NEW ZEALAND INSTITUTE FOR THE STUDY
OF COMPETITION AND REGULATION INC.

Information and Communications Technologies in New Zealand:

Nine Case Studies

Overview

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Executive Summary

The nine case studies[1] in this research span a wide variety of business size, type, sector, product and focus. Together, they provide some cogent lessons for both businesses and policy-makers

Lessons for Businesses

There is no one single formula for successfully investing and implementing ICTs. However, the one factor linking all the successful firms was quality of their human capital. There is no substitute for business managers and decision-makers knowing their own business and industry, as this enables them to select, customise and prioritise the development. There is also no substitute for having knowledgeable and experienced staff participating in the development and implementation of ICT applications, and an organisational commitment to ongoing training and learning in both ICT and other organisational systems. Investing in ICTs without the requisite level of business, industry and environmental understanding, and staff knowledge and commitment, is little better than investing in a lottery.

Successful implementation and use of ICTs is contingent upon the extent to which managers and decision-makers first know and understand the characteristics of their product, business, industry and trading environment. If managers and decision-makers understand their individual 'value chain', then they will be clear about the ways in which they derive value from their businesses, how information contributes to this process, and therefore have a much clearer understanding of both where the ICTs will fit in their individual value chain, and the extent to which they can add to the value created. This positions them to be better able to manage the costs, risks and opportunities that they face in their businesses.

When this degree of clarity is present, then it is much more likely that the firm has both a clear strategy to guide its decisions and operations, and a fuller understanding of the

[1] Whilst nine organisations were studied, due to confidentiality requirements, only eight studies are reported in the public version of the paper.

ways in which any technology fits into the value-creating process. Thus, the technology purchase and implementation becomes an integral part of the firm's strategy, whether it is the use of a technology to gain a competitive advantage or investment being undertaken merely to "keep up with the state of play in the industry".

Firms with this level of understanding will be better placed to implement ANY new technology successfully. The technology purchase is much more likely to be based upon a well-reasoned analysis, and implementation planned and prioritised in such a way that the most valuable or the most fundamental components are installed first. Thus, success is more likely. Notably, well-reasoned analysis also reduces the probability of a firm investing in a technology merely because it exists or because it has been implemented elsewhere. Knowledge of specific firm and industry characteristics will mean that reasoned abstention from specific purchases can be a profitable strategy in some circumstances. Knowing what these circumstances are is critical.

Whilst none of these characteristics are unique to ICT investment, if these mechanisms are in place, then the probability of a successful ICT investment and implementation is increased. If the purposes underpinning ICT investment are well understood, then it is more likely that the firm is both receptive to the need to invest in complementary systems in order to make the ICT investment work successfully, and has put in place processes to monitor and adjust complementary systems to align with the new investment.

The quality of business analysis and decision-making available to businesses is critical to successful ICT implementations. However, the requisite human skills are generic business skills, not specialist ICT technology skills. There is little evidence from the case study companies of difficulty in accessing ICT specialists, yet almost all noted a significant difficulty in recruiting staff with sufficient business and industry knowledge, experience and skills, particularly in risk management, change management, and process analysis and improvement. The significant problem for New Zealand appears to be lack of skilled and experienced business 'knowledge workers'. Whilst firms were prepared 'grow their own' knowledge workers, they are vulnerable to loss of these skills to other markets with higher salaries, compromising the total knowledge and

experience level of the New Zealand management stock and hence the calibre of decision-making, and raising internal training costs. Poor decision-making undoubtedly increases the costs of both implementation and failure in ICT investments.

Lessons for Policy

The businesses that participated in the case studies were unanimous in their opinion that there was little that the government has or could have done by way of an ICT policy that would have made any difference at all to the ways in which they undertook the decision to invest in ICTs or the implementation of their respective systems. The consensus was that the government had no role to play beyond its broad responsibilities to provide a sound and certain legal and commercial environment in which they could undertake their business operations. Principally, the participating companies reported few problems with accessing infrastructures necessary for their activities, and none reported inability to access sufficient suitably qualified technical staff for their activities. Thus, there was little apparent need for policy intervention in the infrastructure or ICT technical skills markets.

However, the participants do see a role for Government in promoting an educational environment and national culture where 'commercial literacy' is as fundamental to educational achievement as general literacy and numeracy. Unless all participants in the economy have an understanding of the interrelationships between business activity and living standards, then it will be difficult to overcome the difficulties of owners, managers, policy-makers, employees, voters and consumers making less than optimal decisions and operational actions as a consequence of lacking the skills to effectively analyse their position, their business, its industry and the environment. This is vital for any economy, but the need for greater understanding is highlighted by the emergence of a 'knowledge economy' that is causing all businesses to refocus on the ways in which wealth is created.

Participants also saw a role for government in promoting information exchange and education about the ways in which information contributes to value as a fundamental underpinning of the move from an economy based upon measuring tangible outputs made by machines to one based upon the use of information by knowledge workers to

create knowledge outputs. This understanding needs to be technology-agnostic: computers are only one form of ICT – human beings are information processors, and skilled humans are an integral part of growing value in an information economy.

'Knowing one's business' is especially important for Government, which must balance its responsibilities as policy-maker, regulator and participant in markets where information is fundamental to value-creation. Unless government understands these issues, then the participants perceive a risk of government intervention harming, rather than helping, progress. To this end, participants have cited cases where legislative barriers are impeding the accrual of benefits: specifically in relation to electronic authentication within government activities, and where the lack of understanding of how information-based companies generate revenue in an information economy is biasing the funds available to support the 'knowledge economy' towards equipment and software makers ('things') at the expense of firms that use knowledge to make information products.

