Abstract:

Suntec City, the 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. A mailed questionnaire survey was conducted to evaluate other developers’ perception and strategic plans for the ICT and Broadband Technologies in their respective office buildings. An incremental net present value model, which encapsulates the above factor and a network externality, was also developed 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 are added to selected variables in a simulation process, the ICT and broadband related rental premium increases to 5.27%.

Key words: Information and communication Technology, Broadband Connectivity, Network Externality
1. **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 the Information and Communication Technology (ICT) will bring to the real estate market. The Chairman of one of the largest public listed real estate firms in Singapore, City Developments Limited, Mr Kwek Leng Beng expressed his apprehension in the Business Times (Singapore) (21 September 1999)\textsuperscript{1} that

“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 of 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 in the sky?”

Would we end up with “empty container 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\textsuperscript{2}, argued that “as more companies begin facing jobs vs. space choices, space reduction programs will spread to the point of 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 argues with careful economic reasoning that 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 location 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 facing 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 sub-urban areas. The ICT-induced space consolidation program puts downward pressure on the office space demand in the prime office space in the central business districts (CBD). However, there were developers in the market who take a positive view that wiring-up can add value to their office buildings and help them to remain competitive in the commercial real estate market:

\textsuperscript{1} Eng, C., 1999, “Singapore at Home & Abroad: Call for Flexibility in Use of Office Space,” *Business Times (Singapore)*, 21 September 1999.

“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 Development

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 project since the early 1999. Touted as the “Asia’s Vertical Silicon Valley,” Suntec City has effectively leveraged on ICT and broadband technologies to enhance office connectivity, a much sought-after feature that puts together a valuable network of companies in IT and financial services in Suntec City. How have other office developers and landlords reacted to the Suntec’s type of ICT and broadband strategy? In a survey involving 20 office scheme in Thames Valley in the UK, Spurge and Almond (2002) found that there were generally mixed views of the 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 the local developers and/or landlords with respects 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 is 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 City 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 the member of the Real Estate Developers’ Association of Singapore (REDAS). The economic gains of the ICT and broadband (ICTB) technologies are numerically analyzed, based a set of input assumptions, using a probabilistic simulation model in Sections 5 and 6. Section 7 concludes the findings and highlights the limitations in the study.

2. Literature Review

Information and communication technology (ICT) and broadband connectivity have become an important and indispensable feature of today’s commercial buildings. Research thus far focuses mainly on issues relating to occupiers’ working practices and operational changes in responses to the increasing ICT and broadband usage rate (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.

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Broadband technology, which is the backbone for high-speed data transmission, enhances the efficiency of various ICT applications like email, mobile telephone, internet, video-conferencing in business today. The ICT and broadband technologies are thus inter-dependent. These technologies are found to be vital and very important by 86% of UK firms in the Thames Valley Corridor surveyed by Spurge (2002). Lease line and Asymmetric Digital Subscriber Line (ADSL) were the two most common form of broadband infrastructure used. 82.0% of the sample firms in Spurge (2002) survey were connected to the broadband facilities via leased lines and 26.2% has broadband connection via the ADSL lines. Majority of the sample firms also feel that the broadband technology will have significant positive impact on business efficiency (93%) and the adoption of new working practices. However, the perceived impact of the ICTB technologies on office space was less conclusive, and the responses also vary according to the firms’ business activities.

An explosive demand for broadband in the UK has been evidenced in the connectivity index developed by King Sturge (2001), which shows a more than 20-time jump from 100 point in 1997 to more than 2100 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 Singaporean have high-speed online connection. As the broadband technology become more pervasive, occupiers’ dependence on the 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, wiring-up office buildings will be as indispensable as the provision of other standard services like lift, air-conditioning, telephone exchanges, security system and others in an office building (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 the cash flow streams (Thomson and Hills, 1999; Almond, 2001). Thomson and Hills (1999) use 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 line in a new 150,000 square feet office building in Central London could be paid-back in four-year 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 breakeven in five years, and this scenario is attained on the assumption that a high level of service penetration rate is achieved (20% in year one, 40% in year two and 60% in year three to five).

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4 The ICT and broadband technology terms are also used inter-changeably 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 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 structure: ADSL, leased line, fibre optics and wireless networks.

