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NETWORK EFFECTS AND BROADBAND CONNECTIVITY IN OFFICE BUILDING

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Suntec City Development P/L

Suntec City (hereafter referred to as Suntec), "Asia's Vertical Silicon Valley," is one of the real estate examples where broadband and information & communication technologies (ICT) have been strongly embraced to enhance the competitiveness and marketability of its office space. In a mailed questionnaire survey participated in by 24 major commercial developers who are members of the Real Estate Development Association of Singapore (REDAS), 60% of the sample developer firms experienced strong competition in attracting and retaining lessees against office buildings equipped with ICT and broadband facilities. Sixty-seven percent of those who felt competition from the better-connected buildings indicated that they have plans to upgrade the existing ICT and broadband facilities over the next three years. They expected the upgrading to enhance the marketability of the building (71%) and also be able to attract tenants who are willing to pay a premium for the ICT and broadband services (43%).

In the post-upgrading period, the majority of respondent firms felt that ICT and Broadband services would have positive impacts on occupancy rate (58%),

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rent (46%), and running and maintenance costs of the building (61%). We developed an incremental net present value model, which encapsulates the above factor and a network externality, to estimate the economic gain of investing in ICT and broadband connectivity in the Suntec City Tower One case. Based on our assumptions of the input variables, we found that the differentiating premium associated with the ICT and broadband connectivity was equivalent to 3.86% of the unit rental value. When probabilistic uncertainties were added to selected variables in a simulation process, the ICT and broadband related rental premium increased to 5.27%.

Keywords

Information and communication Technology, Broadband Connectivity, Network Externality

Introduction

"Today it takes an act of courage to suggest that our biggest factories and office towers may, within our lifetimes, stand half empty, reduced to use as ghostly warehouses or converted into living space. Yet this is precisely what the new mode of production makes possible."

-Toffler (1980)

Some developers of commercial properties in Singapore share the concerns of the possible threat that Information and Communication Technology (ICT) will bring to the real estate market. The Chairman of one of the largest publicly-listed real estate firms in Singapore (City Developments Limited), Mr. Kwek Leng Beng, expressed his apprehension in the *Business Times* (Singapore) (21 September 1999):¹

"The notion of 'home office' or virtual office has created a new breed of companies which invest in internet connections rather than 'brick and mortar.' The impact...this trend will have on future commercial developments (is) fairly obvious. What is not so obvious, however, is the impact that virtual offices will have on existing office buildings. What do we do with empty container[s] in the sky?"

Will we end up with "empty container[s] in the sky"? The debate of the impact of ICT on office space demand persists. Professor Rosen, chairman of the Center for Real Estate and Urban Economics at the University of California at Berkeley,² argued that "as more companies begin facing jobs vs. space choices, space reduction programs will spread to the point of

¹ Eng, C., 1999, "Singapore at Home & Abroad: Call for Flexibility in Use of Office Space," *Business Times (Singapore)*, 21 September 1999.

² Extract from Pacelle, M., 1993, "Vanishing Offices: To Trim Their Costs, Some Companies Cut Space for Employees – Workers Use Cellular Phones And Laptops, Spending More Time with Clients – Life Without a Water Cooler," *The Wall Street Journal*, June 4, 1993.

depressing the office market. The space consumption in the '90s is going to be a lot slower than people think, so the recovery is going to take a lot longer than people think." Taking a different position, Wheaton (1996) is one of the few real estate economists who argued with careful economic reasoning that the ICT revolution will not likely lead to the "demise" of traditional real estate. He argued against the premise that ICT will reduce the demand for real estate. However, he predicted that firms would be more footloose and their office locations would be decentralized. Firms' space considerations would be less dependent on proximity to clients, providers, or their own internal divisions.

While the issue of ICT impact on office space demand is still unresolved, developers are faced with the dilemma of whether they should put in additional investment to upgrade and make their office buildings more ICT and broadband-friendly, and at the same time, bear the risk of tenants consolidating their committed space. With improved connectivity and communication efficiency, more office activities can be relegated to secondary or backroom office space located in suburban areas. The ICT-induced space consolidation program puts downward pressure on office space demand for prime office space in the central business districts (CBD). However, there are developers in the market who take a positive view that wiring up can add value to their office buildings and help them remain competitive in the commercial real estate market:

"Internet value is a 'perceived value' derived by creating a public perception that, by virtue of its positive branding or image, the market is prepared to value the development higher than market or real estate value."

-Mr. Wong Ah Long
The Chief Executive Officer of Suntec
City Development³

Suntec City Development, located in the downtown Marina Centre area, is one of the commercial developments that has successfully rolled up several "waves" of ICT and broadband initiatives to enhance connectivity and network integration within the development project since early 1999. Touted as "Asia's Vertical Silicon Valley," Suntec has effectively leveraged on ICT and broadband technologies to enhance office connectivity, which is a much sought-after feature that puts together a valuable network of companies in IT and financial services in Suntec. How have other office developers and landlords reacted to Suntec's type of ICT and broadband strategy? In a survey involving 20 office schemes in Thames Valley in the UK, Spurge and Almond (2002) found that there were generally mixed

³ "Making Bricks Clicks," Lead story, *Property Review* (Singapore), March 2000, pp. 22-26.

views of developers on the impact of ICT and broadband connectivity on their office leasing activities.

Do Singapore developers face the pressure of increasing tenants' demand for high-speed connectivity? What are the views of local developers and/or landlords with respect to the strategies of upgrading their ICT facilities and wiring up their office buildings? This is one of the two objectives of this study, which was carried out via a mailed questionnaire survey of major commercial developers in Singapore. The second objective of this study is to examine the developers' dilemma with respect to the economic implications of wiring their commercial buildings using a pre-defined simulation model.