One of the participants draws particular attention to the role conflict of government as the owner of information, which can stimulate the creation of new knowledge products and wealth-creating opportunities, whilst simultaneously owning the research-based Crown Research Institutes from which it requires a profit. This dual responsibility creates a tension that draws into sharp relief the responsibility of the government as promoter of research and development using that information for the public good, with its role as owner of information property developed from that information that may result in the information being kept from those who might compete with the government research entities to create and commercialise new and different applications based upon the same information.

As the major participant in the knowledge-intensive health and education sectors in New Zealand, the Government has the responsibility to act as a knowledgeable operator in its own right. By acting as a role model, and building its own knowledge-based industries, the government can contribute to the total knowledge base in New Zealand. It can also take a lead role in enabling and modelling new industry forms, such as joint ventures and pilot projects, in these areas, that reflect the different approaches required to the research and development of knowledge-based products,

which necessitate a different approach to risk management to the research and development required for tangible products.

These actions will provide the underpinnings not just of a sound economy utilising ***electronic ICTs***, but also for a sound ***'information and knowledge-based economy'*** from which all New Zealanders will benefit.

Introduction

"Business people don't want to become software and hardware experts. What they do need is simply implementable systems that are robust and easy to correct if a mistake is made. …. The challenge is to be able to translate from the techno guru to the practical usage". (Locke, 2002: 4).

Information and Communication Technologies (ICTs) are becoming increasingly ubiquitous in society. Their increasing ubiquity in specific firms, industries and countries has been strongly anecdotally (and to a lesser but still significant extent in certain parts of the academic literature[2]) associated with these firms, industries and countries reaping greater benefit from their ongoing investments in ICTs and more widespread use of technologies such as the Internet and Intranets than those which have not pursued ICT investments and utilisation with such vigour (OECD, 2002: 13). As capital investment by firms in ICTs (including in some instances both hardware and software) is measurable and typically captured within national accounts, whilst their proportionate contribution to value added in outputs that utilise the investments is less easy to discern (Haltiwanger and Jarmin, 2000; Triplett, 1998), investments in infrastructure have become de facto proxies for comparing the relative potential of firms, industries and countries to accrue the presumed benefits.

The presumption that ICT investment leads directly to greater levels of benefit accrual by the investing entities has thus spurred the development of a plethora of national and international Information Economy policies designed to encourage firm and industry investment in ICTs[3]. If some investment in ICTs has been shown to yield increases in output values, then *ipso facto*, these policies often presume that greater investment in infrastructure should deliver even greater benefits. Even though the literature cautions that investment in infrastructure requires complementary investment in hard-to-measure intangible factors such as human capital, organisational structures and commercial environments in order to yield the anticipated output gains (Haltiwanger and Jarmin, 2000; Brynjolfsson and Hitt, 2000; Brynjolfsson and Hitt, 2002), the

[2] For a more detailed discussion on the findings in the academic literature, see the subsequent section on Theoretical Development in this paper.
[3] New Zealand, for example, has a separate ICT strategy that sits within the ambit of both the Information Society and Economic Development strategies.

'success' or 'failure' of information society policies still tends to be determined to a significant degree by the extent to which tangible investments have been made in infrastructure.

By such input measures, New Zealand's prevailing Information Society policies should be adjudged as highly successful. New Zealand has led the OECD for much of the last decade in the percentage of GDP spent on ICTs (OECD, 2002: 48). New Zealand's firms are very high subscribers to, owners of, and users of: telephones (fixed and mobile), computers, the Internet and broadband connections (ITU, 2003; Howell and Obren, 2003; Howell and Marriott, 2002) relative to comparator countries such as Australia and the United Kingdom (spectacularly so when controlling for firm size – Howell, 2003a). It is apposite to note that the decade from 1992 to 2002, the same period in which New Zealand led the OECD in the proportion of GDP invested in ICTs, was the longest period since the 1960s in which New Zealand's per-capita GDP growth matched the pace of the total OECD's per-capita GDP growth (Buckle and McLellan, 2004).

Yet despite such affirmations, a popular feeling prevails that New Zealand is somehow 'falling behind' the rest of the OECD in respect of business use of ICTs. This feeling is fuelled by analyses such as that of the Center for International Development at Harvard University's Network Readiness Index recording a drop in New Zealand's ranking from 11th to 23rd between 2002 and 2003[4]. These surveys provide momentum for negative expectations, despite similar surveys such as the Economist Intelligence Unit E-Readiness Survey[5] and IDC Research's Information Society Index[6], which record rises in New Zealand's position from 18th to 17th, and 17th to 6th respectively, over the same period. Negative expectations, nonetheless, when supported by powerful voice, lead to calls for the Government to make alterations to the policy environment. Thus, it is apposite as New Zealand's Ministry of Economic Development (MED) shapes a new ICT strategy, that an examination be made of the ways in which New Zealand firms are using the substantial levels of ICT capital and

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[4] Kirkman g.s., Osorio, C. A. and Sachs, J. J. 2002. *The Networked Readiness Index: Measuring the Preparedness of Nations for the Networked World*. http://www.cid.harvard.edu
[5] http://www.economist.com
[6] http://www.idcresearch.com

communications connectivity that they have already invested in. Whilst existing research polls the use of specific technologies within firms of specific characteristics (Clark, *et al*, 2003 examines internet application use by sector and firm size; Statistics, 2002 examines computer ownership by firm sector and size), research on how firms are using ICTs and complementary human and organisational investments to generate performance improvements that are measurable (if not at the aggregate industry or national level, then at least at the firm level), has not as yet been undertaken.

