosperity were regarded as intrinsic rewards to participate in the ICT diffusion process. 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. There was recognition by Organisation B that significant benefits would accrue from this supply chain engagement and that, through long-term planning and a commitment to resources allocation to facilitate its outcomes, substantial benefits could be accrued through more effective and efficient supply chain relationships.

CASE STUDY RESULTS - ORGANISATION C THE EARLY MAJORITY

Organisation C established a strategic focus on ICT innovation but had not yet fully established a structure to support and implement an active strategy. Nonetheless, this was a planned outcome of their strategy, reflecting the immaturity of its process and program. A significant constraint to strategic innovation implementation was the structure of its enterprise with its division into separate, state based autonomous business units, each with the capacity to veto proposals if they were considered financially insecure. This reflected an apparent short-term focus on return on investment assessment decisions. Organisation C was committed, however, to its organisation's participation in a virtual productive environment utilising e-collaboration and corporate connectivity inclusive of supply chain management, project control and organisational administration. The organisation had devised an implementation strategy and program to facilitate the introduction and diffusion of this initiative. All business units had approved this plan but Organisation C had not conducted any pilot programs for this innovation—being constrained by the business structure. It was, however, prepared to implement the ICT initiative collaboratively from this base position and on an organisational-wide basis, guided by the experiences of other similar companies and individuals in Organisation C.

A small Information Technology (IT) department undertook the rollout or upgrading of ICT applications. This group informally provided technical advise 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 though colleagues, with 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. Users were expected to adopt ICT application initiatives to facilitate organisational productivity gains.

Employees were rewarded intrinsically through upgrading their skills with new ICT applications enhancing their individual competencies. The decentralised, autonomous nature of the organisations business units diluted the level of teamwork and commitment to any enterprise-wide ICT diffusion. Intrinsic motivation and reward for innovation was driven by strong rivalry that existed between each business unit and through Organisation C's competitive organisational cultural. 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 C, reflecting again the highly competitive nature of its corporate structure, considered supply-chain ICT adoption to be a long term initiative that would not entail significant leadership or resource allocations by them with costs to be borne primarily by downstream members of the supply chain.

CASE STUDY RESULTS - ORGANISATION D THE LATE MAJORITY

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.

CASE STUDY RESULTS - ORGANISATION E THE EARLY MAJORITY

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.

CASE STUDY RESULTS - ORGANISATION F– THE EARLY ADOPTER

Organisation F is an enterprise that, through its relationship with its significant global construction European parent company 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 using a web-based industry portal. Much of the technology and adoption practice they planned to utilise in this innovative reflected experience of its mature European market where this technology has been in place and used for some time.

CASE STUDY RESULTS – DISCUSSION

Table 1 provides a synthesis of the above case study descriptions; the ICT diffusion attributes for each of the six case studies are presented according to Galbraith's Star model and Figure 1 illustrate our assessment of the case study organisations' innovation maturity levels. The case study interviews conducted and reported on in this paper indicated definitive innovation characteristics according to the Rogers

Diffusion of Innovations Model. Organisation A clearly appears to be an *Innovator*, as a consequence of its capacity for innovation facilitated by its industry leadership and associated relative financial strength, as well as reflecting its long-term visionary culture. Organisations B and F clearly possess a long-term innovation culture classified as an *Early Adopter.* While not possessing the financial capacity of an *Innovator*, they are respected by their peers and support the adoption of successful initiatives and new ideas. Organisations C and E fit the cultural profile of *Early Majority* as adopting new ideas just before the average member of a system but seldom holding positions of opinion leadership. Finally Organisation D appears to have a *Late Majority* innovation culture—being suspicious of innovations and change agents with resistance to innovations being entirely rational (as their resources are limited and they must be certain that a new idea will not fail before they can adopt).

Table 1 – Case Study Comparison Using the Star Model for ICT Diffusion

GALBRAITH'S STAR ELEMENTS FOR ORGANISATIONS A, B, C, D, E AND F					
Org.	Strategy + Task Action	Structure	People	Process	Rewards
A	Refined + proactive consensus on vision, many years experience	Well-defined, highly established, highly experienced	High level technical support + training, developing supportive culture	Advanced and refined	Intrinsic + career advancement. Reputation working with excellent ICT
B	Refined + proactive consensus on vision, 2+ years experience	Well-defined, well established, developing experience	High level technical support + training, medium developed supportive culture	Developing and refining high COP use	Intrinsic + career advancement. Reputation and gaining ICT expertise.
C	Active + developing vision + consensus X-BU fragmentation	Well-defined, central, X-BU case-building, developing experience	High level technical support @ centre + training, developing supportive culture	Advanced and refined @ centre, not in BU's	Intrinsic + career advancement
D	Re-active to market, underdeveloped vision, low consensus	Poorly-defined, outsource dependency	High dependency on external experts bought-in, low level developing supportive culture	Ad-doc on JIT basis with outsourcing	Intrinsic + career advancement. Tacit organisational expectations
E	Refined + proactive consensus on vision, many years experience	Well-defined, highly established, highly experienced	High level technical support + training, developing supportive culture	Advanced and refined	Intrinsic + career advancement. Reputation working with excellent ICT
F	Active + developing vision + consensus X-BU fragmentation	Well-defined, central, X-BU case-building, developing experience	High level technical support @ centre + training, developing supportive culture	Intrinsic + career advancement. Reputation working with excellent ICT	Intrinsic + career advancement

X-BU = cross business unit, COP = communities of practice see (Wenger and Snyder 2000), JIT = just in time

CONCLUSIONS

This paper examined the ICT diffusion processes as undertaken by six significant Australian construction companies using the Galbraith 'star' model of innovation diffusion and Rogers' Diffusion of Innovation model. The analysis undertaken disclosed a variety of innovation diffusion profiles.

Organisation A is an industry leader in innovation and diffusion with established strategies, programs and structures to implement and monitor their programs outcomes, and an *Innovator* profile reflective of its market leadership. 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. 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. Organisation D projected a short-term returns focus with no strategic or structural innovation or diffusion profile. Case Study D was a *Laggard* in innovation or at best described as a *Late Majority* innovator. Case Study G – the Subcontractor - while not part of the contractor population as analysed, could be considered an *Early Majority* ICT adopter and diffuser

This paper used the Galbraith 'star' model to indicate that ICT innovation diffusion is practiced by substantial Australian construction enterprises to varying extents of maturity. One element of notable practice that becomes evident from the analysis is the substantial commitment to strategy and having a clear vision of ICT adoption and diffusion. Another element is the way that technical support units form communities of practice. While motivation appeared to rely upon intrinsic and career motivation this element should attract more future attention. These support the top-down and bottom-up approach advocated by (Nonaka and Takeuchi 1995, p125). These indications of current practice are reinforced by the classification of the innovation profiles of these enterprises according to Rogers model of Diffusion of Innovation. These analyses will contribute to the development and adoption by the industry of an innovation diffusion best practice template and encourage the adoption of ICT innovation. This is expected to reduce industry fragmentation and enhance enterprise and industry productivity through the supply chain by streamlining communication and coordination.

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