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Understanding Information Communication Technologies

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Despite the well known productivity paradox, information communication technologies seem to have had a significant impact on organisational performance in the last few decades. However research examining the value gained from these entities coupled with other firm resources is underdeveloped and problematic. Reviews of information communication technology and resource based view literatures are undertaken in order to provide an argument for future research examining information communication technologies utilizing the resource based view. Information communication technology research has largely failed to capture the true systemic and dynamic nature of these resources. New research directions are proposed utilising lessons from current research. In particular it is recommended that future research investigating information communication technologies is undertaken in organisations. Future research should be undertaken at a process level, taking multiple measures of performance into account. Additionally, longitudinal research should be undertaken to fully understand the path dependant nature of information communication technologies. There is no wonder debate on the productivity paradox remains because researchers have not been studying information communication technologies along these lines. If researchers continue to adapt more systemic ways for examining information communication technologies we can start to resolve the paradox.

Field of research: Management: Information communication technologies and strategic management

1.0 Introduction

While many different forces and factors have influenced the way businesses operate today, one of the biggest factors is certainly technology[i] (Keen 2000; Lin & Shao 2006). Today technology has enabled new business models and ways of working with secure, easily accessible, communications channels (broadband and wireless) and new platforms for collaboration with the likes of Web 2.0 (Balutis 2009). As a result, there are potentially many opportunities for new sources of competitive advantage to be developed when considering information communication technology investments. Notwithstanding an acknowledged downturn in spending on information technology in the 2000's "businesses around the world continue to spend well over $2 trillion" per annum on information communication technologies (Carr 2003, p 41). Moreover, Prastacos et al. (2002) posit that technology changes are occurring at increasing rates. This spending, coupled with the wide application of these technological developments

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has catalysed interest among information systems scholars and practitioners to understand the value derived from such innovations. In fact, as spending on information technology continues to rise so have the number of studies which have examined the value of such investments (e.g., Bharadwaj*, et al.* 1999; Bhatt & Grover 2005; Brynjolfsson & Hitt 1996; Devan & Min 1997; Devaraj & Kohli 2000; Francalanci & Galal 1998; Lin & Lin 2006; Mukhopadhyay*, et al.* 1995; Rastrick 2008; Sircar & Choi 2009; Skerlavaj & Dimovski 2006; Sohal*, et al.* 2000).

Researchers and practitioners have increasingly shown an interest in the role and effects of information communication technology investments (e.g., Carr 2003; Devaraj & Kohli 2003; Pavlou & El Sawy 2006; Powell & Dent-Micallef 1997). Amongst this interest is an ongoing debate as to whether information communication technologies have an impact on organisational performance. Such debate is often referred to as the "productivity paradox" of information technology[ii] (Brynjolfsson 1993; Brynjolfsson & Hitt 1998; Carr 2003; Dewan & Kraemer 2000; Due 1994; Hildebrand 1994; Mahmood & Mann 2000; Martinsons & Martinsons 2002; Sircar & Choi 2009; Thouin*, et al.* 2008). In his book Strassmann (1990) concludes there is no relation between spending on information technology, profits and productivity. More than a decade later the debate as to the value of information technology still soars. For instance, a recent Harvard Business Review article entitled "IT doesn't matter" (Carr 2003) prompted numerous letters to the editor with strong opposing views. As a consequence a great deal of discussion on the paradox of information technology is still evident today (e.g., Brynjolfsson & Hitt 1998; Carr 2003; Dewan & Kraemer 1998; Kevin*, et al.* 2007; Lin & Lin 2006; Lin & Shao 2006; Mahmood & Mann 2000; Martinsons & Martinsons 2002; Sarkis & Erik 2006; Sircar & Choi 2009; Thouin*, et al.* 2008).