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

7 The King-Sturge connectivity index (2001) is 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.


9 Almond (2001) supports that the value of broadband wiring for an office building can be derived through reduced tenant turnover, fewer void periods, improved marketability, and also additional revenue source from providing telecom services. He, however, does not think that higher rents can be obtained through wiring up a building.
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 occupiers. Majority of them have a clear broadband strategy for their office project, whereas three out of the eight developers feel that the broadband services should be considered as part of the fitting out of the occupiers’ space. Speculative wiring of new office buildings and the exclusive agreement with a single telecom supplier are no longer practiced following the bad experience after the dot-com burst. 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 also allow tenants the flexibility to make their own arrangement for broadband supply, subject to payments of rents for the use of the ducts. Developers will share a fraction of the revenue generated from the broadband services. However, the financial incentive from the broadband connectivity is limited, compared to the higher tenant’s satisfaction and improved relationship with the tenants through wiring of the office building.

Almond (2001) agrees that broadband connected buildings enjoy a competitive advantage, but he does not think strongly that the benefits of wiring the building will come from higher rents. The competitive edge will diminish in longer terms when more buildings become wired (Almond, 2001). Therefore, it is always important for office landlords and developers to stay ahead in the competition and keep abreast with the newest and latest ICT (Spurge, 2002). The IT “waves,” which represent different phases of ICT projects, are the business model adopted by the Suntec City management to propel ahead and maintain its leadership position in the competitive real estate market. We will examine the ICT and broadband strategies in Suntec City 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.

3. **Suntec’s Wave**

3.1 **Suntec City – Case Facts**

Suntec City touted as “The Asia’s Vertical Silicon Valley” is comprised of five office towers, and it has effectively embraced broadband connectivity and ICT to position the project as one of the most sought after commercial space in Singapore. Suntec City, 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) 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 City project offers 4.3 million sq. ft of office, retail and conference facilities, and the breakdown of space usage in Suntec City is summarized in Table 1.

Strategically located in the heart of the Marina Centre, Suntec City 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.

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10 The Urban Redevelopment Authority (URA) is the national planning agency of Singapore, which is responsible for the long-term physical and transportation planning of the island-state. It is also the government agent administering the land sale program by tender for state-owned lands.
### Table 1: Breakdown of Space Usage in Suntec City

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

#### 3.2 Broadband Connectivity

From early 1999, a slew of ICT and broadband initiatives, which include fibre optic broadband access, instant networking, digital offices, common telecommunication connection, internet call center, 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 City has attracted close to 200 IT companies ranging from the established names like Microsoft, Oracle, NCR, Fuji 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 also 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 in the good years, and the rental rate has also outperformed that commanded by premier office buildings located in the traditional CBD area.

With the concerted effort to improve connectivity via broadband facilities and its continuous “waves” of IT initiatives, Suntec City has been able to position itself as the premier IT hub in Singapore. The Suntec City Model has revolutionized from a typical landlord into a Facilities Service Provider (FSP), who offers its occupants not just the physical space, but value creation via networking avenues and new business opportunities.\(^{11}\) The success and proven records of Suntec City has earned it the reputation of the “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 City. However, should these strategies be embraced and replicated in comparable buildings by other developers, would the same effects be reaped? If the answer is “yes”, why are the rivaled developers not aggressively adopting the strategies? What are the drivers and barriers of developers in the adoption of such strategies? The above are series of interesting research questions that would be explored in through questionnaire responses obtained from other developers in the next section.

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\(^{11}\) 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.
4. **Responses of Developers**

4.1 **Survey Sampling**

The sample survey firms were mainly drawn from the membership lists of the Real Estate Developers’ Association of Singapore (REDAS). 300 mailed questionnaires were sent to the sample firms. There were 5% attrition rates due to unsuccessful delivery of the questionnaire. 14% of sample firms do not wish to participate in the survey citing the reasons like their core business is not in real estate, they do not own office buildings in the CBD and others. After eliminating these earlier withdrawals, we manage to receive 24 replies from the sample firms, inclusive of the reply from Suntec City, over the sampling periods in 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 informed that they were either not sure or they did not have the technical knowledge in the ICT and broadband technologies subject to provide useful feedback. Out of the 24 firms who participated in the exercise, 16 of them were involved in real estate development and investment activities, and 3 were in consultancy and project management business. The remaining 5 firms were REDAS affiliated members, whose core business is not in real estate.

4.2 **Survey Results**

The survey findings summarized in this section reflect the general perceptions of the sample developers of their roles in the provision of the ICT and broadband technologies in office buildings. We also examine the differences in the perceptions, if any, between Suntec City (hereafter referred to as Suntec in short) and other developers and sample firms.