To this end, MED has commissioned six case studies as part of an information-gathering exercise that will "assist with the Ministry's investigation into the potential of ICT to improve productivity in the New Zealand context and the development of the new ICT strategy". In addition, the New Zealand Institute for the Study of Competition and Regulation has funded the production of a further three case studies to enable a wider range of organisations to be represented in the analysis.

The case study approach enables policy-makers to gain an understanding from the perspective of the firm how ICTs form part of the firm's value-creating process, and by extension, how different policy approaches will either support and encourage, or impede and discourage, firms to adopt, implement and use ICTs in ways that enable measurable performance improvements to be gleaned. MED intends that the case studies will also "act as examplars, both positive and negative, in the introduction and management of ICTs from which best practice principles in the New Zealand context can be formulated"[7].

The subsequent report comprises the nine case studies. It is structured as follows. A theoretical section surveys the literature on the relationships between information use by firms, investment in ICTs and the creation of measurable performance improvements from these investments. From this theoretical exploration, a framework for analysis of the New Zealand case study firms is developed. Next, the methodology for the case study research is explained, and the nine case studies are presented. The studies are then summarised in the final section that endeavours to integrate the

[7] Quotes taken from the email from Marilyn Head, Policy Analyst, MED to Bronwyn Howell, Research Principal, ISCR, dated October 29, 2003.

outcomes of the case study analyses into common or distinguishing factors that may assist MED in its ICT policy formulation. Finally, some policy recommendations are made.

Theoretical Development

Definition of ICTs

Information and communication technologies (ICTs) are typically defined as any technologies used to "store, receive, transmit, and algorithmically transform any type of information that can be digitised – numbers, text, video, music, speech, programs, and engineering drawings, to name but a few" (Brynjolfsson and Hitt, 2002: 2). Currently, the term 'ICT' generally refers to electronic information processing technologies such as computers and the Internet.

ICTs as General Purpose Technologies

Computers and the Internet are not the only technologies that process information. Human beings, organisations and markets are also processors of information (Galbraith, 1977; Simon, 1976; Hayek, 1945). However, not all information processors are *electronic* information processors. Neither is information processing a new concept (Shapiro and Varian, 1999). Information has always been a fundamental component of the co-ordination of production and exchange, and the costs of acquiring and processing information has been a constraint on the quantity, types and efficiency of activities undertaken (Arrow, 1999). However, changes in technology have enabled activities to be undertaken with information that were not possible or cost-effective previously. "The real information revolution is not that information is suddenly becoming important. Information has always been important. The revolutionary aspect of the information age is the treatment of information in ways that would have been unimaginable only a few decades ago" (Perelman, 1998).

Historically, "most of our economic institutions and intuitions emerged in an era of relatively high communication costs, limited computational capability and related constraints" (Brynjolfsson and Hitt, 2002: 3). Thus, the emergence of new technologies, such as computers and the Internet, that have the power to reduce the costs of co-ordination, communications and information processing can be expected to have some fundamental and far-reaching effects upon organisational and institutional

form. This effect is in addition to the use of new technologies to create new products and new markets for these new products.

The far-reaching impacts of computers and the Internet mean that they are best considered not simply as traditional capital investments enabling the production of goods and services, but as "general purpose technologies (GPTs)" (Helpman and Trajtenberg, 1996). Such technologies offer economic benefits not just from their own use, but also because they facilitate complementary innovations, both technical (eg software) and organisational (eg geographical dispersion of specialised production via outsourcing). The effects of the complementary investments may be large in comparison to the initial investment.

Welfare Gains From GPTs[i]

Whilst there is some contention about the extent to which ICTs have contributed to economic growth at the macroeconomic level (see, for example, Solow, 1987; Gordon, 2000, Triplett, 1998; Oliner and Sichel, 2000; Jorgenson and Stiroh, 2000)[ii], at the firm level, there is a substantial and growing body of evidence linking ICTs with both higher productivity and organisational transformation (see, for example, Brynjolfsson and Yang, 1996; Bresnahan, Brynjolfsson and Hitt, 2000). Brynjolfsson and Hitt (2002: 4) argue that firstly a significant component of the value of ICTs is related to the ability of computers to enable complementary organisational investments such as business and work practices; and secondly, these investments lead to productivity increases by reducing costs and enabling firms to increase output quality in the form of new products or improvements in intangible aspects of existing products such as convenience, timeliness, quality and variety.

However, the accrual of measurable and intangible welfare gains from GPTs does not follow immediately after the development of the technology, or even directly after the deployment of that technology in a firm. Rather, the gains often accrue intermittently (Jovanovic and Rousseau, 2001). Unless the new technology offers an unequivocal and immediate improvement in productivity, firms may opt to depreciate existing investments in physical and human capital first before investing in the new technology (Griliches, 1988). Furthermore, if the new technologies require substantial capital

investment, either for the equipment itself, or in developing the human capital (skills) to utilise the equipment optimally, then even though the technology offers immediate productivity improvements to the firm, and welfare gains to society, deployment will be staged simply because of limitations in access to capital or physical limitations in the production of the new technology (Greenwood and Jovanovic, 1998).