Some empirical research in the area also helps fuel the perception that IT investments fail to live up to expectations (Brynjolfsson & Yang 1996; Kettinger*, et al.* 1994). In contrast, other researchers have demonstrated that information communication technologies are valuable (e.g., Alpar & Kim 1991; Barua & Lee 1997; Devaraj & Kohli 2000; Harris & Katz 1991; Lin & Lin 2006; Menon*, et al.* 2000; Rastrick 2008; Sircar & Choi 2009). The conflicting results suggest that researchers have large gaps in knowledge about the impact information technology has on most firms (Clemons 1986). Wilson (1995) concludes the general understanding of how information technology effects productivity is still extremely limited. Other researchers in the area also suggest knowledge is sparse (e.g., Brynjolfsson & Yang 1996; Devaraj & Kohli 2000) and there has been a call for further review and testing of information communication technology impacts, utilising frameworks from other fields (Barney*, et al.* 2001; Bharadwaj 2000; Jarvenpaa & Leidner 1998; Mata*, et al.* 1995; Powell & Dent-Micallef 1997; Rastrick 2008). Furthermore, if an investment in information systems is made, little is known about what the source or sources of any such advantage may be (if any) (Rastrick 2008).

Current research examining the value of information communication technologies is thus underdeveloped and problematic. Many researchers have failed to understand the embedded and interconnected nature of information communication technologies and have examined them in isolation from other resources. Research has also tended to examine information communication technologies at a point in time. Yet there is

growing recognition that information communication technologies are interconnected and path dependant (constrained by the resource's history) in nature. New research is required to develop this area and address these shortcomings. The resource based view, from the strategic management literature, shows promise as a lens to utilise in future information communication technologies research. While some early studies taking this approach have already been done (e.g., Rastrick 2008; Ray*, et al.* 2004), they remain underdeveloped. The resource based view has the potential to show researchers how to examine interconnected and path dependant resources. The paper provides a review of current research examining information communication technologies and organisational performance identifying key differences and challenges within current research. The resource based view is also reviewed as an alternative lens to utilise in future studies examining information communication technologies and organisational performance. Finally, a summary is provided outlining key characteristics required of future research along these lines.

2.0 Information Communication Technologies and Organisational Performance

As just mentioned, the number of studies which examine information communication technologies and their performance effects can be described as plentiful. Despite such a large research effort the results of studies addressing the organisational value of information technology are inconclusive and conflicting (Lin & Shao 2006). The contradicting findings can be somewhat attributed to differences in research design. Many other researchers support such a notion suggesting that research designs of current studies have had a large impact on the results and subsequently the researcher's ability to understand value derived from information technology (Lee & Barua 1999; Loveman 1994; Melville*, et al.* 2004; Mukhopadhyay*, et al.* 1997; Papp 1999; Rao*, et al.* 1995; Rastrick 2008). To date, empirical studies examining the effects of information technologies on organisational performance have addressed many different aspects of information systems and been measured in a variety of ways. Therefore, it is not surprising that such studies have found mixed results. Differences in empirical approaches include variables such as: definitions of information communication technology, the level of an organisation at which the information communication technology is used, and measures of information communication technology value or performance effect. Research designs have also varied greatly in timeframes. Each of these differences is presented in Table 1 and briefly explored below.

Table 1: Significant differences in current research examining the effects of information technologies on organisational performance

Difference	Current Research	Suggestions for Future Research
Definition of ICT	Largely global measures or definitions such as IT expenditure equals IT usage in organisations (e.g., Harris & Hatz, 1998)	Examine specific technologies in context
Unit of analysis	Current research vary from industry (e.g., Kelley 1994), firm (e.g., Dewan & Min 1997), process or routine as a unit of analysis (e.g., Ray, *et al*. 2004)	While other levels are useful for different things research wishing to examining the link between ICT and competitive advantage should consider the process or routine as a unit of analysis which is where the immediate contributions are seen
Measures of ICT	Large variance is seen in current research from a single global measure (e.g., Bender 1986) to groups of measures (e.g., Ray, *et al*. 2004)	Future research should use a range of financial and non-financial measures
Timeframe	Largely snapshots in time (e.g, Prattipati & Mensah 1997)	Longitudinal studies which allow for the delay in seeing a return on investments

Perhaps the most important difference in the research design of studies of information communication technology is how they are defined and therefore the way in which they are considered. Despite such a quantity of studies, most of the research examining the influence of information communication technologies on organisations has been criticised for the overly simple way in which they are examined. A common approach to examining information communication technologies seen in current research include using information communication technology expenditure as a measure of information communication technologies in organisations (e.g., Bender 1986; Harris & Katz 1988; Lucas 1975; Lucas 1975; Roach 1988; Strassmann 1985; Turner 1985). However it is clear information communication technologies differ in purpose and nature. Information communication technologies have been employed in organisations to meet both operational (e.g., logistics scheduling) and strategic (e.g., providing new services) purposes. The nature of information communication technologies range from narrow (e.g., ATM's) to organisational wide (e.g., enterprise wide systems) applications. Furthermore, it is likely that usage of information communication technologies may also vary substantially across industries, organisations, or even processes (Devaraj & Kohli 2003). Since not all information communication technology investments are alike they are likely to be related to an organisation's performance in different ways. Therefore, the single measure of information technology investment may not signal anything to do with the effectiveness or value of information technology in organisations.