4.2.1. **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, building automation were high. While, Suntec did not feel strong competition from newly constructed office buildings equipped with advanced ICT and broadband facilities in attracting and retaining lessees, but the strong competition was acknowledged by 60% of the sample developer firms. 67% of the developers, who face strong competition, adopt strategies to upgrade their ICT and wire-up their buildings in order to shore up the competition against the better-connected buildings. Two of them will also consider lowering their rental concurrently to retain the existing lessees. Only one developer who did not have any plan to improve ICT and broadband connectivity in view of this competition.

4.2.2. **Improvement and Upgrading of ICT and Broadband Facilities**

38% of the sample firms did not have plans to upgrade the ICT features and connectivity in their buildings in the medium-term. The high costs of investment were cited by 56% of them as the main cause for not doing so. For the 14 sample firms inclusive of Suntec that plan to upgrade the ICT connectivity to their buildings, 71% of them believe that wired buildings will enhance marketability of the buildings and 43% of them think that the ICT upgrading is necessary to attract new lessees who demand for such connectivity in the building.

On the arrangement to provide ICT and broadband facilities to the office lessees, Suntec has linked up with three world-class telecommunication firms, Tridor, StarHub and MCI WorldCom to provide broadband and ICT services to the lessees. It also forms 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 plan to upgrade their ICT and broadband facilities, 21% of them are prepared to absorb the capital costs of upgrading and the other 19% will pass the costs to third-party broadband suppliers (Figure 1).

[Insert Figure 1]

4.2.3. Revenue and Operating Cost in Wired Office Building

The study also evaluates how investments in ICT and broadband connectivity will affect the operation and revenues of the 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-upgrading period, 58% of the respondents felt that occupancy rate would improve, but only 46% of them felt that the ICT ready and broadband connected buildings would command higher rents (Figure 2). 61% of the respondents also predicted that the maintenance and running costs of the upgraded buildings would increase in the long run.

[Insert Figure 2]

4.2.4. 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 the proximity to public transports to be the most important location factor followed by the CBD 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-third or 67% of the respondent to have a level of importance scale of 4 (very important) and above (most important) (Figure 4).

[Insert Figures 3 & 4]

5. Economic Benefit of Information Communication & Broadband Technologies

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

Using 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 the broadband and ICT connectivity, can be
determined, after controlling for variations in the building and location attributes. We also apply
probabilistic simulation models to account for uncertainty in the assumptions for selected variables.

5.1 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 positive impacts
on occupancy rate (58%), rent (46%) and running and maintenance costs of the building (61%).

The results were not inconsistent with the assumptions in Thomson and Hill (1999) and Almond
(2002) models. They predict 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 improved marketability of the building. Higher rents were included in
Thomson and Hill (1999) model, but not in Almond (2002) model also include as an additional
economic benefit of wiring an office building. 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. Comparing with an unwired office building, the first incremental revenue will be
generated from improved occupancy rate and also occupation charges on the broadband services,
while keeping the rent unchanged. The second source of revenue is derived as a result of the
network effects created by broadband usages. On the cost aspect, we assume that developers will
have to fork up 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 the rapid advancement 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 be fully depreciated over these periods.

5.1.1 Valuing Network Effects

The network effect, a concept defined by Katz and Shapiro (1985, 1994), is a market phenomenon
where “surplus\textsuperscript{12} 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
defined when the utility of a user increases when 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
the telecommunication products like fax machines, telephone and broadband. The network
externality in office building and other real estate is a research area, which has been neglected in
the mainstream corporate real estate literature. The traditional valuation theory is also silent on how
this externality can be valued.

Suntec City is a real world example, where the management has capitalized the network effects
through striking partnership and forming strategic alliance with their tenants in providing an
interconnected office environment. Examples of these mutually beneficial initiatives include
allowing Tridor, StarHub and MCIWorldcom to provide telecommunication services to Suntec City
tenants, and forming tripartite alliance with Atos Origin and iCentric Software to provide
application service provider (ASP) accounting software to the tenants. Suntec City’s network has
reached a critical mass, where self-reinforcement of the network occurs. Every time when a new
tenant joins in the network and brings with them added value to the network, the tenants will at the

\textsuperscript{12} Consumer surplus is an economic term, which 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 assuming that the price is constant.
same time reap the network value already existed through the connectivity with other tenants. Suntec City manages to attract a good mix of IT and finance firms. These firms are prepared to pay a premium for the office space, because the economic benefits of being able to tap into the network of other tenants in Suntec City far outweigh the rental premiums. The positive network externality not only contributes a positive premium to the physical office space in Suntec City, it also earns Suntec City the reputation of the “Asia’s Vertical Silicon Valley.”