Even when investment occurs, accrual of productivity gains is not necessarily immediate. New adopters take time firstly to learn of the nature and benefits of using the new technologies (Arrow, 1962) and secondly to use this learning to experiment and adapt use of the technologies by creating complementary investments (Greenwood and Yorukoglu, 1997). Consequently, in the initial stages of deployment, a firm may actually experience decreases in output per unit of input as this learning is undertaken. However, over time the learning translates into measurable gains. In addition, widespread diffusion of the technology may also be delayed by the time taken for embedded learning and the nature of the complementary investments to spread amongst firms (Atkeson and Kehoe, 2001). Thus, Greenwood and Yorukoglu (1997) find that "a plant's productivity increases by 15 percent over the first fourteen years of its life due to learning effects", whilst Atkeson and Kehoe (1997:1) state that it takes "5-7 years until measured output and productivity begin to grow rapidly… The reason that the transition takes time… is that it requires an economy-wide investment in organizational capital". These findings are consistent with Brynjolfsson and Hitt's (2000) firm-level analyses of productivity gains from investment in computers. This research shows positive gains accrued in firms after lags of between five and eight years following investment.

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research shows positive gains accrued after lags of between five and eight years following investment.

The timing of investment in complementary technologies is also significant in the accrual of gains. Where learning is required for a technology to become fully productive, then it is possible to invest too early in the costly technology requiring learning, meaning that capital lies under-utilised whilst learning occurs, at a cost to both the firm and society (Jovanovic and Stolyarov, 2000; 1997). As investments in computers require learning to create the complementary applications and organisational structures and processes, then until such complements are developed, premature investment in ICTs may occur, leading to significant levels of under-utilised ICT capital. Such investment has consequences on societal welfare, as the capital may have been more productively employed in other investments (Howell, 2003).

Environmental Factors

As the ability to accrue productivity and welfare gains from GPTs relies upon the ability to learn and experiment to develop complementary investments, then the extent of their accrual is also dependent upon the ways in which the environment enables and encourages the development of these complementary investments. As the complementary investments from ICTs appear to be very strongly contingent upon the ability of firms to restructure internal processes and external relationships (Brynjolfsson and Hitt, 2002), then the nature of the wider commercial environment is critical. The OECD recognises the role played by environmental risk and uncertainty in the accrual of welfare gains. In particular, the effect of government policies encouraging innovation, and the ability of labour and product markets to enable flexible restructuring as a result of the learning acquired from the use of new technologies, are highlighted as key factors in either encouraging or impeding the accrual of gains (OECD, 2003: 14).

Information and ICTs

ICTs provide new ways to create, store, transmit, receive and utilise information. However, it is also helpful to conceptualise information as either a stock or a flow, independent of the technologies that process it. ICTs can seen as influencing the accrual of welfare by enabling the development of new products and services using information, as well as providing lower-cost methods of undertaking its creation, storage, transmission, reception and utilisation. Furthermore it is possible to identify not just new ways of using the technology, but new ways of substituting existing information processes more efficiently. Just as the use of the electric motor as a GPT could be analysed in relation to the development of new organisational forms that it enabled in businesses that required motive power by examining the ways in which firms use motive power (Greenwood and Yorukoglu, 1997), so can insights be gained into the ways in which firms develop new organisational forms and processes based upon the ways in which they use information (Howell, 2002).

A defining characteristic of information is that it is intangible, has increasing returns, and exhibits non-rival and non-excludable properties (Arrow, 1999). Furthermore, it can be cheaply reproduced, its value does not decline with use, its use by one person does not limit its usefulness to others, and its value is often determined by its use (Shapiro and Varian, 1999). Traditionally, information has been bundled with tangible, rival and excludable carrier media, such as paper or human beings. Reproduction has been either extremely costly or physically impossible. Hence, its characteristics and measurement have been defined not by the value of the information itself, but by the characteristics and measurement of the media with which it is bundled.

If the carrier medium is costly compared to the value of the information, then using the characteristics and measurements of the carrier medium as a proxy for that of the bundle may be sufficient. However, as the cost of the carrier medium decreases relative to the value of the information, then this proxy becomes less satisfactory, both in terms of assessing the value of the bundle, and the economic laws that the bundle obeys. Electronic technologies have enabled substitution of the tangible media with which information has previously been bundled (eg paper, human beings) by an intangible medium (ie digital representation) with much lower costs of storage,

duplication, transmission, reception and processing (Quah, 2003). New, intangible bundles have emerged for existing information products – for example, digital representation of movies previously bundled with film, and electronic transmission of letters previously carried by physical means (email). Thus, a part of the ICT productivity story lies in understanding how these substitutions have changed the form and economics of information bundling, and the ways in which cheaper media have enabled the creation of new information products and services previously conceptually feasible, but not undertaken due to the costs exceeding the benefits accrued.

Just as information (or rather, the costs and benefits of acquiring, storing and processing information) has been fundamental in the determination of organisational forms, then the ways in which information contributes as an input, and information products (eg software) act as processors in the production of goods and services and the facilitation of exchange (that is, information sources, flows, processes etc), provide further dimensions for analysis. Recognising that information can play a role as both a stock and a flow in a production process, as well as contributing to the quality of other stocks (eg its embodiment in physical and human capital) (Malmgren, 1961; Howell, 2001) in addition to its role as a determinant of organisational and transactional forms means that any analysis of the impacts of the technologies that create, store, transmit and process this factor has a richness and complexity beyond even that of the 'classical' GPTs such as the steam engine, electricity, the electric motor and the telegraph. . It must also be recognised that the intangible nature of information, and the effects that changes to the costs of creating, storing, processing and transmitting information have upon organisational form and product type, mean that the welfare gains from the increased use of electronic ICTs may not be easily measurable, or may accrue in sectors of the economy that are not captured in traditional national statistics (e.g. the value of increased choice to the consumer, and the value deriving from the flexibility of being able to undertake activities 24/7 rather than just within traditional business hours) (Bosworth and Triplett, 1998).

