Redefining ICT Embeddedness in the Construction Industry: Maximising Technology Diffusion Capabilities to Support Agility

Architecture, Engineering and Construction (AEC) research often engages linear approaches for embedding/implementing/diffusing new technology into existing business systems and processes. However, developments in information and communication technology (ICT) often fail to deliver their full potential for a number of reasons. This paper presents these challenges and highlights the need to embrace equifinality as part of a structured approach for improving impact diffusion. The central tenet and foci of this work rests with the optimisation of AEC business agility. Given this, a multiple case study approach using three large construction organisations (in Turkey) was used to capture primary data from 30 respondents – representing viewpoints from three management levels: Top Management, Middle Management and First Line Management. Findings are presented in the form of a conceptual framework, the details of which highlight the constructs needed [inter alia ICT adoption/diffusion] to develop organisational: i) responsiveness, ii) flexibility and iii) corporate competence.

Keywords: AEC; agility; ICT; organisational capabilities; strategy; technology diffusion;

Introduction

The World Economic Forum (2016) highlights the importance and significance of AEC, with construction representing 6% of global gross domestic product (GDP) in developed countries and 8% in developing countries. However, low industry performance has been a major area of concern (in comparison to other sectors); which, from a United Kingdom (UK) perspective alone has been captured in various industry reports (Latham, 1994; Egan, 1998; Fairclough, 2002; Wolstenholme, 2009). This phenomenon also resonates with other countries (Akintoye et al., 2012; Smiley et al., 2014), where for example in Turkey,

contractors' ability to adapt to different cultures and environments is
acknowledged (Ozorhon and Demirkesen, 2014). In this respect, performance and
productivity issues are therefore considered inherently complex, and multi-
layered; where recurrent challenges often include the 'uniqueness' of the
construction domain and the need to improve innovation and process through ICT.
The awareness of these needs has led to the creation of new process and design
solutions, especially in the UK, to overcome industry-specific obstacles and fulfil
the performance and efficiency challenges (Farmer, 2016; HM Government,
2013; Infrastructure and Projects Authority, 2017; Department for Business,
Energy and Industrial Strategy, 2018). However, some of these attempts (and
others presented elsewhere in other countries) have shown that whilst some of
these challenges have been addressed, many others still remain due to a number of
factors.

For example, from a technological perspective, ICT has developed at a
seemingly exponential pace, particularly through such conduits as Building
Information Modelling (BIM) (Succar, 2009), information exchange (Lam et al.,
2010), process (Bowden et al., 2006) through to decision-making in prefabrication
(Li et al., 2019).   Acknowledging this, organisations are increasingly aware of the
business benefits that ICT can leverage, including: the integration of BIM with
Industry 4.0 practices (Dallasega et al., 2018); Smart Cities (Yamamura et al.,
2017); Human Smart Cities and Society 5.0 (Skobelev & Borovik, 2017; de
Oliveira, 2016); through to developments in self-healing and self-assembling
materials and 4D printing (Miranda et al., 2017; Headrick, 2015). These
developments have been progressive and pervasive, where for example Arup,

(2017) noted that "Innovation and creativity are the key components of value creation, while employee expectations and working cultures are changing all the time. We are seeing new forms of working that are enabled by digital technologies, on projects that are both complex and global. Understanding and managing these changes is vital, if we want to continue to provide solutions that truly meet the needs of our clients and stakeholders.". So, in many respects, embracing technology can help organisations achieve competitive advantage, but [it is argued here] only if this transformation is carefully managed. This treatise underpins the need to fully engage organisations in this process from the outset. This statement is not made lightly, as construction organisations are historically resistant to change; and even though novel technologies are available for exploitation, failure can still occur due to a myriad of issues (Khosrowshahi & Arayici, 2012; Peansupap & Walker, 2005a). A good example of failure rests with the diffusion cycle of an innovation, where organisations invariably see this as 'one-off' activity, and therefore not truly appreciating the type of innovation diffusion needed to truly deliver and sustain this. A subset of this is 'organisational change', the nuances of which requires a rich and deep understanding of the multifaceted phenomena often embedded within organisations, including capabilities, structures and processes; where Zeng et al. (2015) highlight the critical role of 'embeddedness' in the transformation process. Moreover, it is suggested here that technology diffusion *per se* needs to be more purposefully understood first, then carefully managed and embedded into organisational systems (which includes the operational context of the business

environment). In doing so, capability can be more meaningfully aligned to market drivers in order to achieve competitiveness.

Given the above discussion, this paper posits that superimposing technology diffusion/adoption processes with agility principles could provide a unique perspective for allowing organisations to improve the efficiency of their ICT embeddedness. The assertion presented here is that theories that focus exclusively on the development of organisational capabilities for achieving competitive advantage in isolation provide little or limited opportunities for systemic intervention. Where, systemic intervention requires the wider understanding of all contributory parts. This resonates with *Systems Theory* (Bertalanffy, 1968), which is especially useful for understanding the complexity drivers needed for delivering optimised 'equifinality'. The term equifinality relates to fact that using an open system approach can yield results (goals) through many different paths, routes or trajectories. From this analogy, this paper engages an agility lens to focus on the use of ICT in AEC, using the context of three Turkish construction organisations as an exemplar to highlight these issues. In doing so, the rationale was to uncover the main technology diffusion processes and interrelationships that affect business goals. This paper therefore first outlines the main theories of competitiveness and the dynamic capabilities needed to deliver business drivers, followed by a discussion on the technology diffusion/adoption processes needed to support these. It culminates in the portrayal of the of the "agility lens" elements needed for determining the Agile Technology Diffusion (ATD) parameters. The paper concludes with a

presentation of the main findings in the form of a conceptual framework, which incorporates innovation drivers and corollary key determinants of agility.

Competitiveness and Organisational Capabilities

Competitive advantage tends to reflect a firm's ability to achieve (and preferably sustain) a performance better than the average of the industry (Barney, 1991; Porter, 1980). Thus, in order to explain the nature of competitive advantage, strategic management embraces different theories to explain the principal concepts. Three main approaches include: *The Industrial Organisation Theory, Resource Based Theory and Dynamic Capabilities Theory* (Teece et al., 1997; Barney, 1991). Where, the *Industrial Organisation (IO)* theory gives value to the decisions about where to position the firm as more important than the capacity to implement such a positioning (White, 2004). The *Resource Based View (RBV)* asserts that the competitive power of organisation comes from its own assets, resources and capabilities (Barney, 1991; Wernerfelt, 1984). Where Wernerfelt (1984) defined resources as 'anything which could be thought of as a strength or weakness of a given firm'; while Barney (1991) observed that 'all assets, capabilities, organisational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable firm to conceive of and implement strategies that improve its efficiency and effectiveness'.

Organisational capability can be explained as an organisation's capacity to deploy resources and abilities to achieve its goals (Amit & Schoemaker, 1993). Where in order to achieve the goal of deploying resources, organisations tend to use 'information-based, tangible or intangible processes that are firm-specific and are developed over time through complex interactions among the firm's

resources'. Unlike resources, capabilities are predominantly based on 'developing, carrying and exchanging information through the firm's human capital' (Amit & Schoemaker, 1993). Even though resources are seen as a foundation for leveraging an organisation's capabilities, it is the actual capabilities that mainly serve as the principal source of competitive advantage (Grant, 1991). On this theme, the *Dynamic Capabilities Theory* (DCT) evolved from the RBV and can be loosely described as an approach for managing resource configurations. This includes adding, developing, combining, redeploying or disposal of firm resources (Ambrosini & Bowman, 2009; Teece et al., 1997; Eisenhardt & Martin, 2000; Easterby-Smith et al., 2009; Winter, 2003). In addition, it is also important to reflect on the concept of 'dynamic capabilities', where 'A dynamic capability is the capacity of an organisation to purposefully create, extend or modify its resource base.' (Helfat et al., 2009). This is an important facet of the technology diffusion process as it naturally embraces technology diffusion capabilities.

Diffusion: Theory and Concepts

Research on 'diffusion' became a popular field for anthropologists during 1920's and 1930's (Katz et al., 1963; Valente & Rogers, 1995); where its origins extend back to 1903 (Rogers, 2010). Rogers' theory on Diffusion of Innovations (Rogers, 2010) defined diffusion as 'the process by which an innovation is communicated through certain channels over time among the members of a social system'. The theory of Diffusion of Innovations, defines the innovation-decision as a process that 'consists of a series of actions and choices over time through which an individual or an organisation evaluates a new idea and decides whether or not to incorporate the new idea into ongoing practice' (Rogers, 2010). This process

starts with awareness, regarding the existence of innovation, understanding how and why it works (*Knowledge*). After the *Knowledge* formation (of the favourable or unfavourable attitudes towards the innovation takes place), follows *Persuasion*, in which there is a more detailed investigation on the information requirements. Based on the information received from the previous two stages the *Decision of Adoption* or *Rejection* is given. If the decision is positive, the *Implementation* of the innovation takes place, in which the usefulness of the innovation is evaluated. Based on the evidence that supports the usefulness of the innovation, the process is then finalised by the *Confirmation*, which then leads to further use (Rogers, 2010; Sahin, 2006) (Figure 1).

[Insert Figure 1 here]

Figure 1: Repetitive nature of technology diffusion.

Despite the linear approach expressing that the diffusion process can be seen as a one-time event, researchers from different disciplines, especially in AEC research (*c.f.* Emmitt, 1997; Slaughter, 2000; Manley, 2008), have observed that 'real life' interactions of diffusion dynamics can not be fully expressed exclusively through linearity per se. Where for example, Figure 1 presents the repetitive nature of technology diffusion that organisations tend to face in their business environment. Innovation often occurs in various guises; and organisations view these opportunities differently depending on their attitude and openness to modernisation and change. In this regard, the diffusion process in innovative organisations can be seen as a continuous process.