This study is organized into seven sections. Section 2 reviews literature in the area of ICT and broadband technology application in real estate and their implications. Section 3 introduces briefly the case of Suntec and how the ICT "waves" have been implemented to enhance the connectivity and position the project as a premier office project in Singapore. Section 4 presents the responses of the developers, who are also members of the Real Estate Developers' Association of Singapore (REDAS). The economic gains of the ICT and broadband (ICTB) technologies are numerically analyzed, based on a set of input assumptions, using a probabilistic simulation model in Sections 5 and 6. Section 7 concludes the findings and highlights the limitations of this study.

Literature Review

Information and communication technology (ICT) and broadband connectivity have become important and indispensable features of today's commercial buildings. Research thus far has focused mainly on issues relating to occupiers' working practices and operational changes in responses to the increasing ICT and broadband usage rate (Chinitz, 1995; Newey, 1996; Wheaton, 1996; Lizieri, 1997; Lizieri, Crosby, Gibson, Murdoch and Ward, 1997; Gibson and Lizieri, 1999 a, b & c; Spurge, 2002). These studies examine the critical role of ICT in enabling new market structures, business organization, and working practices. Studies that look at the impact of these ICT and broadband technologies from the supply side perspective (i.e. the responses from developers and landlords of office buildings) are nevertheless limited.

Broadband technology, which is the backbone for high-speed data transmission, enhances the efficiency of various ICT applications like e-mail, mobile telephones, the internet, and video-conferencing in business today.

The ICT and broadband technologies are thus interdependent.⁴ These technologies are found to be vital and very important by 86% of UK firms in the Thames Valley Corridor, as surveyed by Spurge (2002). Lease lines and Asymmetric Digital Subscriber Lines (ADSL) were the two most common forms of broadband infrastructure used.⁵ Eighty-two percent of the sample firms in Spurge's (2002) survey were connected to broadband facilities via leased lines, and 26.2% have broadband connection via ADSL lines. The majority of the sample firms also feel that broadband technology will have a significant positive impact on business efficiency (93%) and the adoption of new working practices.⁶ However, the perceived impact of the ICTB technologies on office space was less conclusive, and the responses also varied according to the firms' business activities.

An explosive demand for broadband in the UK has been evidenced in the connectivity index,⁷ developed by King Sturge (2001), which shows a more than 20-fold jump from 100 points in 1997 to more than 2,100 in 2001. In Singapore, the trend of broadband internet users was up by 30% from 950,000 in 2001 to 1.24 million in 2002. The Infocomm Development Authority (IDA), in their latest survey, showed that two in five Singaporeans have high-speed online connections.⁸ As broadband technology has become more pervasive, occupiers' dependence on broadband facilities will also be increasingly important. We envisage that the broadband and ICT services will become a standard specification of firms in their selection of office space. By then, wired-up office buildings will be as indispensable as the provision of other standard services like lifts, air conditioning, telephone exchanges, security systems, and others (Almond, 2001; Spurge, 2002).

Compared to an unconnected building, a broadband-ready office building commands a premium through a lower yield, quicker leasing and fewer voids, a higher rent, and an occupation charge of the broadband services in

⁴ The ICT and broadband technology terms are also used interchangeably in this paper to collectively represent technologies that are used in a wired office building to enhance connectivity and communicability.

⁵ Broadband is a network that allows for the transmission of information at a bandwidth of more than 2 megabits per second, about 35-time faster than the typical 56 kilobits home modem network. Broadband services can be provided in different network structures: ADSL, leased line, fibre optics, and wireless networks.

⁶ New working practices (NWP) are flexible working styles and cultures adopted by firms, which allow employees to work away from their physical office space. These NWP arrangements include home-working, hot-desking, hotelling, virtual office, and video conferencing

⁷ The King-Sturge connectivity index (2001) was measured by the speed of connection to the internet, and the level of connectivity reflects the current demand for broadband connection within buildings in the UK.

⁸ Tan, A., 2001, "Two in Five Singaporeans use Broadband, Says IDA," Business Times (Singapore), 16 April 2003.

the cash flow streams (Thomson and Hills, 1999; Almond, 2001).⁹ Thomson and Hills (1999) used a hypothetical business model to demonstrate the economic benefits of connectivity to a large multi-tenant office building. They showed that investments in the installation of 2MB leased lines in a new 150,000 square feet office building in Central London could be paid back in four years' time. Almond (2001) also ran cash flow scenario analyses of the feasibility of wiring up a 100,000 square feet multi-tenanted building. Based on an initial investment of £50,000, he showed that the landlord will need to collect a minimum monthly telecom service charge of £2,000 in order to break even in five years, and this scenario was attained on the assumption that a high level of service penetration is achieved (20% in year one, 40% in year two, and 60% in years three to five).

What is the general perception of developers in respect to their roles in the provision of broadband services in office projects? Spurge and Almond (2002) surveyed a sample of 20 speculative office schemes being marketed in the Thames Valley area in the UK, and interviewed eight developers involved in the projects. The eight sample developers interviewed realized the importance of providing broadband connection to their occupants. A majority of them have a clear broadband strategy for their office projects, whereas three out of the eight developers felt that broadband services should be considered part of the fitting out of the occupants' space. Speculative wiring of new office buildings and the exclusive agreement with a single telecom supplier are no longer practiced following the bad experience of the dot-com crash. The standard practice in the broadband supply in office schemes in the UK is now built on two key principles: independence and choice. Developers will select a minimum of two preferred suppliers to provide broadband services in the building, and at the same time, they will also allow tenants the flexibility to make their own arrangements for broadband supply, subject to payments of rent for the use of the ducts. Developers will share a fraction of the revenue generated from broadband services. However, the financial incentive from broadband connectivity is limited, compared to the higher tenant's satisfaction and improved relationship with the tenants through the wiring of the office building.