Theoretically, some spending may lead to competitive advantages, while other spending may not. Therefore, broad measures such as information communication technology spending are likely to mean little. This means a different approach to examining information communication technologies is required. In fact, calls have been made by practitioners and academics to develop more inclusive and comprehensive approaches to examining the potential of information technology to contribute to organisational advantage (Brynjolfsson 1993; Lucas 1999). Gunnarsson et al. (2001) and others (e.g.,

Bresnahan*, et al.* 1999; Brynjolfsson 1993; Griliches 1969; Lucas 1999) surmise that too much attention has been paid to the *technology* in information technology when researchers should be examining information technology and human capital. Extending this argument, Wade and Hulland conclude that information systems "exert their influence on the firm through complementary relationships with other firm assets and capabilities" (2004, p 109). That is, information systems do not lead to a competitive advantage in themselves but by forming part of a complex chain of resources and capabilities which in turn may lead to a sustained competitive advantage. Therefore the simplistic approach undertaken in much of the research to date provides a significant gap for researchers to explore.

Additionally, the unit of analysis has varied significantly in current research examining information technology and organizational performance. Four main units of analysis can be seen in current research, in descending order of scope: industry (e.g., Kelley 1994), firm (e.g., Dewan & Min 1997), process, and routine (e.g., Ray*, et al.* 2004). Despite these alternatives open to researchers, process level studies have grown in popularity (e.g., Barua*, et al.* 1995; Barua & Lee 1997; Kohli & Sherer 2002; Mooney*, et al.* 1995; Mukhopadhyay*, et al.* 1997; Pavlou & El Sawy 2006; Ray*, et al.* 2005; Soh & Markus 1992; Tallon*, et al.* 2000). In fact, many researchers have recommended the use of process-oriented models of value (Bakos 1987; Barua*, et al.* 1995; Devaraj & Kohli 2003; Mooney*, et al.* 1995; Mukhopadhyay*, et al.* 1997; Ray*, et al.* 2002). Industry level studies may allow further understanding of differences between technology usage in different industries. Firm level studies may provide a meta understanding of technology. However, a process view is the most appropriate for understanding information communication technologies and their interconnections with other resources. The process view outlines how the impact of information communication technology investments should be measured at the source of the value, and therefore should be measured at their intermediate (i.e., process) level contributions. In this way many researchers have found effects of information technology at this level (Barua*, et al.* 1995; Crowston & Treacy 1986; Kauffman & Kriebel 1988; Mukhopadhyay & Cooper 1992; Mukhopadhyay & Cooper 1993).

The question of how to measure benefits or performance effects (or links to competitive advantage) from business spending on information communication technologies has been raised by many scholars and practitioners (e.g., Hawawini*, et al.* 2003). The primary reason for the problem is the variety of social and economic measures which can be applied to value information communication technologies, or in fact, measuring the performance of any organisational asset (Zammuto 1982). Thus, the varying methods of measuring performance or advantage reflects a significant challenge to the area of information communication technology research. Weill and Olson suggest many different combinations of measures have been used, often with "more regard to convenience than appropriateness" (1989, p 6). Measures of information communication technology value range from a single global measurement (e.g., Bender 1986) to a group of measurements (e.g., Corn & Sobol 1983). Bender (1986) used the ratio of expenses over premium income as a single measure of information communication technology value. In other studies, productivity, consumer value, and business profitability have been used as a measure of value, either individually or as a group of factors (Hitt & Brynjolfsson 1996). Some researchers believe one measure of performance will not capture all factors that contribute to value (Turner 1985; Zammuto 1982). Consistent with this more complex view of information communication technology value (one measure will not capture all factors), Corn & Sobol (1983) use four measures of information technology value: pre-tax profits; return on assets, return

on net worth, five-year growth rates. In a move from financial measures of information communication technology value Ray et al. (2002) measure performance as a function of customer service, using several measures of performance: a widely used scale, measurement of retention of clients, and a self confessed measure of customer service.