From a technology adoption perspective, this can be influenced by a single person (who accepts or rejects innovation), or through consensus (Fichman, 1992, Gallivan, 2001). This phenomenon has been the focus of considerable attention over the years (Ajzen, 1985; Fishbein & Ajzen, 1975; Ryan & Deci, 2000; Bandura, 1986; Davis, 1989; Venkatesh, 2000;Venkatesh & Bala, 2008); observing that new technology diffusion is often a complex process that is affected by several factors, not just with the technology itself, but also at individual, organisational and environmental levels (Peansupap & Walker, 2005b; Hameed et al., 2012b; Jeyaraj & Sabherwal, 2008; Del Aguila-Obra & Padilla-Melendez, 2006).

ICT and Diffusion in Construction

From a terminology perspective, it is important to recognise the parameters that have shaped research discourse in AEC literature. For example, the term "IT" was traditionally used in diffusion/adoption research as a general term to indicate the area (Froese, 2010; Karahanna et al, 1999); but further developments manifested in a more encompassing term "ICT" (Peansupap and Walker, 2005a); and further discourse in this area include Carmen de Pablos, (2009), Wang, et al, (2011) and Ilhan et al., (2019).

Given the need to appreciate ICT diffusion within AEC, various authors have attempted to unpick the complicated interactions that exist between the technology diffusion process in order to provide new insight and understanding into these relationships (*c.f.* Bin Zakaria et al., 2013; Lees & Sexton, 2014; Shibeika & Harty, 2015; Lindgren & Widén, 2018; Okakpu et al., 2018). Thus, taking the unique characteristics of AEC into account (and the disparate processes

involved); it was considered important to explore this diversity in context with the continuous nature of the diffusion process; and more specifically, how this links to organisational agility and ATD capabilities. The challenge here was to provide a firm basis for repetition, as providing a more granular understanding of this can help to more fully define the contextual nature of "agility".

Agility

The first use of agility in a business context relates back to the early 1990s, in which a group of researchers from Iaccoca Institute of Lehigh University proposed an approach to regain USA's dominance in the manufacturing industry. Subsequently, a report was published titled 'The 21st Century Manufacturing Enterprise Strategy', where the authors asserted that the manufacturing paradigm should be given a new nature with the implementation of agility principles (Nagel, 1992). After the presentation of 'agility' as a new capability for organisations, the term was subject to numerous studies and various definitions (Table 1).

[Insert Table 1 here]

From the discussion above, it can be observed that even though the agility concept has been described in slightly different ways, these definitions generally concur that agility is the ability that enables an organisation to 'respond' quickly and effectively to a 'change' that was unanticipated so that they can 'recover' and continue to 'thrive' in their competitive environment.

Agility in technology diffusion

Subsequent to the introduction of agility in the manufacturing industry as a solution for gaining competitive advantage, focus moved to understanding new ways of achieving agility. In this respect, a variety of frameworks were developed to demonstrate the nature of agility (Goldman et al., 1995; Sharifi and Zhang, 1999; Fayezi et al., 2017; Baskarada & Koronios, 2018). From this, research into agility became more mature, and this concept is now accepted as one of the leading dynamic resources and capabilities of an organisation to achieve and sustain competitive advantage in dynamic markets (Helfat et al., 2009, Sambamurthy et al., 2003; Sherehiy et al., 2007). Whilst historically, the focus of agility research has primarily centred on business processes; equally, this remit has now expanded to include particular foci, including ICT. Where for example, Dunlop-Hinkler et al. (2011) observed the positive impact of this (especially in order to develop organisational abilities to respond quickly to technological changes) and introduced the term 'technology agility'. This approach acknowledged that organisations should not just develop skills to diffuse novel technologies *per se*, but should also be capable of managing this process rapidly and efficiently (in order to survive and compete). In other words, organisations should be: i) responsive to emergent technologies ii) competent to manage the change process that new technology brings, and iii) flexible in terms of their resources to respond the needs of this change (Ezcan et al., 2015). These three facets of ATD can be leveraged through three core capabilities: i) Responsiveness ii) Flexibility and iii) Competence (Figure 2).

[Insert Figure 2 here]

Figure 2: Fundamentals of Agile Technology Diffusion (Ezcan et al., 2015)

From Figure 2, it can be seen that the three core capabilities are fundamental prerequisites of the agile diffusion process. Where for example, Sharifi and Zhang (1999) defined responsiveness [from a manufacturing perspective] as 'the ability to identify changes and respond quickly to them, reactively or proactively, and to recover from them'. It is important to acknowledge that AEC organisations should be able to: sense, perceive and anticipate changes and risks in the environment (Malik, 2013), whilst also being capable of reacting to change and its demands (Holweg, 2005). Consequently, they should be able to recover from the negative impact of new technology implementation (Stuart, 1996). Intrinsically, this means that organisations also need to be flexible. Where the flexibility of an organisation can be defined as 'the capability to make changes and the capacity to control to achieve best fit towards business needs with little consumption of resources and disturbance on performance' (Ni, 2007). In this regard, in order to provide optimum results, organisational flexibility should cover three main type of resources, namely: Human Resources (Bhattacharya et al., 2005), IT Infrastructure (Masrek & Jusoff, 2009) and Processes (Narasipuram et al., 2008). Whilst flexibility is important, organisations should also naturally embrace responsiveness, especially when considering the implications of change; where Sharifi and Zhang (1999) defined this as having an 'extensive set of abilities to provide a basis for productivity, efficiency, and effectiveness of a company's activities'. In summary therefore,

organisations should be capable of: developing diffusion related strategies aligned with their business strategy (Albeladi et al., 2014; Gholamzadeh &Jalali, 2013); and be able to manage and deliver this throughout the change process (Brisson-Banks, 2010; Davis and Songer, 2009). Following this analogy, this paper is based in part on the precepts presented by Ezcan et al. (2015), but supported by additional evidential case study material grounded and contextualised within the Turkish construction industry.

Turkish Construction Industry

The Construction Industry is one of the main drivers of Turkish economy, representing 6% of Gross Domestic Product (GDP) (KPMG, 2019). Turkish contractors are well known for their service quality, technical capability and experience in international markets (Dikmen and Birgönül, 2003; Işık, Aladağ, Demirdöğen, & Aygün, 2018; Ozorhon and Demirkesen, 2014). From a market perspective, according to the latest data available from Turkish Contractors` Association, Turkish contractors completed more than US$379bn of work between 1972-2018 (TCA, 2019). Moreover, the Engineering News Record`s (ENR) affirms Turkey's impact on the international markets, ranking construction contractors, "both publicly and privately held, based on general construction contracting export revenue - generated from projects outside each firm's respective home country" (ENR, 2019).

Research Methodology

The underpinning research methodological rationale of this study was to define AEC organisations' approach to ICT embeddedness. The assertion proffered here

was that developing technology diffusion capabilities through an agility perspective could engender a deeper and more meaningful understanding of ICT Embeddedness. In this regard, this research aimed to uncover agile-specific technology diffusion capabilities within companies operating in the Turkish Construction Industry. This included the core diffusing processes and corresponding perceptions of Turkish actors engaged this sector. The starting trajectory for this work used outputs from previous studies on 'agility' to shape and refine the observational 'lens' (Hawking and Mlodinow, 2010) in order to reveal the essence and impact of agility within the technology diffusion processes and the organisational capabilities needed to construct them.

Since technology diffusion is a process that mainly take places in a social system (Rogers, 2010), the philosophical stance of this work was to understand the factors and mechanisms that affect people's behaviour within organisations. Which from an AEC perspective, included the unique transformational actions needed to purposefully embrace novel technologies within organisational structures. The construction context was important here, as social reality is constructed by the subjective meanings of actors within this environment [as opposed to other business remits]. Thus, experiences are predominantly formed through interaction with individuals, absorbing both organisational context and cultural norms (Creswell, 2007). Accepting this premise, the methodological development process needed to appreciate the interconnectedness of the core parameters that supported an Agile Technology Diffusion (ATD) framework (including organisational delivery abilities). A three-phased research methodological approach was therefore adopted (Figure 3).

[Insert Figure 3 here]

Figure 3: Research Methodology: Three Phased Approach

From a philosophical worldview perspective, this paper embraces interpretivism as the main lens for discovery. This was considered particularly appropriate for determining social and mental constructs associated with actors, especially given the need to measure and observe phenomena; where actors' perception, experience and understanding of 'objective reality' needed to be captured and understood. In order to improve data fidelity and increase research rigour, it was deemed important to engage more than one research methodological approach (Fellows & Liu, 2015; Holt & Goulding, 2014; Miles et al., 2013). Consequently, an explicit mixed methodological approach (Holt & Goulding, 2017) was employed to support the design, data collection, analysis and validation process.

As a starting point, in order to determine the main drivers that typically affected or influenced the technology diffusion process, initially, a systemic cascading literature review was undertaken using keywords such as "technology diffusion", "technology adoption", "innovation diffusion", "ICT diffusion" and "ICT adoption". This review was purposive, insofar as it focussed on peer reviewed journals within AEC, albeit supported by work from management, social science and information systems research (Figure 3). These factors were later distilled through an iterative filtering process using Content Analysis, where agility was 'tagged' against its ability to influence or affect the diffusion process.