Almond (2001) agreed that broadband-connected buildings enjoy a competitive advantage, but he did not think strongly that the benefits of wiring the building will come from higher rents. The competitive edge will diminish in the long run when more buildings become wired (Almond, 2001). Therefore, it is always important for office landlords and developers to stay

⁹ Almond (2001) supported the idea that the added value of broadband wiring for an office building can be achieved through reduced tenant turnover, fewer void periods, improved marketability, and also additional revenue sources from providing telecom services. He, however, did not think that higher rents can be obtained through wiring up a building.

ahead in the competition and keep abreast of the newest and latest ICT developments (Spurge, 2002). The IT “waves,” which represent different phases of ICT projects, are the business models adopted by Suntec management to get ahead and maintain its leadership position in the competitive real estate market. We will examine the ICT and broadband strategies in Suntec’s development, and also review the perceptions of other comparable developers on the ICT and broadband impact on their office projects in the next two sections.

Suntec’s Wave

Suntec City – Case Facts

Suntec, touted as “Asia’s Vertical Silicon Valley,” is comprised of five office towers, and it has effectively embraced broadband connectivity and ICT to position itself as one of the most sought after commercial spaces in Singapore. Suntec, the largest commercial development in Singapore, was developed by a group of eleven Hong Kong tycoons on an 11.7 hectares commercial site sold by the Urban Redevelopment Authority (URA)¹⁰ of Singapore in December 1988. The site was developed into a fully integrated project with a convention and exhibition center, five office towers, and a shopping and entertainment center. Developed as a ‘city within a city,’ the S\$2.3 billion Suntec project offers 4.3 million sq. ft of office, retail, and conference facilities, and the breakdown of space usage in Suntec is summarized in Table 1.

Strategically located in the heart of the Marina Centre, Suntec, with 2.3 million square feet of office space in five office towers, seriously rivals the existing CBD at Raffles Place, which is just five minutes away by car.

Broadband Connectivity

From early 1999, a slew of ICT and broadband initiatives, which included fibre optic broadband access, instant networking, digital offices, common telecommunications connections, internet call centers, a plug and play environment, 4G network, wireless broadband services, and many others, has been implemented in phases in the so-called “Suntec IT Waves” projects. By virtue of its broadband capability and e-business strategy, Suntec has attracted close to 200 IT companies ranging from established names like

¹⁰ The Urban Redevelopment Authority (URA) is the national planning agency of Singapore, which is responsible for the long-term physical and transportation plans for the island-state. It is also the government agent who administers the land sales program by tender for state-owned lands.

Microsoft, Oracle, NCR, Fuji, and Xerox, to up-and-coming IT start-up companies. The congregation of the most influential multi-national and "blue-chip" IT companies has created an ideal environment for new and existing occupants and tenants to leverage on information technologies and partnership opportunities in their business ventures. The leverage of the ICT and broadband technology has borne fruits. It has enjoyed a very healthy occupancy rate, which reached 95% and above during good years, and the rental rate has also outperformed that commanded by premier office buildings located in the traditional CBD area.

Table 1: Breakdown of Space Usage in Suntec

Name of Building	Use	NLA (sq ft)	Date of Completion	Status
Suntec City Mall	Retail	889,000	1994/95	Rental basis
Suntec City One	Office	484,000	1995	Strata sold
Suntec City Two	Office	484,000	1995	Strata sold
Suntec City Three	Office	484,000	1997	30% Strata sold
Suntec City Four	Office	484,000	1997	Rental basis
Suntec City Five	Office	394,000	1994	Rental basis
Suntec International Exhibition & Convention Centre (SIECC)	Exhibition & Convention	1,076,000	1995	Rental basis
		Total	4,295,000	

With a concerted effort to improve connectivity via broadband facilities and its continuous “waves” of IT initiatives, Suntec has been able to position itself as the premier IT hub in Singapore. The Suntec Model has revolutionized from a typical landlord into a Facilities Service Provider (FSP) who offers its occupants not just physical space, but value creation via networking avenues and new business opportunities.¹¹ The success and proven records of Suntec has earned it the reputation of “Asia’s Vertical Silicon Valley”.

The broadband and information communication technology (ICT) strategies have been claimed to be one of the critical components in the success story of Suntec. However, should these strategies be embraced and replicated in comparable buildings by other developers, would the same benefits be reaped? If the answer is yes, then why are rival developers not aggressively adopting these strategies? What are the drivers and barriers for developers in the adoption of such strategies? The above represent interesting research

¹¹ This FSP business concept has been successfully patented by Suntec City in Hong Kong and Taiwan. The patent (No. 10/010/319) titled “System and Method for Increasing Perceived Value of a Property to Tenants” has also been filed in the US.

questions that would be explored through questionnaire responses obtained from other developers in the next section.

Responses of Developers

Survey Sampling

The sample survey firms were mainly drawn from the membership lists of the Real Estate Developers' Association of Singapore (REDAS). Three hundred mailed questionnaires were sent to the sample firms. There was a 5% attrition rate due to an unsuccessful delivery of the questionnaire. Fourteen percent of sample firms did not wish to participate in the survey, citing reasons like their core business was not in real estate, they did not own office buildings in the CBD, and others. After eliminating these earlier withdrawals, we managed to receive 24 replies from the sample firms, inclusive of the reply from Suntec, over the sampling period of July and August 2002. The low response rate of nearly 10% was not unexpected. Follow-ups by e-mail and telephone calls were made to persuade respondents to participate in the survey exercise. Many of the non-response firms indicated that they were either not sure, or they did not have enough technical knowledge of ICT and broadband technologies to provide useful feedback. Out of the 24 firms that participated in the exercise, 16 of them were involved in real estate development and investment activities, and 3 were in the consultancy and project management business. The remaining 5 firms were REDAS-affiliated members whose core business was not in real estate.

Survey Results

The survey findings summarized in this section reflect the general perceptions of the sample developers of their roles in the provision of ICT and broadband technologies in office buildings. We also examined the differences in the perceptions, if any, between Suntec and other developers and sample firms.