Timeframe differences in current research are also problematic. While information communication technology resources are recognised to be complex and often path dependant (constrained by the resource's history), current studies are largely snapshots in time (e.g., Prattipati & Mensah 1997). Consistent with a more evolutionary view of performance measures some researchers call for a historical or longitudinal study to cope with the circular nature of information communication technology investments and firm performance (Weill 1992). It is widely anticipated that investments in information communication technologies may not show a positive payoff for several years after implementation (Brynjolfsson & Yang 1996).

It is clear to see that any one of these issues (definition of information communication technology, units of analysis, measurement of information communication technology value, and timeframe) let alone a combination could lead to inconsistent findings in a study of information communication technologies in organisations. Despite such empirical differences there is a common chorus suggesting that the value of information systems lies in its relationship with other organisational assets (e.g., Keen 1993; Powell & Dent-Micallef 1997; Rastrick 2008; Ray*, et al.* 2005; Walton 1989). Keen (1993) argues the key to information communication technology success lies in the capacity of organisations to combine information communication technology with existing organisational advantages. Waltson (1989) supports this by commenting that information communication technology success depends on the integration of resources. Powell & Dent-Micallef (1997) suggests human and business resources combine with information technologies to produce competitive advantage through the integration of resources. Ray (2000, p ii) also concurs with this, commenting that information communication technology resources used in a "process, individually and in interaction with non – IT resources, explain process performance".

In summary, information communication technologies are thought to be valuable while viewed in combination with other organisational resources and capabilities (Barua*, et al.* 1996; Brynjolfsson & Yang 1997; Kearns & Lederer 2003; Melville*, et al.* 2004; Milgrom & Roberts 1990; Powell & Dent-Micallef 1997; Ray*, et al.* 2005; Walton 1989), which means broad measures and high level studies of information communication technologies are not appropriate. Therefore, developing more inclusive and comprehensive models of information communication technologies in organisations at the level of the business process would make a significant contribution to information communication technology research. Since conceptual and early empirical work along these lines has begun it seems timely to take lessons from current research and look for new ways to proceed. This means information communication technologies should be examined *in* organisational contexts, at the level of the business process, and using multiple measures of performance as a reference. Moreover such research should be of a longitudinal nature. Furthermore, a significant opportunity may be to utilise frameworks from other fields such as the resource based view from the strategic management field (Barney*, et al.* 2001; Bharadwaj 2000; Jarvenpaa & Leidner 1998; Mata*, et al.* 1995; Powell & Dent-Micallef 1997). This paper reviews the resource based view because of is focus on understanding value and interconnections of organizational resources. In addition if research is to use a process approach the resource based view which allows for this level of understanding of resources, is an appropriate way forward.

3.0 The Resource Based View and Information Communication Technologies

The resource based view provides an alternative and effective way to consider information communication technologies in organisations. The resource based view states that advantages are gained in organisations that utilise resources and capabilities which are unique, inimitable and unevenly distributed (Barney 1991). Applications of the resource based view have focused on several different facets of business including: firm verses industry effects, the impact of resources and capabilities, corporate strategies, international strategies, strategic alliances, and rules for riches (Barney & Arikan 2001). Resource based view applications which examine the impact of different resources and capabilities have the potential to aid research in understanding information communication technologies and organisational performance. Research which explores the impact of different resources and capabilities is primarily concerned with identifying strategic assets, that is, identifying specific resources which, when analysed utilising resource based logic are valuable, rare, and imperfectly mobile.

While there has been a long history of theoretical discussion of the resource based view (e.g., Andrews 1971; Barney 1991; Lippman & Rumelt 1982; Nelson & Winter 1982; Penrose 1959; Stinchcombe 1965; Teece 1980; Teece 1982; Wernerfelt 1984) only in the last ten years has the field been advanced by a stream of empirical investigations (e.g., Cheah*, et al.* 2007; Cockburn*, et al.* 2000; DeCarolis & Deeds 1999; Eisenhardt 1989; Hatch & Dyer 2004; Hult & Ketchen 2001; Khandekar & Sharma 2005; Kim*, et al.* 2006; Lorenzoni & Lipparini 1999; Schroeder*, et al.* 2002; Wiklund & Shepherd 2003). The late growth of empirical applications can somewhat be attributed to problems of identifying and understanding valuable resources. Measurement of resources and capabilities in empirical work of the resource based view varies extensively in current research (Hoopes*, et al.* 2003). This is not surprising since identifying and measuring resources can be problematic. Understanding where to look for resources and capabilities and how to measure what is found is of significant concern to the field. Sources or ways of identifying resources and capabilities used in current research include management information systems and financial balance sheets (Grant 1991), archival proxies (Miller & Shamsie 1996), structural equation modeling (Hult & Ketchen 2001; Hult*, et al.* 2002), asking research participants (Hall 1992), and by way of the researcher's own observations (Hall 1993).