A team of six domain experts with knowledge and experience in: construction processes, strategy, leadership, ICT implementation, and agility practices were selected to i) agree these core findings, and ii) participate in the case studies investigations. A multiple-case study approach (Yin, 2013) was adopted in this study, the purpose of which was to secure a more detailed and in-depth understanding of the phenomena. Thus, similar cases were selected through purposive sampling in order to provide 'literal replication' (Fletcher & Plakoyiannaki, 2010). Given this, three case studies were selected in order to satisfy data replication requirements (Yin, 2013; Marshall et al., 2013). All three case study companies reported in this paper originated from Turkey; the purposive sampling of which applied a predominant business focus of construction/civil engineering (Table 2). These three companies were considered 'representative' given the nature of their business and services offered, and their experience in technology diffusion.

[Insert Table 2 here]

In order to engage a 'representative' and 'balanced' view of each of these three case study organisations, it was deemed necessary to capture the perspectives of three organisational tiers, namely: First Line Management, Middle Management, and Senior Management. Purposive sampling was used in this selection process. Moreover, given the need to secure 'saturation', for each of these three levels, it was deemed necessary to select four respondents for First Line Management, four respondents for Middle Management, and two

respondents for Top Management. This distribution and corresponding level of expertise can be seen in Table 3.

[Insert Table 3 here]

Each of the three case studies were conducted against strict data capture protocols to ensure homogeneity. Qualitative and quantitative data was captured from each respondent through in-depth interviews and semi-structured questionnaires. For data assessment, Content Analysis was used for qualitative data evaluation in order to determine the main factors (capabilities) that enable agility in technology diffusion process. Respondents were asked to rate the level of existence of the confirmed criteria based on a scale of 1-5 (where 1 = low, and 5 = high). Relative importance ranking of the variables were then determined in line with previous studies (Shahsavand et al., 2018; Durdyev et al., 2017; Hadidi et al., 2017). Of particular note here, this approach followed similar studies presented elsewhere, albeit reflecting application context, such as; Relative Importance Index, Severity Index, Relative Agreement Index, etc. (Holt, 2014; Chen et al., 2010; Chileshe & Dzisi, 2012). Given the nature of this study (and the need to determine the existence of ATD capabilities); the term "Relative Existence Index" (REI) is used to avoid interpretive confusion. Where, the REI was determined using the following formula (EQ1), which was adapted from Chen et al. (2010).

EQ1 Relative Existence Index

$$Relative\ Existence\ Index\ (REI) = \sum_{i=1}^{5} \left(\frac{\omega_i.f_i}{a.n}\right)$$

i	= scale anchor point given to each criterion by the respondent (*ranging from 1 to 5*)
ω_i	= weight for each point (*rating in scale of points, from 1 to 5*)
f_i	= frequency of the point i by all respondents
n	= total number of responses
a	= highest weight (5 in this study)

The results from these analyses were then ranked from negative to positive

existence; where the parameters with high ranking show the strong points of the

organisations, and low ranking identify areas for improvement. However, in

situations where two or more factors had the same score, then the one with the

lowest standard deviation was assigned the highest importance ranking (Chileshe

& Dzisi 2012). If they also had the same standard deviation, then they were

considered to share the same arithmetic mean of all ranks they occupied.

Research findings

The following findings are presented through three core themes, namely:

Technology Diffusion Drivers, Agile Technology Diffusion Capabilities, and

Agile Technology Diffusion Capabilities of Turkish Organisations (Current

State).

Technology diffusion drivers

The process of technology diffusion can be seen as a stratified series of

subsystems, the complexity of which not only cascades between the various

levels, but can also be seen to influence outcomes. Given this symbiosis, in an

attempt to provide greater clarity, the elements gathered from Technology

Diffusion-Adoption literature are grouped under four main levels, namely: technology, individual, organisation and environment (Table 4).

[Insert Table 4 here]

Table 4 identifies the four core silos associated with technology adoption. The drivers presented reflect the nature and impact of these divers on the diffusion process. Where: "Technology" is based on the characteristics of the new technology to be implemented; "Individual" focusses on the impact of the characteristics of individuals making the technology adoption decision; "Organisation" includes the impact of inter-organisational relationships and characteristics; and "Environment" includes the external operating environment. However, whilst this categorisation may be considered over-simplified, it is important to acknowledge that each of these levels have corresponding sub-drivers. An example of these sub-drivers can be seen for the "Individual Level" (Table 5).

[Insert Table 5 here]

Agile Technology Diffusion Capabilities

Technology can be a significant enabler for gaining and sustaining competitive advantage (Teece et al., 1997; Zeng et al., 2015; Dunlop-Hinkler et al, 2011). Acknowledging this, the work presented here aims to redefine ICT embeddedness based on the integration of agility and dynamic capabilities approaches (Figure 4).

This framework was developed using data derived from the three case studies, following a similar approach proposed by Dunlop-Hinkler et al. (2011) [regarding the need for embedding agility into the technology diffusion process], and work by Sharifi and Zhang (1999) [regarding the methodology for achieving agility in manufacturing organisations].

[Insert Figure 4 here]

Figure 4: Agile Technology Diffusion Framework

From Figure 4, it can be seen that the central core "A" [Agility] is supported by three central pillars: "R" [Responsiveness]", "C" [Capability], and "F" [Flexibility]. Each of these central pillars are supported by three systems and three subsystems. For example, "R" is supported by systems: "RA", "RC" and "RR"; where the subsystems for "RA" are "RA1", "RA2", and "RA3". This approach is replicated for all systems and subsystems in the Agile Technology Diffusion Framework. The details and the definitions of the subsystems are provided in the related figures (Figures 5 – 13 inclusive).

Responsiveness

This framework was developed with industry using data from the case study findings. In this respect, the assessment of the actual technology diffusion process in construction organisations was actuated through a number of iterative phases. The initiation phase of technology diffusion starts with organisations actually being aware of the technology – particularly the importance of this in the

competitive environment. This phase also includes awareness of emerging technologies, trends and changes in industry demand. Anecdotally, respondents highlighted the need to embrace the monitoring process, where this should not just be limited to 'technical requirements in the bid documents'.

> e.g. "..since we have to follow the technical specifications in bid documents, we bound to the limits that are specified in these documents and do not go for something else..."

Market awareness is important, but so is the need of balancing organisational resources in terms of: process, people and technology. For example, knowing how quickly organisations will be affected if they can not keep pace with the change is one thing; but, acknowledging the need to understand the juxtaposition of organisational resources, and how this both shaped and informed by corporate culture is another.

> e.g. "..this is not something that is transformed into a corporate philosophy..it is pursued by the efforts of some individuals.."

More often than not, organisations fail to fully understand the impact of change (even in one department of an organisation) on the business. This includes a raft of issues, from communication, through to staff motivation and morale.

> e.g. "..staff can be sacked very easily..company does not care if this will affect other units or staff's motivation.."

Only after being aware of the internal and external links/dependencies, should an organisation consider moving to the next stage. In doing so, they should undertake an impact assessment to predict the potential risks and consequences that often occur with new change – particularly on people, process and technology. This evaluation should include both cognate and non-cognate representatives, including hierarchical decision-makers; as in some cases, the needs of end users do not get fully 'translated' into the final decision.

e.g. "..we assess the pros and cons of the implementation of new technology..", "..however this assessment do not include the impact on the people issues..".

Notwithstanding these complications, there is a need for organisations to: *Sense, Perceive and Anticipate Changes and Risks in the Environment (RA)*. These include the sub-capabilities of: *Monitoring and reporting (Internal & External) (RA1); Connectivity awareness (RA2);* and *Analysis of risk and consequences (RA3)* (Figure 5).

[Insert Figure 5 here]

Figure 5: Sub-capabilities of RA

After achieving 'awareness', organisations should be able to better appreciate the immediate reaction to a technology and its concomitant impact on change. This requires a clear strategic vision and direction of travel for all parts of the organisation, including operational levels.

e.g. "..they do not ask for staff's contribution and do not inform us about the strategy.."

This necessitates the need for clear information management and dissemination, as this can help support the change processes required. In doing so, it is important to present this information in a transparent, consistent and timely manner in order to avoid 'mixed messages' or subsequent confusion.

e.g. "..people like to avoid taking initiative..", "..nobody wants to take the risk..when things get complicated the responsibilities are handed off to others.."

In this regard, an organisation's ability to give *Immediate Reaction to Change and Its Demands (RC)* consists of the following sub-capabilities of: *Strategic vision and outcome expectancy (RC1)*; *Information and knowledge management (RC2)*; and *Devolved and responsive decision-making (RC3)* (Figure 6).

[Insert Figure 6 here]

Figure 6: Sub-capabilities of RA

Recovery from change can often be quite challenging for organisations, as this can embrace unfamiliar territory and processes. Where, organisational recovery can be described as the process in which an organisation attempts to recuperate to the standard it was before the period of difficulty (Allen & Toder,

2004; Rumelt, 1995). In this research, organisational recovery is viewed from the initial negative impact that new technology implementation invoked, and the impact this had on organisational change. Therefore, it is advocated that an organisation's ability to recovery from this change necessitates the existence of three main capabilities (or three consecutive steps). Where the first initial step is the assessment of the recovery needs; followed by the development of a recovery plan that embraces the priority areas; and finally, the steps needed in the recovery process to return back to the pre-change state.

In this regard, an organisation's ability to *Recover from Change (RR),* consists of sub-capabilities of: *Assessment of recovery needs (RR1); Development of recovery plan (RR2);* and *Reorganisation (RR3)* (Figure 7).