Effects of ICT and Broadband Technologies

In general, the awareness of the respondent firms on various ICT and broadband technologies like fibre optics, broadband, satellite and wireless accessibility, and building automation were high. While Suntec did not experience strong competition from newly constructed office buildings equipped with advanced ICT and broadband facilities in attracting and retaining lessees, strong competition was acknowledged by 60% of the

sample developer firms. Sixty-seven percent of the developers, who faced strong competition, adopted strategies to upgrade their ICT and wire up their buildings in order to compete against the better-connected buildings. Two of them will also consider lowering their rents concurrently to retain existing lessees. Only one developer did not have any plans to improve ICT and broadband connectivity in view of this competition.

Improvement and Upgrading of ICT and Broadband Facilities

Thirty-eight percent of the sample firms did not have plans to upgrade the ICT features and connectivities in their buildings in the medium-term. The high cost of investment was cited by 56% of them as the main cause for not doing so. For the 14 sample firms inclusive of Suntec that planned to upgrade the ICT connectivity to their buildings, 71% of them believed that wired buildings will enhance the marketability of the buildings, and 43% of them thought that the ICT upgrade was necessary to attract new lessees who would demand such a connectivity in their buildings.

In arranging to provide ICT and broadband facilities to office lessees, Suntec has linked up with three world-class telecommunication firms: Tridor, StarHub, and MCI WorldCom to provide broadband and ICT services to its lessees. It also formed a tripartite alliance with Atos Origin and iCentric to offer Application Service Provider (ASP) accounting software to the lessees. For other sample firms, the joint venture, with cost sharing arrangement, with a third party internet service provider (ISP) (31%) and the exclusive contract arrangement with a single broadband supplier (31%) are the two most popular options.

For the respondents who planned to upgrade their ICT and broadband facilities, 21% of them were prepared to absorb the capital costs of upgrading, while the other 19% would pass on the costs to third-party broadband suppliers (Figure 1).

Revenue and Operating Costs in a Wired Office Building

The study also evaluates how investments in ICT and broadband connectivity will affect the operation and revenues of office buildings in Singapore. The majority of the firms (67%) will not envisage significant effects of ICT and broadband upgrading on default and pre-termination of leases. In the post-upgrade period, 58% of the respondents felt that occupancy rates would improve, but only 46% of them felt that ICT-ready and broadband-connected buildings would command higher rents (Figure 2). Sixty-one percent of the respondents also predicted that the maintenance and running costs of the upgraded buildings would increase in the long run.

Figure 1: Ways to Recover the Capital Costs of Upgrading the ICT and Broadband Services

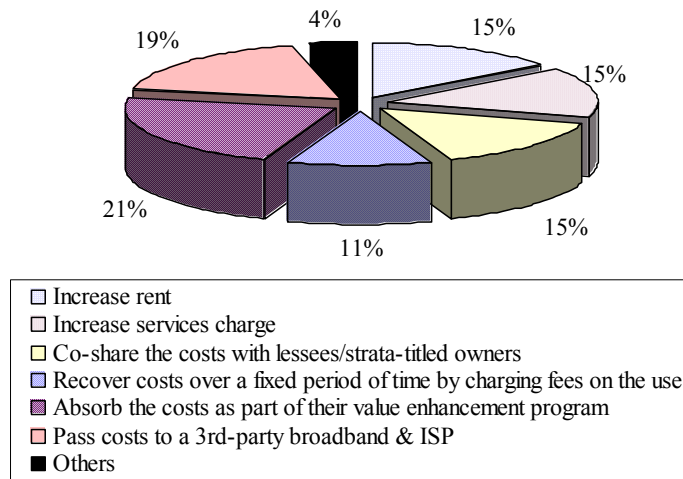
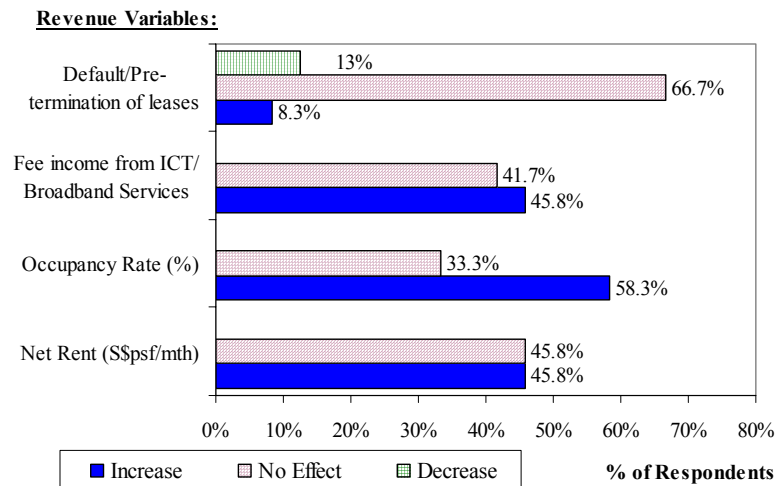


Figure 2: Post-Upgrade Effects of ICT & Broadband Facilities on the Revenue Variables



Differentiating Attributes of Office Buildings

When asked to select the most important location and property attributes that differentiate an office building, the respondents felt that proximity to public

transportation to be the most important location factor, followed by the CBD's location and proximity to support and shared business services (Figure 3). On building attributes, the respondents felt that contract rent and flexibility in space layout that provides for future expansion are the two most significant differentiating factors. The provision of ICT and broadband connectivity were found by two-thirds, or 67%, of the respondents to have a level of importance scale of 4 (very important) and above (most important) (Figure 4).