In search of understanding the impact of different resources and capabilities researchers have aimed to address specific issues in different contexts. Examples include Prahalad and Hamel's (1990) use of the resource based view to study diversification, Hart's (1995) use of the resource based view in environmental management, and Christensen's (1995) study of innovation based firm resources. Studies have also been applied to a number of disperse fields such as human resource management (Wright*, et al.* 2001) and entrepreneurship (Alvarez & Busenitz 2001); and examined several different industries such as pharmaceuticals (Henderson & Cockburn 1994) and retail (Powell & Dent-Micallef 1997). Several specific types of resources have also been examined for their effect on performance. Resources examined include; an organisation's culture (e.g., Moingeon*, et al.* 1998), employee know-how (e.g., Glunk & Wilderom 1998; Hall 1992; Hall 1993), and entrepreneurial skills (e.g., Hoskisson*, et al.* 2000), and many more.

Of note there have been several applications of the resource based view focused on information communication technologies. Current research has examined information communication technology related aspects such as; business strategies, specific technologies, IT infrastructure, online social structures, and the broad effects of information communication technologies. For instance, Christianse and Venkatraman (2002) used the resource based view to examine whether locking in customers and suppliers with information technology was an effective strategy. Similarly, Wade and Gravill (2003) examined IT firms which were diversifying internationally. He (2004) utilised the resource based view and developed a three tier model of enterprise resource planning system challenges. Broadbent et al. (1999) examined the extent of IT infrastructure and its effect on the organisation. Butler (2001) uses resource based logic to examine online social structures. Bharadwaj's (2000) research used a broad measure of IT and linked that to performance.

Studies which examine specific information communication technology resources as sources of advantage are also emerging. For example, Ray et al. (2004) found that intangible and socially complex capabilities such as service climate and managerial IT knowledge, are positively related to customer service performance. Many others have suggested linkages among information communication technology resources and suggested that the coupled resources lead to a competitive advantage (but do not test the link between the group and performance or sustained competitive advantage). For instance, Bharadwaj et al. (1998) outlines an IT capability construct made up of six elements (IT business partnership, external IT linkages, business IT strategic thinking, IT business process integration, IT management, and IT infrastructure). Armstrong and Sambamurthy (1999) examine the influences of senior leadership, sophistication of IT infrastructures and organisational size on IT assimilation. Rastrick (2008) examined information communication technology resource combinations suggesting that an integrated group of resources and capabilities is a likely source of competitive advantage.

As outlined researchers have demonstrated usage of the resource based view in information communication technology areas, most do not focus on identifying valuable information communication technology resources. What is missing is research which specifically focuses on identifying interconnected resources and capabilities *and* linking these to value or competitive advantage. Two emerging streams of resource based view research, dynamic capabilities and the knowledge based view, specifically address the combination or linkages between resources and capabilities. More specifically, dynamic capabilities research suggests that value is gained when resources are utilised in coupled and innovative ways (Eisenhardt & Martin 2000; Miller 2003; Teece*, et al.* 1997). The KBV also adds to this suggesting that knowledge resources are a critical part of interconnected routines (Conner & Prahalad 1996; Grant 1996; Grant & Baden-Fuller 1995; Liebeskind 1996; Spender 1996; Spender 1996; Wright*, et al.* 2001). This research which emphasises the complexity and interconnectedness of organisational resources may provide guidance for future research. More specifically these research streams suggest that knowledge acquired through change and implementation of resources and knowledge of the change process itself will be key sources of competitive advantage. This has direct application to information communication technology resources which as already outlined are faced with constant change. If resources associated with knowledge and change are likely to be sources of advantage examining information communication technology processes to create and apply change in organisations is necessary for advancing the research area.