[Insert Figure 7 here]

Figure 7: Sub-capabilities of RR

Flexibility

Respondents from these three case studies generally accepted the need to embrace change as part of strategic reorientation. However, they also noted the need to define clear roles and responsibilities as part of this reorientation and recovery process. This includes the need to reflect on both current and future demands of the workforce, which often includes re-training to meet need needs. Organisations may also encounter barriers or resistance to change, especially where job roles are significantly changed.

e.g. "..in construction production, except special tasks that need special professionalities, people can and should work in different positions, under different responsibilities.."

Acknowledging this, the capability of *Human Resources Flexibility (FH)* consists of the following sub-capabilities of: *Ability to switch different positions-responsibilities (multi-skilled) (FH1); Quickly learn new procedures and solve specific problems (FH2);* and *Change work habits as a response to changes in demands (FH3)* (Figure 8).

[Insert Figure 8 here]

Figure 8: Sub-capabilities of FH

The introduction of new technology into an organisation does not necessarily mean that the 'old technology' immediately becomes redundant or useless.

e.g. "..our IT infrastructure is very weak in some sites.. the IT investments for projects are planned at the beginning.. if you have delays..your infrastructure, especially the hardware gets weaker.."

More often than not, a transition period is introduced, and in some cases, two parallel streams may be in operation. Respondents from this study emphasised this issue, noting that synchronising hardware and software on site with the head office was a fundamental prerequisite of securing efficiency gains

and streamlining the communication process. Information sharing was seen as a central part of business connectivity and interoperability.

e.g. "..they do not care about it much..we asked for some changes however had no results.."

In this regard, the capability of *IT Flexibility (FI)* consists of the following sub-capabilities: *Development of an IT infrastructure for handling changes in number of users, workloads and transactions (FI1); Development of an IT infrastructure that is modern and can be used with ease (FI2);* and *Development of an IT structure that possesses electronic linkages among departments, branches and external parties (FI3)* (Figure 9).

[Insert Figure 9 here]

Figure 9: Sub-capabilities of FI

The introduction of new technology can often have a significant impact on organisational processes. These processes often include predefined procedures and ways of delivering the core business operations. Respondents highlighted the need to ensure new process paths are aligned to any changes made as part of the recovery process. This includes the need to support training and development, as in many cases new organisational skills will need to be procured to deliver these new processes or ways of working.

e.g. "..some can do this but some can't..people state different reasons for this.. actually they all possess the ability.."

Acknowledging this, the capability of *Process Flexibility (FP)* consists of the following sub-capabilities: *Development of a range of possible solutions (FP1); Provide mobility (FP2);* and *Provide uniformity (FP3)* (Figure 10).

[Insert Figure 10 here]

Figure 10: Sub-capabilities of FP

Competence

One of the core challenges organisations usually face when going through a change or recovery process is that of employee engagement and empowerment.

e.g. "..it is right in theory..however, things usually do not go like this in practice.. they do not want to take initiative.."

These three cases studies are no exception. Respondents emphasised the need for them to take their own decisions in the organisation; and that it was the responsibility of the company to develop greater understanding and skills to empower people. This naturally embraced a number of peripheral issues, including top management support, trust, incentivisation, and fostering an organisational culture which is both innovative and collaborative.

e.g. "..actually some of the tools that we are using are twenty years old..", "..actually company wants you to use new technologies but do not want to invest for them.."

e.g. "..people do not want to share information with each other..they keep it at minimum..they..do not want to give advantage to each other..this causes uneasiness.."

In this regard, the capability of *Leadership (CL)* consists of the following sub-capabilities: *Motivation of staff to implement new technology (CL1); Development of a culture to support new technology implementation (CL2)*; and *Development of trust (CL3)* (Figure 11).

[Insert Figure 11 here]

Figure 11: Sub-capabilities of CL

One of the core findings arising from this study was the need to reengineer processes after the introduction of new technology. There was a need to exemplify this in a structured way in order to not only help diffuse new technology *per se*, but redefine changes in roles and responsibilities, as a result of this new technology. This includes the provision training and technical support as part of this transition, including clear lines of communication to effectuate the change process.

e.g. "..you can easily discuss anything with your colleagues and your chiefs..we have this culture.."

In this regard, the capability of *Managing Change (CM)* consists of the following sub-capabilities: *Reengineering processes (CM1); Provide services and support (CM2);* and *Development of communication (CM3)* (Figure 12).

[Insert Figure 12 here]

Figure 12: Sub-capabilities of CM

One of the key facets organisations tend to omit when restructuring their systems and processes is that of data fidelity. This includes the alignment of the organisation's information technology (IT) systems with its information systems (IS) strategy and business strategy (Ward & Peppard, 2002; Goulding & Alshawi, 2002).

> e.g. "..these kinds of new software or technologies may be purchased without having detailed information, with the desire to provide a quick solution.."

Given this, respondents from this study highlighted the importance of this, especially concerning technical specifications and wider technology diffusion. There was a distinct need to ensure staff had the skills and capability to sustain the success of new technology implementation, underpinned by a bespoke training strategy aligned with the company's IT, IS and business strategy.

> e.g. "..in the recruitment process, priority is on the; former employees and the applicants with references from the company.."
>
> e.g. "..these kind of trainings are provided but the participation level is not so high due to the heavy workload.."

In this regard, the capability of *Strategy Development (CS)* consists of the abılıty to: *Development of IT/IS strategy (CS1); Development of HR strategy (CS2);* and *Development of training strategy (CS3)* (Figure 13).

[Insert Figure 13 here]

Figure 13: Sub-capabilities of CS

Table 6, which is linked to Figure 4, provides the Agile Technology Diffusion Capabilities derived from the three case studies in hierarchical order.

[Insert Table 6 here]

Current stage of agile technology diffusion capabilities

From the three Turkish construction organisations examined the mean score, standard deviation and REI can be seen in Table 7.

[Insert Table 7 here]

In total, 30 respondents' views were captured from the three organisations – the arrangements and experience of which can be seen in Table 3. During the interview process, respondents were asked to share their perception on the

existence of ATD capabilities and asked to rate the level of existence of the confirmed criteria based on a scale of 1-5 (where 1 = low, and 5 = high).

The overall rankings show that "CM3 / Development of communication" [0.890 REI – Rank 1] was perceived to be the most powerful capability of the three representative construction organisations in terms of ATD. The second and third rankings were shared by the capabilities of: "CM2 / Provide services and support" [0.860 REI – Rank 2] and "CS3 / Development of training strategy" [0.860 REI – Rank 3], with the same REI value. The weakest point of the organisations was "RR3 / Reorganisation" [0.687 REI – Rank 27] appertaining to the recovery from change process. The capability of "RC3 / Devolved and responsive decision-making" [0.707 REI – Rank 26] and "FH3 / Change work habits as a response to changes in demands" [0.750 REI – Rank 25] were also placed at the bottom of the list. When considering the rankings of capabilities under Agility (Responsiveness, Flexibility and Competence) separately, the capabilities that were perceived to have the greatest impact on these core capabilities were: "RC1 / Strategic vision and outcome expectancy" [0.830 REI – Rank 1] for *Responsiveness*; "FI3 / Develop an IT structure that possesses electronic linkages among departments, branches and external parties." [0.857 REI – Rank 1] for *Flexibility;* and, "CM3 / Development of communication" [0.890 REI – Rank 1] for *Competence.* Conversely, the capabilities perceived to have the least impact on the core capabilities were: "RR3 / Reorganisation" [0.687 REI – Rank 9] for *Responsiveness*; "FH3 / Change work habits as a response to changes in demands" [0.750 REI – Rank 9] for *Flexibility*; and "CS2 / Development of HR strategy" [0.770 REI – Rank 9] for *Competence.*

Discussion

The case study findings confirm the technology diffusion process can not be considered a one-time event. Moreover, it should also be noted that solutions should be embrace the process rigour advocated by Slaughter (2000) and Manley (2008). The rationale presented here is that the findings from the diffusion process highlighted in this paper tend to follow different courses and rates throughout the different departments and levels of an organisation – even within the same organisation. This finding resonates with the work of Shibeika and Harty (2015) and Peansupap and Walker (2005a; 2005b). One of the main difficulties in this respect relates to the lack of vertical and horizontal communication. This impinges (or indeed fosters) a lack of trust, which in turn have an inverse impact on innovation diffusion.

The Agility 'lens' presented in this research presented the core capabilities of agility of diffusion. These findings are consistent with the conceptual model presented by Zhang and Sharifi (2000). In this respect, case study findings from this study revealed that responsiveness appeared to be the most neglected capability of the three Turkish construction organisations. As one of the main elements of responsiveness, the 'sensing' ability of organisations included the awareness of both internal and external sources, and the top-down effects therefore shape this interplay. This aligns with Malik, (2013), and interestingly, with Emmitt (2001) concerning product awareness and innovation. Of particular note here is that whilst companies may not be fully aware of the impact or potential impact of new technologies on organisation resources (especially in terms of people, process and technology), they are aware of the need to do

something. This 'need' was presented by Peansupap and Walker (2005a), noting how 'gaps' can often lead organisations to misunderstand: i) connectivity and general awareness, ii) the risks and impact of change on the organisation, iii) the consequences of this change on information sharing, and finally, iv) the impact on decision making and the distribution of power within the organisation.