Operations Strategies and ICTs

> *"The world of the future will be an ever more demanding struggle against the limitations of our intelligence, not a comfortable hammock in which we can lie down to be waited upon by our robot slaves." (Norbert Weiner)*

Operations managers are responsible for producing the supply of goods and services in organisations, thus they make decisions regarding the operations functions and the transformation systems used. The operations strategy of a firm is the what and how of activities directed towards distinctive operations competence that evaluate potential impacts of situations and alternatives in structured time dimensions, and integrate a pattern of decisions to balance the resource commitments, output requirements, and risks in various focused transformation efforts (Stonebraker and Leong, 1994). In the field of operations strategy the resource commitment decisions are generally categorized as those around the elements of capacity, facilities, process technology, sourcing, workforce, quality, work planning and organisation structure (Hayes and Wheelwright, 1984).

There is a growing competitive importance for using ICTs successfully in operations because of the pressures arising from increasingly shorter product life cycles, the demand for more customized products, services or solutions, the need for quick response by producers, and the distributed nature of the operations of some organisations. For operations managers, this means there is more information to be managed and greater advantage to those that do it well.

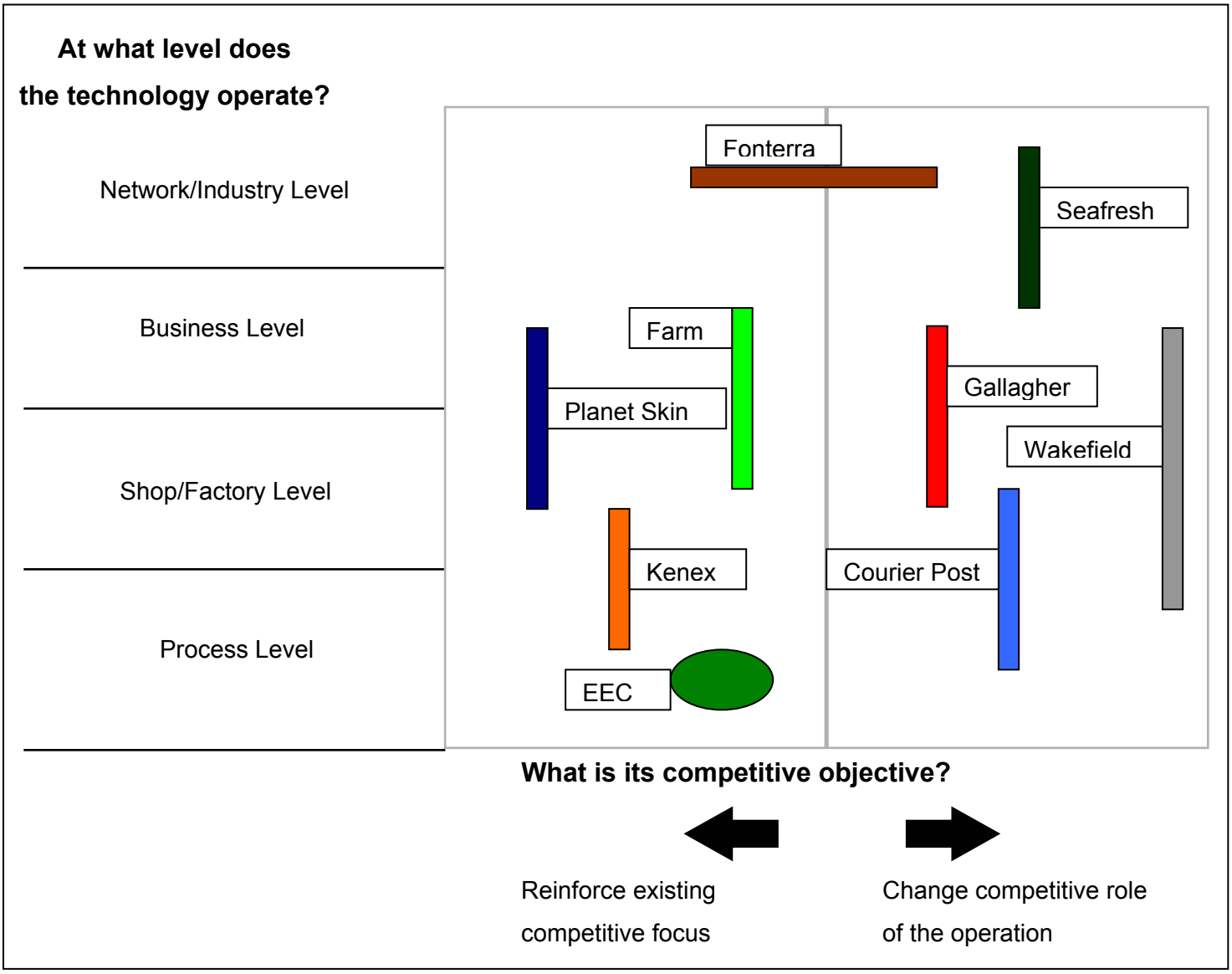
ICTs have also become more central to the operations function within organisations because of the increasing decentralization of Information Technology (IT). Distributed architectures, networking and open standards permit more local control, configurations and innovation. More and more responsibility is being placed on operations managers to manage ICTs and this entails a new skill set for traditionally trained managers. In small businesses, the operations manager may well also be the owner-manager. This is important because it allows those people charged with building operations advantage and distinctive competence to have access to information and tools with fewer intermediaries (Upton, 1995).