While clear advances to the resource based view (such as understanding how to examine and measure resources, and understanding linkages between resources and capabilities) have been made, a striking gap in the current research is the lack of qualitative contributions in general and in information communication technology related research in particular. Most of the empirical studies undertaken have been large scale surveys or employed other quantitative methods (e.g., Dewan & Kraemer 1998; Rai*, et al.* 1997). This methodological gap appears despite many calls for more diversity in methods (Chan 2000; Powell & Dent-Micallef 1997; Rouse & Daellenbach 1999). For instance, Powell and Dent-Micallef (1997) comment that the field would benefit from the use of alternative methodologies. Rouse and Daellenbach (1999) more specifically state that large scale, multi-industry studies are not appropriate for resource based view research. This is due to the nature of resource based advantages, which by definition, implies advantages are organisational in origin and are complex. If resources we seek to examine are so embedded in organisations, how can we hope to analyse them if not by being in organisations? Indeed, researchers recommend more field based methods be employed which would help provide "in-depth knowledge and understanding of the organisation and its processes" (Rouse & Daellenbach 1999, p 489). In her review of the field Chan (2000) also recognised that the field may not be fully understood without more qualitative contributions to the conversation.

In summary, resource based view research to date faces challenges about the simplistic way in which resources are examined. However, recent conceptual and empirical resource based view research developments start to shed light on *how* valuable resources are combined with other organisational resources to create competitive advantages. The dynamic capabilities approach and the knowledge based view outline new places to search for sources of advantage. Employing a qualitative research design would also contribute to another significant gap in current literature. None of these issues have been adequately dealt with in current information communication technology research. The next section provides a brief review of the contributions from each of these bodies of work and suggests a further research agenda to further the conversation in this area.

4.0 Examining Information Communication Technologies in the Future

Given the ongoing interest and spending on information systems in organisations there is little doubt that understanding these entities in more detail is valuable. It is also evident that these resources should not be examined in isolation which has presented significant challenges to researchers in the past. Drawing from lessons from prior information communication technology research it is clear that research should be undertaken at the level of the business process. Moreover it is important that future researchers consider multiple measures of performance beyond balance sheet figures. Current research also suggests that future studies should be of a longitudinal nature.

Problems associated with understanding organisational resources are not unique to the field of information systems. Strategic management researchers have faced similar challenges; however advances in this field (particularly in the area of the resource based view) have something to offer information communication technology research going forward. In particular, recent conceptual and early empirical resource based view research outlines new places to look for interconnections among resources and capabilities. It is not surprising then that work is emerging in this area taking heed of lessons from the resource based view and applying it to information communication technology research. As outlined, conceptual and early empirical work is beginning to

utilise the resource based view as a lens for studying information communication technologies. Research currently examines business strategies and board effects of information communication technologies. While work at the intersection of these two areas is growing, it is important to note that research with a specific focus on identifying valuable resources and capabilities utilising the resource based view is sparse. Moreover, qualitative research utilising the resource based view would be a fruitful way forward. More specifically, what is needed is the use of in-depth fieldwork in organisations.

In summary, research which takes notes of the lessons from each of these bodies of work would make a significant contribution to understanding information communication technologies in organisations. What is needed of future research is prolonged engagement in organisations to examine information communication technology resources in combination with other organisational resources. Furthermore a longitudinal study would allow analysis of the changes to resources and capabilities along with an appreciation of the effects on multiple measures of performance over time. As outlined current research is underdeveloped and lacks longitudinal studies to fully understand the path dependant nature of information communication technologies. Current theory suggests that knowledge and change which would be observed in research such as this is where true sources of advantage lies. Appropriate methodologies for such studies include case studies, grounded theory or action research *in* organisations. Applying a unified study such as this in the information communication technology context would help researchers and practitioners to gain a better understanding of information communication technology based resources, how firms develop these over time, and how they can lead to competitive advantages. Gaining such an appreciation of the sources of information communication technology value has obvious significance to practitioners. Since it is their role to leverage organisational resources and accumulate, develop and protect strategic resources, identifying valuable organisational resources and capabilities and how they are connected becomes critical to senior managers successfully completing their roles.

5.0 References

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[i] The terms ‘technology’, ‘information technology’, and ‘information communication technology’ are used interchangeably in this paper as is the case in much of the literature.

[ii] For an extensive discussion and review of the productivity paradox see Brynjolfsson and Hitt (1998).