Additional findings from this study observed that these three organisations understood the importance of change (in line with Kritchanchai and MacCarthy, 1999); yet, they seemed not to fully appreciate the formal engagement mechanisms needed to align business strategy drivers into a clear vision (to deliver this change). In some respects, this is a particular challenge for management. Notwithstanding this, and acknowledging that the concept of 'organisational recovery' is a relatively new concept for construction organisations, findings from this study recognised the need to develop organisational abilities for assessing, planning and acting to recover the negative impact caused by change. This resonates with the findings of Stuart (1996) on the trauma of organisational change.

Part of organisational change is the need to have clear training strategies to deliver technical capability, but also the softer skills needed to deliver business flexibility. These findings relates to work presented by Bhattacharya et al., (2005) on employee behaviour on firm performance; with Peansupap and Walker (2005a) on the effectiveness of ICT diffusion; and with the need for a flexible and integrated infrastructure (Masrek and Jusoff, 2009). One of the challenges presented here is precisely how these requirements can actually be more meaningfully embraced? This in itself has been recognised in the manufacturing

sector, where 'Neither practitioners nor academics agree upon, or know, how flexibility can be gauged or measured in its totality' (Koste and Malhotra, 1999). What seems to be happening is that organisations often rely on individual skills and leadership abilities; the corollary of which places emphasis on individuals, rather than the 'systems' that deliver business goals. Business goals are an integral (essential) part of this understanding, and possibly one of the most neglected areas not yet fully understood (Albeladi, et al., 2014; Gholamzadeh and Jalali, 2013; Jeyaraj and Sabherwal, 2008).

Finally, the results from this analysis generally align to the widely perceived perception that construction organisations are predominantly 'rigid', and somewhat resistant to change (Peansupap & Walker, 2005a; Davis & Songer, 2009; Gambatese & Hallowell, 2011). All organisations involved in this study were categorised and large-scale conglomerate. Given this, there is an argument to be had that proffers the agility, responsiveness and flexibility of an organisation is scalable. Where, agility and innovation could in some case favour smaller organisations. Notwithstanding this, perhaps the most important issue to consider is '…what makes agile companies special is their ability to balance fast action and rapid change, on the one hand, with organizational clarity, stability, and structure, on the other' (McKinsey, 2016). From the three construction cases studies presented here, it can be seen that on the whole, respondents are fully aware of the dynamic operating environment. They are also aware of the need to embrace change in order to align strategic competence with commercial drivers. However, it seems that the hierarchical structures within these companies have often failed to communicate effectively. This includes the need to codify and relay

transparent, consistent and cogent information between organisational layers. In doing so however, it is important to note that this will in turn also affect the decision-making process. Whilst this to some extent can be described through an umbrella term 'organisational culture', the manifestation of this can significantly hinder (or help) the recovery process. In the three case studies investigated, it was interesting to observe that employee flexibility was very self-driven and loosely coupled. This suggests that whilst organisational ability to manage change seems to present a more stable position than might have been expected, the corollary of this is that there is an underlying need to provide 'Strategic Vision and Outcome Expectancy' in line with 'Development of Communication', and these are not mutually independent.

Conclusion

This research stemmed from the need to provide a dynamic business model to help construction organisations capture, harness and diffuse ICT innovation to deliver increased agility (in line with market drivers). In this regard, it presented a novel approach for delivering technology diffusion in construction organisations – the context of which was Turkey. In doing so, it provides new evidence for support agile technology diffusion; which has then been used by these organisation to help shape and redefine their overall technology embeddedness. The evidence collected from three cases not only confirmed the core capabilities of Agile Technology Diffusion but also provided clarification on the sub capabilities needed to ensure success.

The findings presented here provide organisations with a formal conceptual framework for managing ATD, the rubrics of which highlight the

fundamental areas of focus, particularly on the need to develop abilities to respond to (and manage) ICT-related change. This framework can be used as a strategic asset to achieve competitive advantage and can also be tailored to fit the specific needs of organisations. Evidence from this study also presents additional understanding and insight into the core theoretical and philosophical foundations of the technology diffusion processes. Equally, there is a further need to 'unpick' the actual specific performance criteria that underpins organisational capability.

Additional introspective reflection naturally invites critique; and in the case of the research presented here, it is important to provide additional insight needed to both shape and inform future studies. For example, whilst the findings presented can be considered representative of the Turkish construction organisations in question; these organisations must be viewed as 'bounded' or at the very least contained within their sphere of influence (as all three of these companies under investigation were deemed 'large enterprises'). Therefore, the degree of fit or match to smaller companies such as: micro enterprises (<10 persons employed), small enterprises (10 - 49 persons employed) and small to medium-sized enterprises (50 - 249 persons employed) need to be further investigated.

Finally, it is also important to highlight the impact of organisational capability and maturity, as these concepts have been seen to be particularly beneficial in supporting ATD. The next stage of this work will address these factors using contextualised data derived from other countries and different contexts. This will not only help support homogeneity, but will also reinforce and

strengthen data veracity and confidence levels for wider generalisability and

repeatability.

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Table 1: Main Definitions of Agility

Reference	Definition
(Goldman et al., 1995)	Agility is the ability to thrive in a competitive environment of continuous and unanticipated change and to respond quickly to rapidly changing, fragmenting global markets that are served by networked competitors with routine access to a worldwide production system and are driven by demand for high-quality, high-performance, low-cost, customer-configured products and services.
(Yusuf et al., 1999)	Successful exploration of competitive bases (speed, flexibility, innovation, proactivity, quality and profitability) through the integration of reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast-changing market environment.
(Zhang & Sharifi, 2000)	Agility is primarily concerned with the ability of enterprises to cope with unexpected changes, to survive unprecedented threats from the business environment, and to take advantage of changes as opportunities.
(Dove, 2001)	The ability of an organisation to thrive in a continuously changing, unpredictable business environment.
(Hooper et al., 2001)	The ability of an enterprise to develop and exploit its inter- and intra-organisational capabilities.

Table 2. Case Study Company Details

	Overview
Company 'A'	One of the pioneering contractors in the Turkish construction industry. Core operations include: construction, housing, public service buildings, refineries, chemical and petrochemical/power/industrial plants, pipelines, and transportation. Operating remits include: Turkey, Russia (The Russian Federation, Kazakhstan, Turkmenistan etc.) and Middle East and North Africa (MENA) region. *(Turnover: 590m. USD)*
Company 'B'	One of the largest contractors in Turkey. Core operations include: construction, heavy civil engineering works, refineries and petrochemical/industrial/power plants, pipelines, marine structures and electrical/communication works. Operating remits include: Turkey, the Middle East, North Africa, Caucasia and Central Asia, East and Central Europe. *(Turnover: 833m. USD)*
Company 'C'	A construction holding group company in Turkey. Core operations include: construction, marine works, bridges, highways, tunnels, oil/gas power plants, power transmission lines, dams, residential-commercial-industrial buildings, water/sewage treatment plants, urban infrastructure, engineering and construction management services. Operating remits span 24 counties, including: Turkey, the Middle East and North Africa (MENA) region. *(Turnover: 540m. USD)*

Table 3: Distribution of respondents' experience by management levels

Management Level	Experience (Years)					TOTAL NR
	0 - 5	6 - 10	11 - 15	16 - 20	21 -	
Top Management (TM) *(Board of Directors, Chief Executive Officer, General Manager, Managing Director, President, etc.)*	-	-	-	1	5	**6**
Middle Management (MM) *(Department Heads, Branch Managers, Junior Executives, etc.)*	1*	-	4	3	4	**12**
First Line Management (FLM) *(Engineers, Architects, Surveyors, Technicians working under the middle management)*	6	5	1	-	-	**12**
TOTAL	7	5	5	4	9	**30**

Notes: NR-Number of Respondents; * has previous work experience in other industries

Table 4: Technology Diffusion-Adoption Drivers

TECHNOLOGY	INDIVIDUAL	ORGANISATION	ENVIRONMENT
Relative Advantage	Demographics	Awareness	Competitors
Cost	Enjoyment	Capabilities	Government
Security	Experience	Culture And Norms	Industry
Quality	Fear and Anxiety	Leadership	Outsourcing
Complexity	Motivation	Top Management	Customer
Benefits	Personal Characteristics	CEO	Characteristics
	Resistance to Change	Strategy	Market
	Skills and Training	Human Capital and Skills	Partners
		Financial	Legal Issues
		Power	
		Change Management	
		Trust	
		Peer Support	
		Communication	
		Structure	
		Training and Education	
		Infrastructure	
		Job/Task/Project Characteristics	
		Process	
		Resources	
		Risk	
		Social	

Table 5: Technology diffusion-adoption drivers and sub-drivers of Individual
Level