Figure 3: Major Location Attributes in Office Buildings

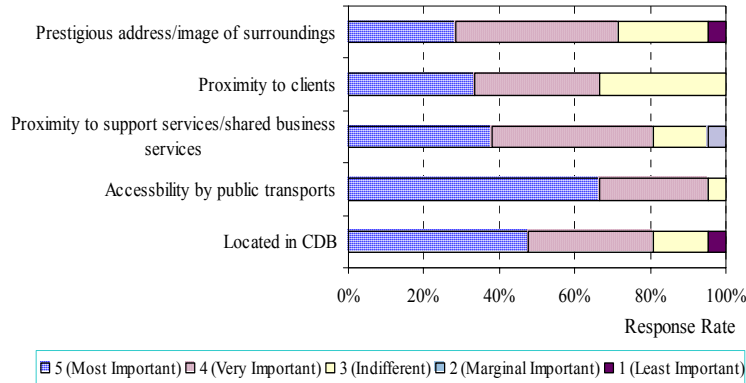
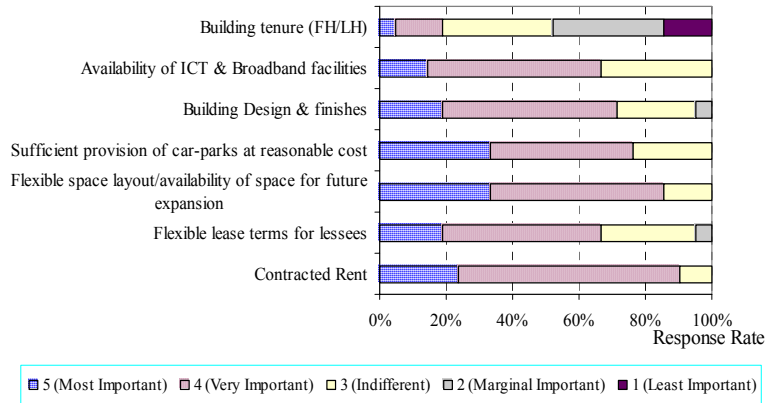


Figure 4: Major Property Attributes that Differentiate Office Buildings



Economic Benefits of Information Communication & Broadband Technologies

How much would the economic gains for improved connectivity to an office building be? How long will I be able to recoup my investment? These are important questions in the minds of many developers when evaluating the feasibility of upgrading the ICT and broadband facilities of their office buildings. Thompson and Hill (1999) applied a business cash flow model with inputs of a hypothetical UK office building, and found the payback period of the investment in broadband technology to be approximately four years. Almond (2001), on the other hand, showed that threshold telecom service usage of a tenant had to be above £2000 to justify the initial capital investment in wiring up a 100,000 square feet office building.

Using the Suntec City Tower One office building with a leaseable floor area of 484,000 square feet as our case for analysis, the incremental value of the office tower vis-à-vis a comparable hypothetical office tower, which is not connected by broadband and other ICT services, is evaluated. The incremental effects, which are solely attributed to broadband and ICT connectivity, can be determined after controlling for variations in the building and location attributes. We also applied probabilistic simulation models to account for uncertainty in the assumptions for selected variables.

Cash Flow Simulation Scenarios

Based on our earlier survey results, the majority of respondent firms felt that ICT and Broadband services would not affect the leasing risks in office buildings, but they would have a positive impact on occupancy rates (58%), rents (46%), and the operational and maintenance costs of buildings (61%). The results were not inconsistent with the assumptions in Thomson and Hill (1999) and Almond's (2002) models. They predicted that broadband connectivity will improve the value of an office building through factors like a lower yield, quicker leasing and fewer voids, occupation charges of the broadband services, and an improved marketability of the building. Higher rents were included in Thomson and Hill's (1999) model, but not in Almond's (2002) model. Given the above inputs, we will explore in the next section the feasibility of investing in connectivity using the incremental cash flow approach.

In the proposed model, economic gains arising from improved connectivity for tenants are derived from two sources. Compared to an unwired office building, the first incremental revenue will be generated from improved occupancy rates and occupation charges on broadband services, while keeping rents unchanged. The second source of revenue will be derived

from the network effects created by broadband usage. On the cost aspect, we assumed that developers will have to fork over a fixed investment cost upfront and also incur additional running costs for keeping the broadband and ICT services in functional condition. Broadband and IC technologies have a short lifespan due to rapid advancements in newer technologies. The incremental cash flow pro-forma, therefore, covers only a time span of five years based on the assumption that the investment in ICT and broadband will fully depreciate over this period.

Valuing Network Effects

The network effect, a concept defined by Katz and Shapiro (1985, 1994), is a market phenomenon where “surplus¹² that a consumer derives from buying a good depends on the number of other agents who join the network associated with that product.” A positive network externality is derived when the utility of a user increases in tandem with the network size increases as a result of more users joining in (Katz and Shapiro, 1994). This network value exists in many products, in particular telecommunication products like fax machines, telephones, and broadband. The network externality in office buildings and other real estate is a research area that has been neglected in mainstream corporate real estate literature. The traditional valuation theory is also silent on how this externality can be valued.

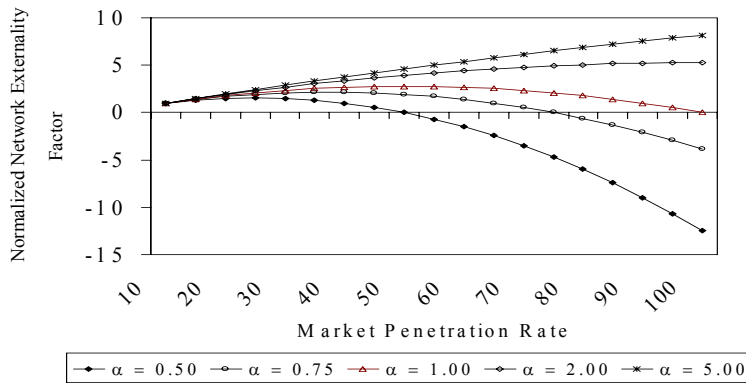
Suntec is a real world example where management has capitalized on the network effects through striking partnerships and forming strategic alliances with their tenants in providing an interconnected office environment. Examples of these mutually beneficial initiatives include allowing Tridor, StarHub, and MCI Worldcom to provide telecommunication services to Suntec tenants, and forming tripartite alliances with Atos Origin and iCentric Software to provide application service provider (ASP) accounting. Suntec’s network has reached critical mass, where self-reinforcement of the network will occur. Every time a new tenant joins in the network and brings with it added value to the network, all tenants will at the same time reap the network’s existing value through connectivity with other tenants. Suntec manages to attract a good mix of IT and financial firms. These firms are prepared to pay a premium for office space because the economic benefits of being able to tap into the network of other tenants in Suntec City far outweigh the high rents. The positive network externality not only contributes a positive premium to the physical office space in Suntec, it also earns Suntec the reputation of being “Asia’s Vertical Silicon Valley”.