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 subsequent 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 of the network connectivity. The size of an office building corresponds directly to the economics of scale advantage in the creation of network effects. However, the network externality can be neutralized when more buildings are inter-connected.

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 reduce 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, \[N(\pi) = q^\alpha(\alpha Q - q)\], where \(\pi\) reflects the market penetration rate and \(\alpha\) 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 when an increase in one of unit of office space will result in a reduction in the network value is set at critical point of \(\frac{\alpha Q}{2}\), when \(\frac{dN(\pi)}{dq} = 0\). If a constant “shadow” network value, \(r_e\), 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 \[P(q) = r_e \cdot N(\pi)\].

[Insert Figure 5]

5.1.2. Incremental Valuation Model for A 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 the Suntec City’s decision in the ICT and broadband investment, \([\text{INPV}(q)]\), can be estimated using the following equation,

\[
\text{INPV}(q) = \sum_{i=1}^{T} \left[ r_i \cdot (\Delta \alpha \cdot q)^{b} - \Delta c \cdot q^{c} \right] \cdot (1 + i_c)^{-t} + \sum_{i=1}^{T} \left[ r_i \cdot q + r_e \cdot N(\pi) \right] \cdot (1 + i_c)^{-t} - I_0 \cdot q \\
(1)
\]

\(^{13}\) On the assumption that consumers are homogenous in their valuation of network externality, Kart and Shapiro (1985) develop a simple model to value a consumer’s willingness to pay for a product with expected network size of \(y\). The model comprises two component in the pricing of the product, \([r + v(y)]\), where \(r\) is the intrinsic value of the product, and \(v(y)\) is the value of network externality attached by the consumer, which is a function of the network size.
where,

- \( r_s \) = Unit annual rental for office space (S$/sf per annum)
- \( r_b \) = Annual charges/revenues shared with telecommunication suppliers for the use of the right to supply broadband services to the tenants (S$/sf per annum)
- \( r_e \) = Unit annual rental premium that tenants will pay for the connectivity benefit (S$/sf per annum)
- \( \Delta c \) = Incremental unit annual costs incurred in keeping the broadband and ICT services in operation condition (S$/sf per annum)
- \( I_0 \) = Unit Fixed lump sum investment costs incurred upfront in laying the ICT and Broadband technologies in the building ($/sf)
- \( \Delta o \) = 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 (\( \pi \)) and the market size multiplier (\( \alpha \)).
- \( \gamma \) = Elasticity of scale measure for the incremental operation costs, where \( \gamma \geq 1 \) to reflect a convexity of the cost curve
- \( \theta \) = Elasticity of scale measure for the incremental rental, where \( \theta \leq 1 \) to indicate 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 will be fully depreciated at the end of time \( T \).

The right hand side of equation (1) for INPV can be decomposed into three components. The first two components represent the additional revenue sources as a result of the ICT and broadband services. The first term refers to an increase in rental revenue from leasable space, and the second term is 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 system in the operational mode all the time. These costs exclude those expenses that will have been incurred to keep the normal operation of the building, whether wired or non-wired. We build in different elasticity of scale measures to the rental and cost function to allow adjustments for size effects.

The second revenue term is associated with the network effects created by the ICT and broadband connectivity in the office building. Firms will pay additional rental premiums to be connected to the existing network in the office building. At the same time, we also assume that the 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 the 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 broadband cables compared to un-wired office buildings. Therefore, we assume that a lump sum fixed cost of \( q*I_0 \) will be incurred at the beginning of the period in this analysis. This cost will be fully depreciated over a fixed time-span that coincides with the lifespan of the technologies.
6. Simulation Analysis

6.1 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 the q=484,000 square feet office space is evaluated over a time span of T=5 years. For our illustration purposes, the network externality factor is set at 2.08 on the assumption that the market penetration rate is $\pi = 25\%$ and the office size multiplier is $\alpha = 1.0$ (Figure 5). Assumptions for other input variables are listed in Table 2.\textsuperscript{14}

For a base case scenario, all the variables in Table 2 are assumed to be deterministic, and the incremental net positive (negative) value represents the economic benefits (losses) of taking the decision to invest in ICT and broadband technologies in the subject office building.

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

Next, we build in dynamics to the deterministic INPV model by incorporating probability distributions for selected variables to account for possible uncertainties in a real environment (Table 3). The probabilistic nature of the variables will be simulated jointly using @Risk program to derive at the dynamic INPV and the distributions.