DRIVERS	SUB DRIVERS	CITED IN
DEMOGRAPHICS	Age	(Tabak & Barr, 1999; Venkatesh, Morris, Davis, & Davis, 2003)
	Gender	(Ahuja & Thatcher, 2005; K. Davis & Songer, 2008; Jeyaraj & Sabherwal, 2008)
	Innovativeness	(Sepasgozar & Bernold, 2012; Verdegem & De Marez, 2011)
	Profession	(K. Davis & Songer, 2008)
EXPERIENCE	IT Expertise	(Jeyaraj & Sabherwal, 2008; Sheffer & Levitt, 2010; Venkatesh & Davis, 2000)
	Openness to Experience	(Patterson, 1999)
	Prior Experience	(Beaudry & Pinsonneault, 2005; Tabak & Barr, 1999; Talukder, 2012)
MOTIVATION	Behavioural Intention to Use	(Hameed, Counsell, & Swift, 2012a; Jeyaraj & Sabherwal, 2008; Venkatesh, 2000)
	Computer Playfulness	(Venkatesh, 2000)
	Determination to Succeed	(Amabile, 1983)
	Image	(Karahanna, Straub, & Chervany, 1999; Moore & Benbasat, 1991; Talukder, 2012)
	Independence	(Patterson, 1999)
	Intrinsic Motivation	(Jeyaraj & Sabherwal, 2008; Yousafzai, Foxall, & Pallister, 2007)
	Motivation to Use New Tech.	(Davis & Songer, 2008; Kamal, 2006; Talke & Hultink, 2010)
	Objective Usability	(Venkatesh, 2000)
	Overload	(Ahuja & Thatcher, 2005)
	Perceived Ease of Use	(Karahanna et al., 1999; Venkatesh, 2000)
	Perceived Playfulness	(Yousafzai et al., 2007)
	Perceived Usefulness	(Karahanna et al., 1999; Venkatesh, 2000)
	Perceived Voluntariness to Use	(Venkatesh, 2000)
	Performance Expectancy	(Venkatesh et al., 2003)
	Receive Intangible Reward	(Peansupap & Walker, 2005b)
	Receive Professional Credibility	(Peansupap & Walker, 2005b)
	Receive Tangible Reward	(Peansupap & Walker, 2005b)
	Relevance to Personal Job	(Peansupap & Walker, 2005b)
	Satisfaction	(Jeyaraj & Sabherwal, 2008)
	Tenure	(Frambach & Schillewaert, 2002; Yousafzai et al., 2007)
RESISTANCE TO CHANGE	Misunderstanding and Lack of Trust	(Gupta, Dasgupta, & Gupta, 2008)
	Not Being Aware of the Benefits	(Daim, Tarcan Tarman, & Basoglu, 2008)
	Parochial Self-Interest	(Gupta et al., 2008)
SKILLS AND TRAINING	Basic Skill of Using ICT	(Peansupap & Walker, 2005b)
	Educational Level	(Hambrick & Mason, 1984; Tabak & Barr, 1999)
	Personal Capability to Learn ICT	(Peansupap & Walker, 2005b)
	Skills and Knowledge	(Yousafzai et al., 2007)
ENJOYMENT	Enjoy Exploring New Tools	(Peansupap & Walker, 2005b)
	Enjoy Learning From Others	(Peansupap & Walker, 2005b)
	Enjoyment with Innovation	(Talukder, 2012)
	Perceived Enjoyment	(Venkatesh, 2000)
	Playfulness	(Jeyaraj & Sabherwal, 2008)

DRIVERS	SUB DRIVERS	CITED IN
FEAR AND ANXIETY	Anxiety	(Beaudry & Pinsonneault, 2005; Peansupap & Walker, 2005b; Venkatesh, 2000)
	Avoidance	(Jeyaraj & Sabherwal, 2008)
	Difficult, Complex or Frustrating to Use ICT	(Peansupap & Walker, 2005b)
	Effort Expectancy	(Venkatesh et al., 2003)
	Fear of Uncertainty	(Teo, Ranganathan, & Dhaliwal, 2006)
	Fear of Unknown	(Gupta et al., 2008)
	Job Relevance	(Hameed et al., 2012a)
	Job Rotation	(Hameed et al., 2012a)
	Job Security	(Gupta et al., 2008; Yousafzai et al., 2007)
	Job Task Difficulty	(Jeyaraj & Sabherwal, 2008)
	Job Task Variation	(Jeyaraj & Sabherwal, 2008)
	Losing Work Relationships	(Gupta et al., 2008)
	Power Concerns	(Attygalle, von Hellens, & Potter, 2010; Jasperson et al., 2002)
	Reduced Job Status	(Gupta et al., 2008)
	Trust	(Yousafzai et al., 2007)
PERSONAL CHARACTERISTICS	Computer Attitude	(Yousafzai et al., 2007)
	Individual Differences	(Venkatesh & Bala, 2008)
	Low Tolerance for Change	(Gupta et al., 2008)
	Personal Commitment	(Peansupap & Walker, 2005b)
	Personal Confidence	(Peansupap & Walker, 2005b)
	Personal Initiative	(Frese & Zapf, 1994)
	Personal Innovativeness	(Jeyaraj & Sabherwal, 2008; Talukder, 2012; Yousafzai et al., 2007)
	Personal Values	(Frambach & Schillewaert, 2002)
	Readiness for Change	(Davis & Songer, 2008)
	Response to Risk	(Sepasgozar & Bernold, 2012)
	Risk Propensity	(Tabak & Barr, 1999)
	Self-Efficacy	(Yousafzai et al., 2007)
	Self-Confidence	(Barron & Harrington, 1981)
	Tolerance of Ambiguity	(Barron & Harrington, 1981)
	Voluntariness	(Moore & Benbasat, 1991; Venkatesh & Davis, 2000)

Table 6: Agile Technology Diffusion Capabilities

Organisational Capability

R / Responsiveness

RA / Sense, Perceive and Anticipate Changes and Risks in the Environment

  RA1 / Monitoring and reporting (Internal & External)

  RA2 / Connectivity awareness

  RA3 / Analysis of risks and consequences

RC / Immediate Reaction to Change and Its Demands

  RC1 / Strategic vision and outcome expectancy

  RC2 / Information and knowledge management

  RC3 / Devolved and responsive decision-making

RR / Recovery from Change

  RR1 / Assessment of recovery needs

  RR2 / Development of recovery plan

  RR3 / Reorganisation

F / Flexibility

FH / Human Resources Flexibility

  FH1 / Ability to switch different positions-responsibilities (multi-skilled)

  FH2 / Quickly learn new procedures and solve specific problems

  FH3 / Change work habits as a response to changes in demands

FI / IT Flexibility

  FI1 / Development of an IT infrastructure design can handle changes in number of users, workloads and transactions

  FI2 / Development of an IT infrastructure that is modern and can be used by ease

  FI3 / Development of an IT structure that possesses electronic linkages among departments, branches and external parties

FP / Process Flexibility

  FP1 / Development of a range of possible solutions

  FP2 / Provide mobility

  FP3 / Provide uniformity

C / Competence

L / Leadership

  CL1 / Motivate staff to implement new technology

  CL2 / Development of a culture that supports new technology implementation

  CL3 / Development of trust

CM / Managing Change

  CM1 / Reengineering processes

  CM2 / Provide services and support

  CM3 / Development of communication

CS / Strategy Development

  CS1 / Development of IT/IS strategy

  CS2 / Development of HR strategy

  CS3 / Development of training strategy

Table 7: Mean Score, Standard Deviation and REI Findings

Organisational Capability	MS	SD	REI	RiC	RiT
R / Responsiveness					
RA1 / Monitoring and reporting (Internal & External)	3.850	0.852	0.770	2	16
RA2 / Connectivity awareness	3.833	0.711	0.767	5	21
RA3 / Analysis of risks and consequences	3.767	0.612	0.753	7	24
RC1 / Strategic vision and outcome expectancy	4.150	0.684	0.830	1	7
RC2 / Information and knowledge management	3.833	0.735	0.767	4	20
RC3 / Devolved and responsive decision-making	3.533	0.706	0.707	8	26
RR1 / Assessment of recovery needs	3.850	0.756	0.770	3	18
RR2 / Development of recovery plan	3.800	0.566	0.760	6	23
RR3 / Reorganisation	3.433	0.807	0.687	9	27
F / Flexibility					
FH1 / Ability to switch different positions-responsibilities (multi-skilled)	3.817	0.782	0.763	8	22
FH2 / Quickly learn new procedures and solve specific problems	3.850	0.778	0.770	7	17
FH3 / Change work habits as a response to changes in demands	3.750	0.626	0.750	9	25
FI1 / Development of an IT infrastructure design can handle changes in number of users, workloads and transactions	3.983	0.804	0.797	5	12
FI2 / Development of an IT infrastructure that is modern and can be used by ease.	4.233	0.653	0.847	3	6
FI3 / Development of an IT structure that possesses electronic linkages among departments, branches and external parties	4.283	0.691	0.857	1	4
FP1 / Development of a range of possible solutions	4.267	0.487	0.853	2	5
FP2 / Provide mobility	3.917	0.617	0.783	6	14
FP3 / Provide uniformity	4.150	0.589	0.830	4	8
C / Competence					
CL1 / Motivate staff to implement new technology	4.083	0.744	0.817	5	10
CL2 / Development of a culture that supports new technology implementation	3.883	0.691	0.777	8	15
CL3 / Development of trust	3.933	0.653	0.787	7	13
CM1 / Reengineering processes	4.067	0.653	0.813	6	11
CM2 / Provide services and support	4.300	0.761	0.860	2	2
CM3 / Development of communication	4.450	0.442	0.890	1	1
CS1 / Development of IT/IS strategy	4.117	0.691	0.823	4	9
CS2 / Development of HR strategy	3.850	0.745	0.770	9	19
CS3 / Development of Training strategy	4.300	0.664	0.860	3	3