¹² Consumer surplus is an economic term that is used to describe the excess benefits derived by a consumer in purchasing a good at a given price. It is measured by the triangular area delineated by the demand curve, and the equilibrium price line assumes that the price is constant.

Robert Metcalfe, the founder of 3Com Corporation and designer of the Ethernet protocol for computer networks, states that the usefulness, or utility, of a network equals the square of the number of users. In a network with N-nodes, the network value is computed as $[N(N-1)]$, or approximately N^2 for large N. This concept was subsequently coined Metcalfe's law by Gilder (1993). In the real estate context, the number of nodes or the number of users connected to the network is difficult to measure. We propose to use the size of physical office space as the proxy for network connectivity. The size of an office building corresponds directly to the economy of scale advantage in the creation of network effects. However, the network externality can be neutralized when more buildings are interconnected.

The marginal diminishing network effect will set in when a critical office mass is reached. The premium that a tenant is willing to pay for getting connected to the network will be reduced at an increasing rate beyond this critical point. The network externality effect can be represented as a convex function of the office size (q), which is bounded by a finite size of Q using the following normalized network factor, $[N(\pi) = q*(\alpha Q - q)]$, where π reflects the market penetration rate and α is a multiplier of the finite market size. Figure 5 shows the network externality curves with different $[\alpha = 0.50, 0.75, 1.00, 2.00, 5.00]$. The inflexion point at which an increase in one unit of office space will result in a reduction of the network value is set at the critical point of $[\alpha Q/2]$, when $[dN(\pi)/dq = 0]$. If a constant "shadow" network value, $[r_c]$, that an office tenant is ready to pay for the network benefits over a fixed period of time can be determined, the network externality value can be computed as $[P(q) = r_c * N(\pi)]$.

Figure 5: Normalized Network Externality Curves



Incremental Valuation Model for Real Estate with Network Externality

By combining the convex network externality function defined in the earlier section to the formal network model of Kart and Shapiro (1985) under a competitive market environment,¹³ the incremental net present value (INPV) for Suntec's decision to proceed with ICT and broadband investment, [INPV(q)], can be estimated using the following equation:

$$INPV(q) = \sum_{t=1}^T [r_s * (\Delta o * q)^\theta - \Delta c * q^\gamma] * (1 + i_r)^{-t} + \sum_{t=1}^T [r_b * q + r_e * N(\pi)] * (1 + i_e)^{-t} - I_0 * q \quad (1)$$

where,

- r_s = Unit annual rental for office space (\$\$/sf per annum)
- r_b = Annual charges/revenues shared with telecommunication suppliers for right to supply broadband services to tenants (\$\$/sf per annum)
- r_e = Unit annual rental premium that tenants will pay for the connectivity benefit (\$\$/sf per annum)
- Δc = Incremental unit annual costs incurred in keeping the broadband and ICT services in operating condition (\$\$/sf per annum)
- I_0 = Unit Fixed lump sum investment costs incurred upfront in laying the ICT and Broadband technologies in the building (\$\$/sf)
- Δo = Incremental occupancy rate attributed to broadband connectivity in the subject building (%)
- q = Leasable floor area (square foot)
- $N(\pi)$ = Normalized network externality factor that is dependent on the market penetration rate (π) and the market size multiplier (α).
- γ = Elasticity of scale measure for the incremental operation costs, where [$\gamma \geq 1$] reflects a convexity of the cost curve
- θ = Elasticity of scale measure for the incremental rental, where [$\theta \leq 1$] indicates a concave rental revenue function
- i_r = Rental yield/discounting factor for the rental streams generated from additional office space leased.
- i_e = Discounting factor for the ICT and broadband related revenue streams, which is more risky compared to the standard rental streams from office space leases (i.e. [$i_e > i_r$]).
- T = Estimated life span of the broadband and ICT technologies, and the value of the technologies that will be fully depreciated at the end of time T .

13 On the assumption that consumers are homogenous in their valuation of network externality, Kart and Shapiro (1985) developed a simple model to value a consumer's willingness to pay for a product with an expected network size of ye . The model comprises two components in the pricing of the product, [$r + v(ye)$], where r is the intrinsic value of the product, and $v(ye)$ is the value of network externality attached by the consumer, which is a function of the network size.

The right hand side of equation (1) for INPV can be broken down into three components. The first two components represent the additional revenue sources as a result of the ICT and broadband services, with the first term referring to an increase in rental revenue from leasable space, and the second term being revenue-related to the ICT and broadband services. Assuming that the rental rate remains unchanged in a wired building, the occupancy rate will rise because of the lower turnover and/or higher rate of filling up vacant space in the building. The landlord may, on the other hand, have to incur additional costs to keep the ICT and broadband systems in operational mode all the time. These costs exclude those expenses that will have been incurred to maintain the normal operation of the building, whether wired or non-wired. We built in different elasticities of scale measures to the rental and cost function to allow for adjustments in size effects.

The second revenue term is associated with the network effects created by the ICT and broadband connectivity in office buildings. Firms will pay additional rental premiums to be connected to the existing network in an office building. At the same time, we also assumed that telecommunication suppliers will share part of their revenues with the landlord as fees for using the ducting infrastructure to supply broadband services to their end users. On the cost side, the costs of installing broadband cables to the backbone of an office building in the UK are in the region of £1 to £2 per square foot (Almond, 2001). Even if cable installation costs can be partially or fully absorbed by the telecommunication suppliers, there are still costs incurred to provide sufficient structural support and ducting space to facilitate the laying of broadband cables compared to unwired office buildings. Therefore, we assumed that a lump sum fixed cost of $[q \cdot I_0]$ will be incurred at the beginning of the period in this analysis. This cost will fully depreciate over a fixed time-span that coincides with the lifespan of the technologies.