<table>
<thead>
<tr>
<th>Probabilistic Variable</th>
<th>Probability Distribution Type</th>
<th>Specification of Distribution Function in @Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental Occupancy $\Delta o$</td>
<td>Discrete distribution</td>
<td>RiskDiscrete(0.05, 0.1, 0.15, 0.2, 0.25) (5, 6, 4, 2, 1)</td>
</tr>
<tr>
<td>Incremental Operating Cost $\Delta c$</td>
<td>Triangular distribution</td>
<td>RiskTriang (0.0, 0.2, 0.4)</td>
</tr>
<tr>
<td>Annual shared revenue from ICT&amp;B Services $r_b$</td>
<td>Normal distribution</td>
<td>RiskNormal(0.1, 0.1)</td>
</tr>
<tr>
<td>Network Externality Value $r_e$</td>
<td>Normal distribution</td>
<td>RiskNormal (0.25, 0.5)</td>
</tr>
<tr>
<td>Unit Fixed Investment Cost $I_0$</td>
<td>Lognormal distribution</td>
<td>RiskLognorm (4, 2)</td>
</tr>
</tbody>
</table>

\textsuperscript{14} Network externality valuation is a relatively new research area in corporate real estate. Empirical data are not available at this stage to verify the input parameters associated with the 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 are obtained.
Based on the assumptions given in Table 2, the deterministic INPV on the feasibility of providing ICT and Broadband in Suntec Tower One turns up to be positive and estimated at $896,224, which is converted to a premium of 3.86% of the unit rental value. We further examine the sensitivity of the INPV by changing the value range for unit rental value, (r_u: $36.00/sf p.a. to $72.00/sf p.a.), incremental operating cost (Δc: $1.20/sf pa. 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 4. 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 pre-defined 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. 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%.

7. Conclusion

Suntec City, the Asia’s Vertical Silicon Valley, is one of the real estate examples where ICT and broadband technologies have been strongly embraced to enhance the competitiveness and marketability of its office space. In a mailed questionnaire survey participated by 24 major commercial developers who are the member of Real Estate Development Association of Singapore (REDAS) members, 60% of the sample developer firms felt strong competition in attracting and
retaining lessees against office buildings equipped with ICT and broadband facilities. 67% of those who felt competition from the better-connected buildings indicated that they have plans to upgrade the existing ICT and broadband facilities in 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%). 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 plan to upgrade, they are prepared to absorb the capital costs of upgrading or to pass the costs to a third-party broadband suppliers.

In the post-upgrading period, the majority of respondent firms felt that ICT and Broadband services would have positive impacts on occupancy rate (58%), rent (46%) and running and maintenance costs of the building (61%). These responses were consistent with the earlier observations in Thompson and Hills (1999) and Almond (2001). In addition to the above factors, we also identify the network externality that is created with the broadband connectivity in an office building. With all these factors in mind, we develop an incremental net present value model to estimate the economic gain of investing in ICT and broadband connectivity and apply 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 converted to an approximately 3.86% of the unit rental value. When probabilistic uncertainties are added to selected variables in a simulation process, the ICT and broadband related rental premium increases 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 enhanced landlord-tenant relationship, lower leasing risks, higher market branding and image, prestige of building and other perceived value improvement. Empirical verification of the simulation results using actual empirical data, if they are available, will be an important area of research in the future.

Acknowledgement:

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Reference:


Figure 1: Ways to recovery the capital costs of upgrading the ICT and Broadband services

- Increase rent: 15%
- Increase services charge: 15%
- Co-share the costs with lessees/strata-titled owners: 11%
- Recover costs over a fixed period of time by charging fees on the use: 21%
- Absorb the costs as part of their value enhancement program: 19%
- Pass costs to a 3rd-party broadband & ISP: 4%
- Others: 15%

Figure 2: Post-Upgrading of ICT & Broadband Facilities Effects on The Revenue Variables

**Revenue Variables:**

- Default/Pre-termination of leases: 66.7% increase, 8.3% no effect, 13% decrease
- Fee income from ICT/Broadband Services: 45.8% increase, 41.7% no effect, 13% decrease
- Occupancy Rate (%): 58.3% increase, 33.3% no effect, 13% decrease
- Net Rent ($psf/mth): 45.8% increase, 45.8% no effect, 13% decrease

% of Respondents
Figure 3: Major Location Attributes in Office Buildings

Figure 4: Major Property Attributes that Differentiate Office Buildings
Figure 5: Normalized Network Externality Curves

![Normalized Network Externality Curves](image)

Figure 6: Sensitivity Analysis of INPV

![Sensitivity Analysis of INPV](image)
Figure 7: Distribution of Incremental NPV ($)

Mean = 1223646

Values in Millions