Nb: MS- Mean Score of the existence where (1) strongly disagree (2) disagree (3) neutral (4) agree and (5) strongly agree
SD - Standard Deviation; REI - Relative Existence Index; RiC - Existence Level Ranking within core Capability group (**R**esponsiveness, **F**lexibility or **C**ompetence); RiT - Existence Level Ranking in Total.
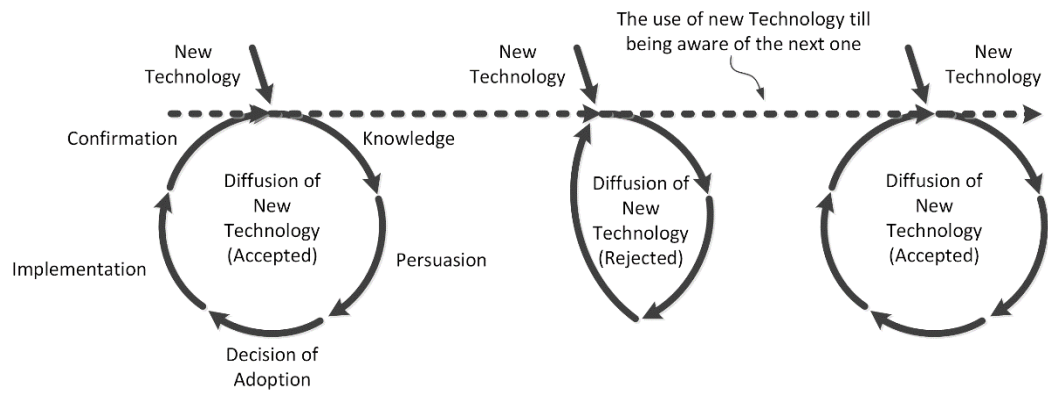
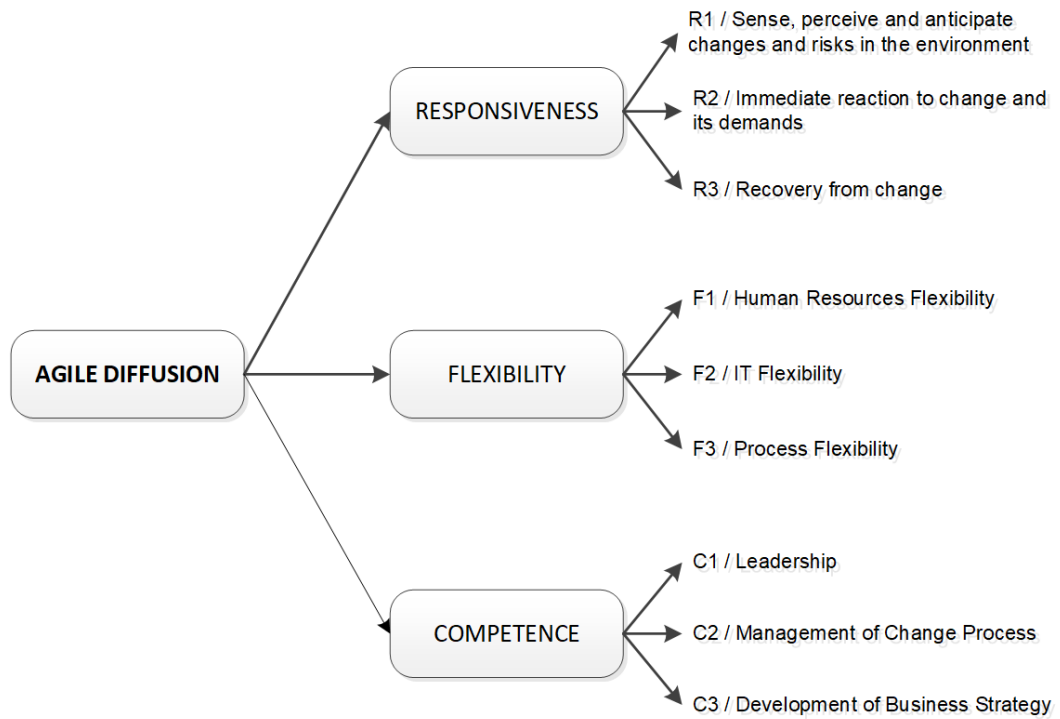Figure 1: Repetitive nature of technology diffusion.

Figure 2: Fundamentals of Agile Technology Diffusion (Ezcan et al., 2015)
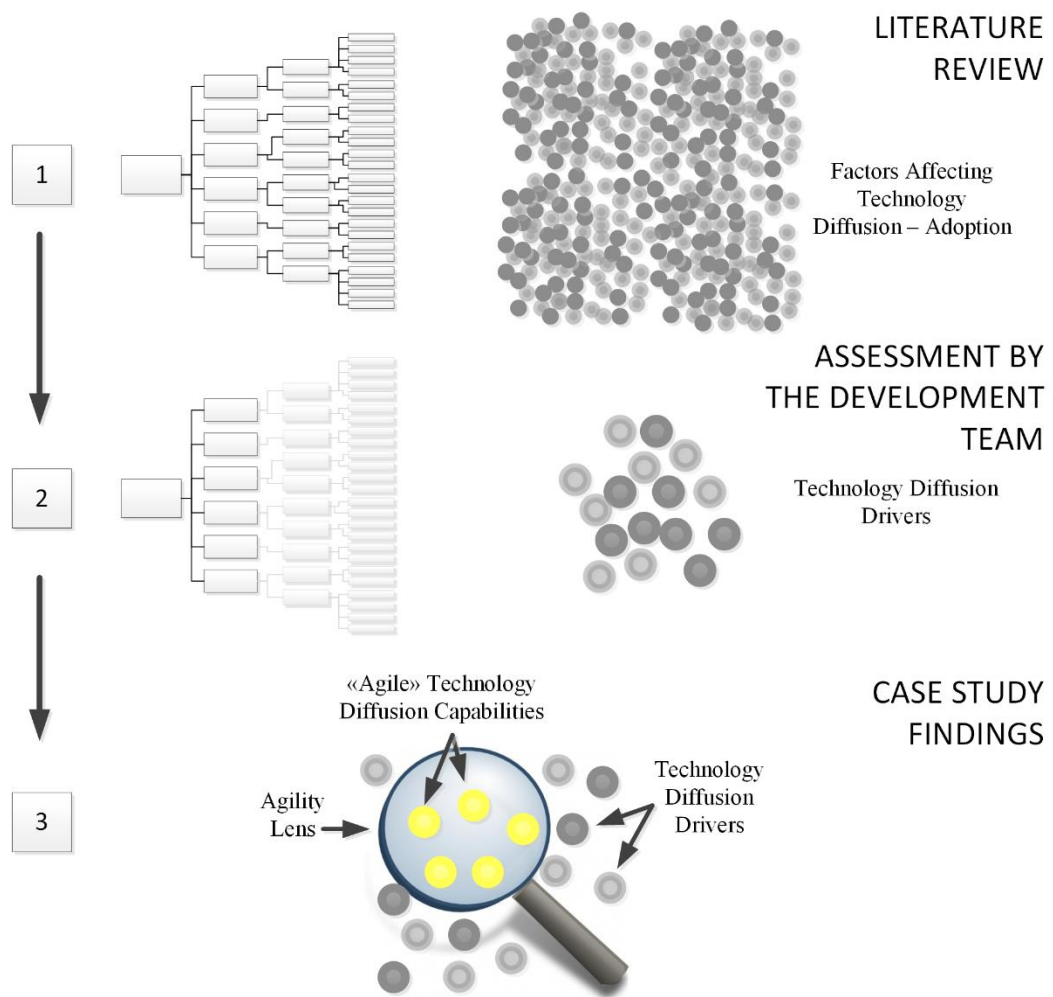
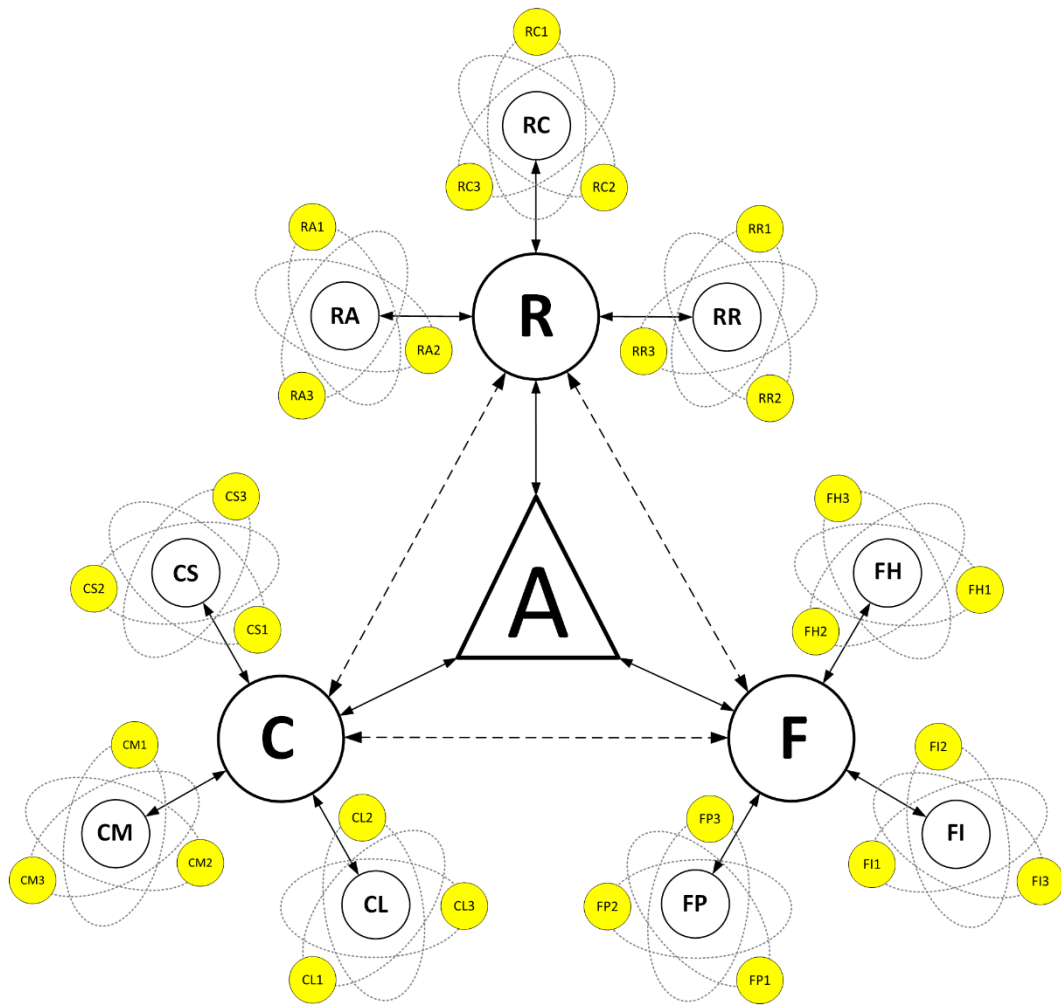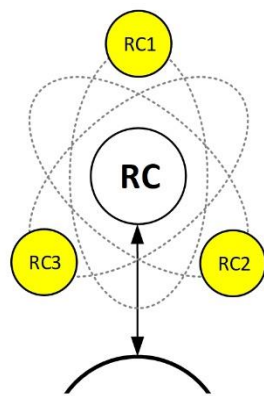Figure 3: Research Methodology: Three Phased Approach