Simulation Analysis

Input Assumptions

The incremental net cash flow model in Equation (1) is used to measure the economic gains (losses) of providing ICT and broadband services vis-à-vis a comparable building that is not wired. Using Suntec City Tower One as a case for analysis, the net economic value of the ICT and broadband connectivity for $q=484,000$ square feet office space was evaluated over a time span of $T=5$ years. For our illustration purposes, the network externality factor was set at 2.08 on the assumption that the market

penetration rate is equal to 25%, and the office size multiplier is $\alpha=1.0$ (Figure 5). Assumptions for other input variables are listed in Table 1.¹⁴

For a base case scenario, all the variables in Table 1 were assumed to be deterministic, and the incremental net positive (negative) value represents the economic benefits (losses) of making the decision to invest in ICT and broadband technologies in the subject office building.

Next, we built in dynamics to the deterministic INPV model by incorporating probability distributions for selected variables to account for possible uncertainties in a real environment (Table 2). The probabilistic nature of the variables will be simulated jointly using @Risk program to derive at the dynamic INPV and the distributions.

Table 1: Assumptions for Input Variables in Simulation Analysis

Input Variable	Assumptions
○ Unit annual rental (\$\$/sf p.a.)	$r_s = \$48.00$
○ Annual revenues from the provision of broadband and ICT services (\$\$ p.a.)	$r_b = \$1.20$
○ Unit annual rental premium for network connectivity (\$\$/sf p.a.)	$r_e = \$3.00$
○ Incremental costs for maintaining broadband and ICT operations (\$/sf p.a.)	$\Delta c = \$2.40$
○ Unit lump sum costs in providing ICT and Broadband technologies (\$/sf)	$I_0 = \$4.00$
○ Incremental occupancy rate attributed to broadband connectivity (%)	$\Delta o = 10.00\%$
○ Elasticity of scale measure for the incremental operation cost	$\gamma = 1.02$
○ Elasticity of scale measure for the incremental rent	$\theta = 0.97$
○ Rental yield for office space (%)	$i_r = 4.50\%$
○ Discounting factor for ICT and broadband related revenue streams (%)	$i_e = 6.00\%$

¹⁴ Network externality valuation is a relatively new research area in corporate real estate. Empirical data is not available at this stage to verify the input parameters associated with network externality. However, more empirical research in this subject can be carried out when landlords of wired buildings are more forthcoming in sharing their data. The INPV results in this analysis can be easily revised when the actual data is obtained.

Table 2: Probability Distribution Specifications for Selected Dynamic Variables

Probabilistic Variable		Probability Distribution Type	Specification of Distribution Function in @Risk
○ Incremental Occupancy	Δo	Discrete distribution	Risk Discrete(0.05, 0.1, 0.15, 0.2, 0.25) (5, 6, 4, 2, 1)
○ Incremental Operating Cost	Δc	Triangular distribution	Risk Triang (0.0, 0.2, 0.4)
○ Annual revenue from ICT&B Services	shared from r_b	Normal distribution	Risk Normal(0.1, 0.1)
○ Network Externality Value	r_e	Normal distribution	Risk Normal (0.25, 0.5)
○ Unit Fixed Investment Cost	I_0	Lognormal distribution	Risk Lognorm (4, 2)

Analysis of Results

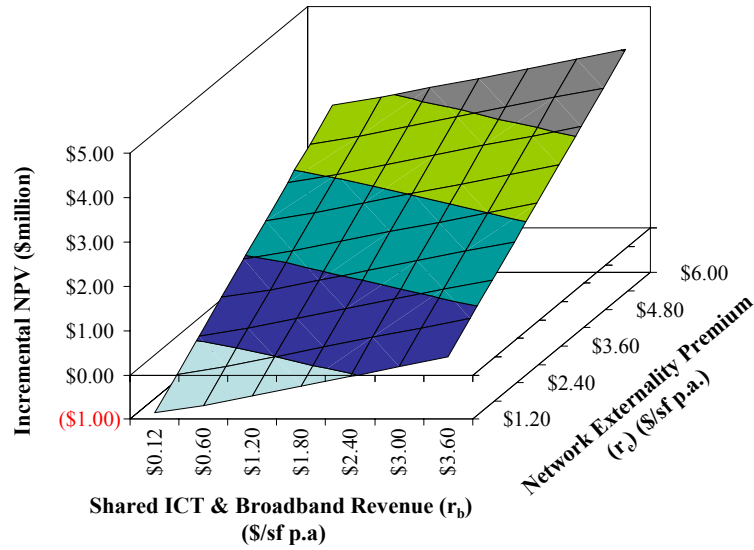
Based on the assumptions given in Table 1, the deterministic INPV on the feasibility of providing ICT and Broadband in Suntec City Tower One turns up positive, and is estimated at \$896,224, which is converted to a premium of 3.86% of the unit rental value. We further examined the sensitivity of the INPV by changing the value range for unit rental value (r_s : \$36.00/sf p.a. to \$72.00/sf p.a.), incremental operating cost (Δc : \$1.20/sf p.a. to \$5.40/sf p.a.), shared revenues on ICT and Broadband services (r_b : \$0.12/sf p.a. to \$3.60/sf p.a.), rental premium associated with the network effects (r_e : \$1.20/sf p.a. to \$6.00/sf p.a.), and the upfront initial investment cost (I_0 : \$1.00/sf to \$7.00/sf). The results of the sensitivity analysis are summarized in Table 3. At an annual office rent of \$48.00/sf, the ICT & Broadband investment is feasible unless the incremental operating cost increases above \$4.20/sf p.a., or the initial lump sum installation cost increases above \$72.00/sf. By varying the shared ICT & broadband revenue and the network externality premium, we could also expect the INPV value surface to be above the zero level, if the network externality premium does not drop below \$1.80/sf p.a. and the shared revenue is above \$2.40/sf p.a. (Figure 6).