ICTs in operations can operate at various levels from the most straightforward, the process level (what lot is run next? Is the process under control?), to the most complex, the industry/network level (is there a supplier that can make this?). ICTs in operations also have a competitive role or purpose, viz. to reinforce an existing “order

winner" or to change the way the operation competes. A change in the competitive advantage the operation aims to deliver will certainly mean a reexamination of other elements of the operations strategy (Upton, 1995).

The figure below combines these dimensions of level and purpose into one framework (Upton, 1995) and it shows where the case writers think the ICT application in each case fits.

Figure 1: Level and Purpose of ICTs



Developing a Framework for Analysis

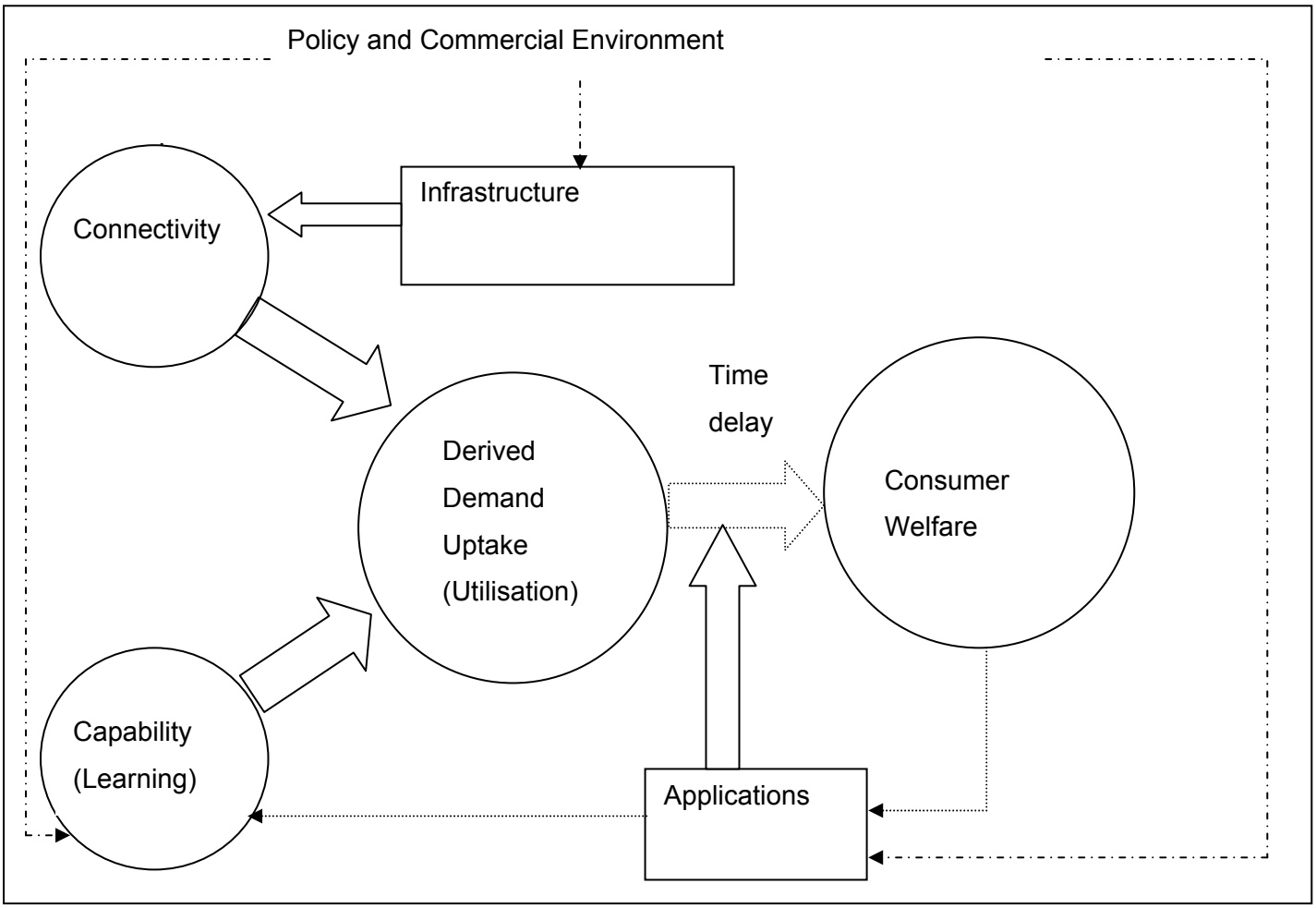
A comprehensive analysis of the accrual of benefits from ICTs, in order to develop some normative guidelines for both managers and policymakers, requires an understanding of both the substitution effects (both of processing technologies and carrier media) and the need for both complementary innovation and learning. In this sense, ICTs themselves (eg computers, the Internet) can be conceptualised as infrastructures, requiring complementary applications (eg software, processes, organisational constructs) to yield maximum benefits. Learning enables both the development of the complementary investments in the GPT sense, and the accrual of other learning-based benefits as occurs with investment in any new technologies, whether of general purpose or not. However, both the substitution and the investment in innovative learning are driven by the desire to extract greater efficiency from the use of a new physical or organisational technology. The result is a complex interaction of infrastructure, applications, learning and utilisation.