Figure 4: Agile Technology Diffusion Framework

RA1 / Monitoring and Reporting (Internal and External)

An organisation's ability to be aware of (monitor and report); (i) the emerging technologies, trends and changes in the industry and (ii) the level of organisation's resources.

RA2 / Connectivity Awareness

Ability to be aware of an organisation's internal and external interdependencies/links in order to develop an understanding of the potential impact of 'change' on these connections.

RA3 / Analysis of Risks and Consequences

Ability to analyse the potential risks and the consequences of 'change' on organisational resources.

Figure 5: Sub-capabilities of RA

RC1 / Strategic Vision and Outcome Expectancy

Ability to define a clear vision for the organisation that removes uncertainty and provides clear direction for responding to a sudden change or crisis.

RC2 / Information and Knowledge Management

An organisation's ability to manage and share information and knowledge in order to provide transparent communication on decisions.

RC3 / Devolved and Responsive Decision Making

Assigning appropriately qualified staff to make independent decisions to improve the speed of response in case of sudden changes (where needed).

Figure 6: Sub-capabilities of RC
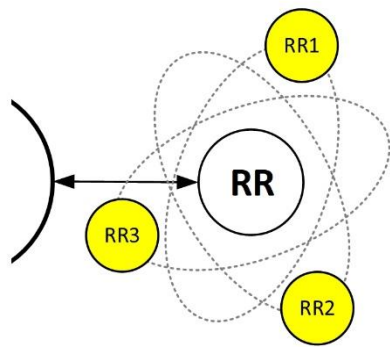
RR1 / Assessment of Recovery Needs

Assessment of recovery needs and resources to address the impact of sudden or unplanned change.
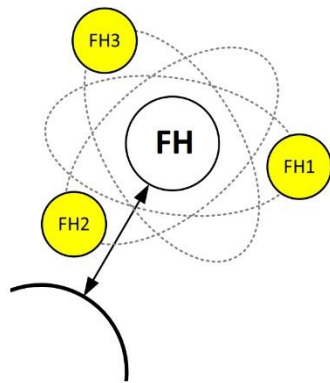
RR2 / Development of Recovery Plan

Development of a recovery plan that embraces the priority areas and the steps to be followed.

RR3 / Reorganisation

Implementation of the recovery plan and reorganisation of resources to meet the required state.

Figure 7: Sub-capabilities of RR

FH1 / Ability to switch different positions-responsibilities (multi-skilled)

Staff ability to work in different positions with wider responsibilities if needed.
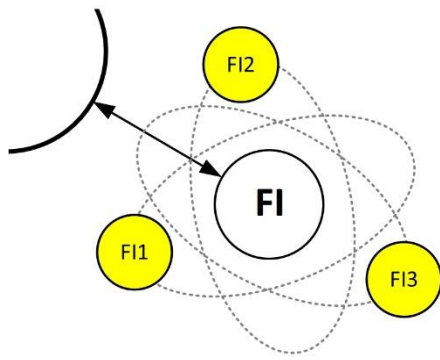
FH2 / Quickly learn new procedures and solve specific problems

Staff ability to learn new procedures in order to solve specific problems quickly.

FH3 / Change work habits as a response to changes in demands

Staff ability and flexibility to change work habits in response to new change requirements.

Figure 8: Sub-capabilities of FH

FI1 / Develop an IT infrastructure design to handle changes in number of users, workloads and transactions. (Scalability and Modularity)

Organisation's ability to develop an IT infrastructure design that can work efficiently despite changes in the numbers or users, workloads or transactions.

FI2 / Develop an IT infrastructure which is modern and can be used with ease.

Organisation's ability to develop an IT infrastructure which uses well-known modern hardware/software and that can be easily used.

FI3 / Develop an IT structure that possesses electronic linkages among departments, branches and external parties.

Organisation's ability to develop an IT infrastructure that enables advanced communication and interoperability between all departments, branches and external parties.

Figure 9: Sub-capabilities of FI
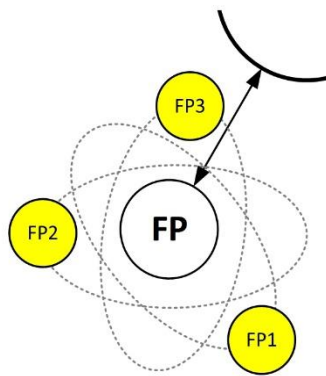
FP1 / Develop a range of possible solutions

Ability to provide a range of different solutions, pre-designed or just-in-time in order to respond to change.
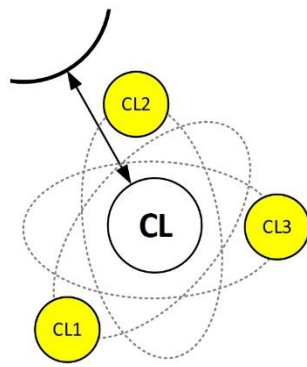
FP2 / Provide Mobility

Ability to provide different solutions within optimum time and cost impact.

FP3 / Provide Uniformity

Ability to provide similar results within (and across) alternative solutions.

Figure 10: Sub-capabilities of FP

CL1 / Motivation of Staff to implement new technology

Organisation's ability to motivate staff to implement new technology by providing support, empowerment and incentives.

CL2 / Development of Culture to support new technology implementation

Organisation's ability to develop a culture that supports new technology implementation, including: collaboration, power-sharing, participation in decision making, sharing knowledge, new experiences etc.

CL3 / Development of Trust

Ability to develop trust: (i) between colleagues to enable sharing information and discuss problems, and (ii) between colleagues and superiors to provide self-confidence in staff and reduce resistance to change.
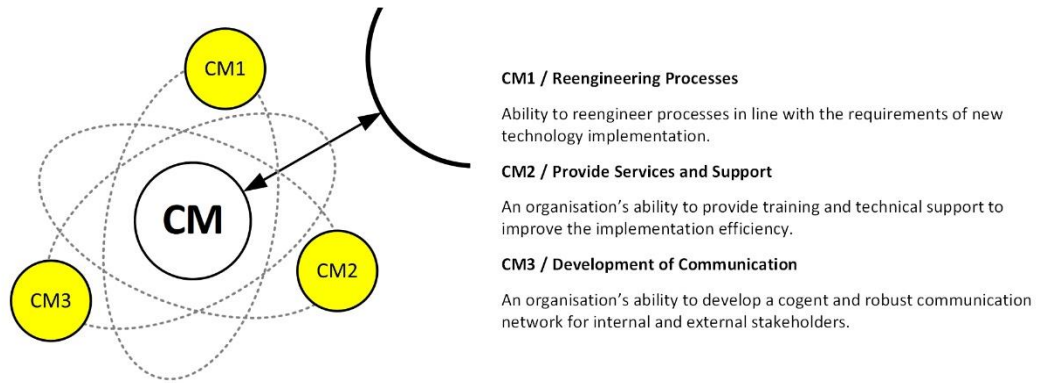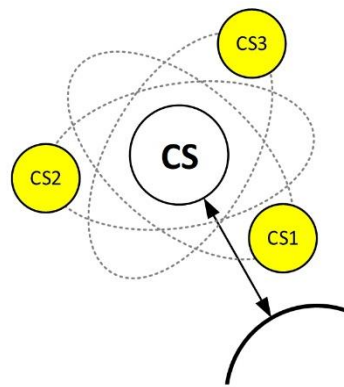
Figure 11: Sub-capabilities of CL

CM1 / Reengineering Processes

Ability to reengineer processes in line with the requirements of new technology implementation.

CM2 / Provide Services and Support

An organisation's ability to provide training and technical support to improve the implementation efficiency.

CM3 / Development of Communication

An organisation's ability to develop a cogent and robust communication network for internal and external stakeholders.

Figure 12: Sub-capabilities of CM

CS1 / Develop IT/IS Strategy

Ability to develop and implement an IT/IS Strategy that embraces the diffusion plan of new technology in alignment with the Business Strategy.

CS2 / Develop HR Strategy

Ability to develop and implement a Human Resource (HR) strategy focussed on staff readiness to deploy new technology to improve performance and deliver innovation.

CS3 / Develop Training Strategy

Ability to develop and implement a training strategy that focuses on not only improving organisational skills, knowledge and attitude towards new technology, but also on specific knowledge needed to deliver business success.

Figure 13: Sub-capabilities of CS