When dynamics are added through the Monte Carlo simulation process with predefined random distributions for selected variables as in Table 2, the expected INPV remains positive and increases by 36.50% to \$1,223,646. This is equivalent to 5.27% of the annual rental value.

Table 3: Sensitivity Analysis of INPV

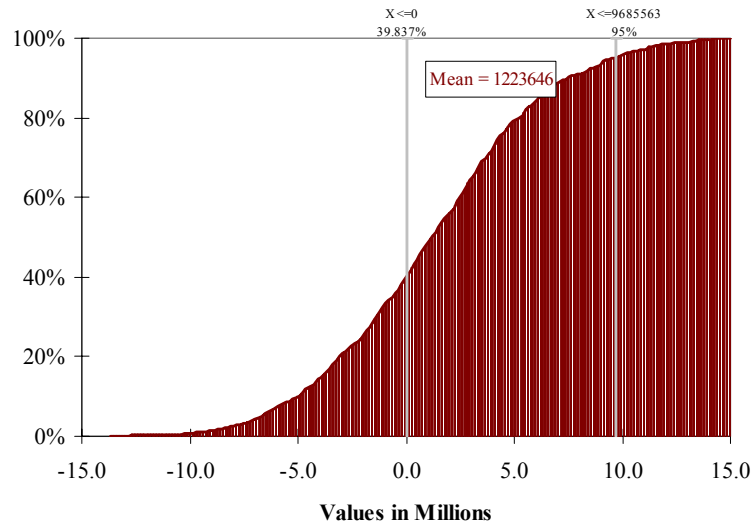
		Unit Annual Office Rental (\$/sf p.a.)						
		36.00	42.00	48.00	54.00	60.00	66.00	72.00
Incremental Operational	1.20	1,164,553	1,333,158	1,501,763	1,670,367	1,838,972	2,007,577	2,176,182
	1.80	861,784	1,030,388	1,198,993	1,367,598	1,536,203	1,704,807	1,873,412
	2.40	559,014	727,619	896,224	1,064,828	1,233,433	1,402,038	1,570,643
	3.00	256,245	424,849	593,454	762,059	930,664	1,099,268	1,267,873
	3.60	-46,525	122,080	290,685	459,289	627,894	796,499	965,104
	4.20	-349,294	-180,689	-12,085	156,520	325,125	493,730	662,334
	4.80	-652,064	-483,459	-314,854	-146,249	22,355	190,960	359,565
	5.40	-954,833	-786,228	-617,624	-449,019	-280,414	-111,809	56,795
Unit Investment cost in	12.00	2,011,014	2,179,619	2,348,224	2,516,828	2,685,433	2,854,038	3,022,643
	24.00	1,527,014	1,695,619	1,864,224	2,032,828	2,201,433	2,370,038	2,538,643
	36.00	1,043,014	1,211,619	1,380,224	1,548,828	1,717,433	1,886,038	2,054,643
	48.00	559,014	727,619	896,224	1,064,828	1,233,433	1,402,038	1,570,643
	60.00	75,014	243,619	412,224	580,828	749,433	918,038	1,086,643
	72.00	-408,986	-240,381	-71,776	96,828	265,433	434,038	602,643
	84.00	-892,986	-724,381	-555,776	-387,172	-218,567	-49,962	118,643

Figure 6: Sensitivity Analysis of INPV



Based on the cumulative distribution of INPV in Figure 7, the investment in the ICT and broadband services will only turn out to be infeasible (i.e. $INPV < 0$, with only a probability of 39.84%).

Figure 7: Distribution of Incremental NPV (\$)



Conclusion

Suntec City is one of the real estate industry's best examples in which ICT and broadband technologies have been strongly embraced to enhance the competitiveness and marketability of its office space. In a mailed questionnaire survey participated in by 24 major commercial developers who are members of the Real Estate Development Association of Singapore (REDAS), 60% of the sample developer firms experienced strong competition in attracting and retaining lessees against office buildings equipped with ICT and broadband facilities. Sixty-seven percent of those who experienced competition from the better-connected buildings indicated that they have plans to upgrade existing ICT and broadband facilities in the next three years. They expected the upgrades to enhance the marketability of their buildings (71%), and also help them attract tenants who are willing to pay a premium for the ICT and broadband services (43%). On the other hand, high capital investment (56%) was the main reason cited by those who did not feel the need to upgrade their existing ICT and broadband facilities. For the respondents who planned to upgrade, they were prepared to absorb the capital costs of upgrading or to pass the costs to third-party broadband suppliers.

In the post-upgrade period, the majority of respondent firms felt that ICT and broadband services would have positive impacts on occupancy rates (58%), rents (46%), and running and maintenance costs of their buildings (61%). These responses were consistent with the earlier observations by Thompson and Hill (1999) and Almond (2001). In addition to the above factors, we also identified the network externality that is created with the broadband connectivity in an office building. With all these factors in mind, we developed an incremental net present value model to estimate the economic gain of investing in ICT and broadband connectivity, and applied this model to Suntec City Tower One in our case analysis.

Based on our assumptions on the input variables, we found that the differentiating premium associated with the ICT and broadband connectivity was estimated at \$896,224, which is approximately 3.86% of the unit rental value. When probabilistic uncertainties were added to selected variables in a simulation process, the ICT and broadband-related rental premium increased to 5.27%. However, it shall be noted that these rental premiums estimated by the simulation model do not capture other intangible economic benefits like an enhanced landlord-tenant relationship, lower leasing risks, higher market branding and image, the prestige of certain buildings, and other perceived value improvements. Empirical verification of the simulation results using actual empirical data, if they are available, will be an important area of research in the future.

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