Consumers desire benefits from new technologies, and purchase new products and services based upon receiving a greater level of welfare from the purchase, within budget constraints. Businesses purchase new technologies and produce new goods and services that enable a greater level of return, in the long run, for a given level of inputs, or the same return for fewer inputs. The actual demand for the technology is derived from the demand for applications utilising the technological infrastructures. Without a demand for the applications, and the necessary learning in how to achieve the gains from the applications, no matter how available the technology may be, its utilisation will not occur. Hence, demand for the technology is itself a derived demand. For information communication technologies, the extent of their uptake will be determined by the extent to which information plays a part in the production and exchange processes of potential users of those technologies. As information is ubiquitous and fundamental to all production and exchange processes, then the potential exists for electronic ICTs to become part of all such processes. Moreover, the extent to which electronic ICTs substitute for non-electronic ones, and the nature of the complementary investments and innovations required, will be contingent upon the types, quantities and natures of information required to undertake the processes.

The ability to generate welfare gains is further influenced by the ways in which the policy and commercial environment encourages development and investment in each of infrastructures, applications and learning, and the willingness of firms to undertake these activities, given that the benefits can be expected to take some time to amass. When future benefits are uncertain, investment in any of connection to infrastructure (technology investment), application development and purchase, and learning occurs based upon the expectation of future gains. However, these do not always accrue. Unsuccessful firm-level developments will fail, whilst successful ones will survive. Presuming no or low barriers to sharing information, successful infrastructures and applications will diffuse throughout the economy (Jovanovic and McDonald, 1993). The result is societal welfare gain.

This inter-relationship is schematically represented in Figure 2.

Figure 2: Welfare-Enhancing Technological Diffusion



The New Zealand Context

Whilst the foregoing discussion identifies key theoretical issues underpinning productivity, efficiency and welfare gains from business implementation of ICTs, and references empirical evidence of such gains in, principally, the United States environment, the literature on empirical evidence in the New Zealand environment is sparse. Surveys of specific technology adoption by businesses have been conducted (eg MED, 2002; Clark, Bowden and Corner, 2003). However, due to their e-business frame and the importance given specifically to the use of the Internet, these surveys have focused principally upon the use of ICTs to co-ordinate transactions *between* companies (eg email, use of websites, websites capable of receiving payments, on-line products, on-line purchases. These studies are less informative about the use of ICTs *within* businesses, for example the use of computerised management of production, accounts processing and the use of cell phones and text messaging. Thus, the literature does not capture either the economy-wide or firm-specific performance of New Zealand's investment in ICT capital. This is a significant omission, given that for nearly a decade, New Zealand has led the OECD in the proportion of GDP spent on computer and communications technologies (OECD, 2002: 48).

Given New Zealand's high levels of ICT spending relative to other investments, and the period over which these investments have accrued, the Brynjolfsson and Hitt (2002) findings imply that at the firm level at least, increased measurable productivity returns to these investments should be becoming apparent, providing the necessary complementary investments in firm-specific implementations applications and learning have been made. Indeed, it cannot be discounted that some of the strong productivity growth Buckle and McLellan (2004) find in New Zealand in the mid to late 1990s may be attributable to the level of investment in ICTs beginning in the early 1990s.

However, the findings based upon United States empirical research may not necessarily be transferable directly to the New Zealand context given New Zealand's very large percentage of small firms (Locke, 2003)[8], the small size and open nature of the New Zealand economy, the New Zealand economy's reliance upon primary

[8] Approximately 45 percent of the employed workforce is employed through small businesses with less than 20 employees, and 97 percent of private sector enterprises are small businesses. Locke (2003): 2.

products, and the physical distance of New Zealand from both the rest of the world and its major trading partners (Evans and Hughes, 2003). Research to ascertain the extent to which New Zealand business investment in ICTs and their complements are delivering productivity improvements and welfare gains within the New Zealand commercial and policy environment, at the firm level is indicated.

Research Methodology

In order to address the lack of empirical evidence about the ways and extents to which New Zealand businesses are accruing productivity gains and contributing to growth in welfare, and the ways in which the commercial and policy environments are either nurturing or impeding this development, the Ministry of Economic Development has commissioned a series of case studies.

Research Purpose

The purpose of the study is to examine the use of information and the ways in which ICT investments have been employed to support these uses of information in a sample of New Zealand firms. Individual case studies will provide examples of ICT implementation and use that may provide guidance to other firms on the process of making ICT investments. Collectively, the case studies will contribute to a growing body of evidence of New Zealand firms' use of information and ICTs. Inferences will be made from the case studies about the ways in which the New Zealand commercial and policy environment supports firms in their endeavours to increase productivity and welfare from the use of information and ICTs, and recommendations will be made to the Ministry of Economic Development

Case Study Format

A case study format for analysis has been selected, in accordance with the findings in the literature that productivity and welfare gains are more likely to be detected in micro-economic data from firms than in the macro-economic level in industry, sector and national accounts.

Case Study Process

Data for the case studies will be identified using a combination of publicly available documents, existing CANZ and ISCR research archives, and face-to-face semi-structured interviews with key personnel in each of the case study firms. A schedule

of questions used as prompts in the semi-structured interviews is contained in the appendix to this report.

The questions have been derived using the theoretical insights highlighted in the preceding section. The purpose is to learn both the extent of the productivity and competitive advantages gained by the companies from the use of ICTs, and the ways in which these companies have implemented the technologies. The case studies will highlight the uses of both information and ICTs in the businesses, and the incentives and obstacles that the firms encountered in their implementation and use of ICTs.

Case Study Content

The case study of each firm will examine:

1. The firm and its business model, including its primary competitive differentiators, within the context of its industry;
2. Use of information in the firm's business processes;
3. Use of ICTs in relation to the firm's information usage requirements, business model and competitveness;
4. Management of ICT investments, including assessment, planning and implementation, and complementary investments made by the firm in order to capture the benefits of ICTs;
5. The firm's experience with ICT investments, including successes, failures and lessons learned; and
6. The firm-based benefits gained from ICTs, including gains in productivity, market share and competitiveness, and the additional welfare accrued by consumers as a result of improvements in product convenience, timeliness, quality and variety. The distribution of the benefits is also addressed, with the identification of both tangible and intangible benefit accrual to both the firm and other participants (e.g. customers) explored. The extent to which these benefits would be captured in industry and national accounts (i.e. official statistics) is also addressed.

Each case study takes as its pivotal point the ways in which information influences the operational nature of the business, its internal and external communication processes,

and the structure of both the firm and the industry in which it operates. Thus, the core presumption of each case study is that use of ICTs is a subset of the all information technologies utilised, and the extent to which any information technology is utilised is determined by the information requirements and usages of the firm. This is consistent with the schema presented in Figure 2.

Case Study Firm Selection

Nine organisations were selected for inclusion in the study. The organisations selected for study were required to be established organisations with a history of use of ICTs of at least two years. The one exception to this is Kenex, which has been operating for only eighteen months. However, the applications used by Kenex are three years old, and the same individuals who now operate the company as a private enterprise developed the applications whilst working for government entities. Hence, the application has a history of more that two years, even though the company has a shorter life.

The only other selection criterion specified by the researchers was that the sample should include at least one firm where use of an ICT has 'failed', so that negative as well as positive learning points could be identified. The Southfresh/Freshnet marketplace was chosen in this capacity. The B2B marketplace application was not commercially sustainable when operated by Southfresh, but the software applications developed by Southfresh are now being successfully used by Foodstuffs.

Due to the short time frame within which the case studies had to be prepared (six weeks), candidates were selected from a pool of potential organisations known to the researchers and staff at the Ministry of Economic Development in order to reduce the time taken to gain participant consent. ISCR corporate members Fonterra Co-Operative Dairy Company and New Zealand Post offered the Fonterra group, Courier Post and the Electoral Enrolment Centre as candidates. The CANZ project company Gallagher Group Ltd agreed to participate, whilst MED brokered the agreement of Wakefield Radiology and Southfresh/Freshnet. The remaining three firms: Kenex, Planet Skin and Ward's Farm; were known to individual researchers.

Table 1 describes the size of the firms, industry, and export focus and type of information product of the firms that have been studied. Figure 1 also depicts the purpose and level of technology use within the firms and its impact on competitiveness. These summaries demonstrate that the sample contains a wide variety of firm size, industry sector, export focus, product type and competitive use of ICTs. Thus, the researchers are confident that the findings drawn from the nine case studies are broadly representative of the issues facing most New Zealand companies in the use of ICTs. There is no evidence that the findings are unduly skewed towards the requirements of any specific business type as a result of sample selection. However, as the sample size is small, the authors caution that the conclusions and findings drawn from the analysis, whilst indicative, cannot be taken as proven unless verified by a more extensive research exercise undertaken on a more scientifically selected sample.

Nonetheless, Table 1 shows that the sample contains four small, four large and one medium-sized businesses, using the Statistics New Zealand classification of small businesses having fewer than ten employees, large over 100, and medium between 10 and 99 employees. Although it comprises too many large organisations to be considered representative of the New Zealand business population, the sample provides examples of all the sizes of business represented in the New Zealand economy.

The sample contains three firms that export directly, and cover a range of industry sectors: service, government, manufacturing, agriculture and research and development. There is a slight skewing towards the service sector. However, this is indicative of the size of the service sector in the New Zealand and world economies (up to 70 percent of GDP by some definitions), and further reflects the proportionately higher level of investment in computer capital in the service sector compared to other sectors (Jorgenson and Stiroh, 2000). Furthermore, three of the sample firms produce a product that meets Shapiro and Varian's (1999) definition of an information product (comprised totally of digitisable outputs). Whilst the marketplace that the Southfresh/Freshnet application services deals in physical products, the actual marketplace operation is solely an information exchange function and is fully

digitisable. Hence, the researchers consider that it too meets the definition of an information product.

The companies selected cover ICT applications at different levels of business activity, from processes to industry and also encompass those that seek to reinforce existing competitive focus and those that sought to change their competitive focus as shown in Figure1. Foe example, Gallaghers move to reduce emphasis on make-to-stock and increase their ability to produce more on a make-to-order basis to increase responsiveness and reduce inventory carrying costs.

Table 1: Sample Firm Profiles

Company	**Size**	**Exporter**	**Industry**	**Information Product**
Planet Skin	Small	No	Service	No
Courier Post	Large	No	Service	No
Electoral Enrolment Centre	Large	No	Government	Yes
Wakefield Radiology	Medium	No	Service	Yes
Gallaghers	Large	yes	Manufacturing	No
Fonterra	Large	yes	Manufacturing/ Agriculture	No
Farm	Small	No	Agriculture	No
Southfresh/Freshnet	Small	No	Service	Yes
Kenex	Small	yes	Service/ Research & development	Yes

[i] For a literature review of productivity gains from General Purpose Technologies, see Howell and Obren (2002).

[ii] In addition to the acknowledgement that capital investment in computers is disproportionately represented in the services sector, where productivity gains are notoriously difficult to measure (Triplett and Bosworth, 2000).