ENVIRONMENTALLY SUSTAINABLE DEVELOPMENT: A LIFE CYCLE COSTING APPROACH FOR A COMMERCIAL OFFICE BUILDING IN MELBOURNE, AUSTRALIA

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A range of property and construction options is analysed using standard life cycle costing methodology. The options are to renovate the existing building, buy an alternative building and renovate and buy a development site and construct a new building. The do nothing option and a hypothetical option to construct a new building on an ideal site are analysed as benchmarks. Life cycle costing principles are discussed in particular where assessment difficulties are caused as a result of market pricing and taxation related to energy tariffs, greenhouse gas emissions, tax deductibility and depreciation allowances. The results show that the optimum option is to buy a suitable site and construct a new building and that the least sustainable option, in the case study, is to stay in the existing property and renovate the building. Although staying in the existing building and doing nothing is the lowest financial cost, the energy and greenhouse emissions are significantly worse than the alternative options.

Keywords: building accommodation options, energy, greenhouse gas, life cycle cost.

INTRODUCTION

This project consists of a study into the specification, modelling and post-construction performance measurement of an environmentally designed ecologically sustainable commercial office building (Bamford *et al.* 1998). The project is being carried out by a research team at the University of Melbourne which has been supported by the Australian Research Council and by industry partners, namely, Lincolne Scott Australia and the Australian Conservation Foundation (ACF). Two activities are being conducted in parallel, first, the body of research and second, the provision of future accommodation for the ACF. The project is of approximately three years' duration. Broadly, the first year comprises the selection of a suitable location and the pre-design and design work; the second year will comprise contract documentation and construction and the third year is to comprise the commissioning, occupation and performance measurement of the new premises. This latter process will carry on beyond the end of the main project period as the ACF property will provide a continuing and important laboratory for the observation of workplace practices and facilities management.

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The purpose of this paper is to analyse a range of property and construction options to assist the ACF to crystallize ideas on the location and configuration of its future Headquarters premises in Melbourne. The paper concentrates on a discussion of:

- property and construction matters including a sample of available properties,
- life cycle costing and energy including the provision of comparative figures for the broad options.

PROPERTY

Several key property and construction issues have been identified in this study. These issues relate to the acceptance of the project by the property market and, accordingly, the project must be commercially viable. Tenure, location and risk are also discussed.

Commercial viability

A detailed viability study is to be prepared and this must demonstrate that the project is financially feasible. At present, city office property in Melbourne is still affected by the oversupply of office space during the 1980s and the recession that followed and market rentals are at about half the levels required for project feasibility (Flannigan, Parker and Robinson 1999). However, city fringe and suburban office properties were not affected by the recession to the same degree and are presently demonstrating rentals at close to viability levels. Accordingly, the should be capable of financial viability having regard to the main development variables such as the likely cost of a low rise investment quality office project together with an internal fitout and the likely rental value and operating costs.

Commercial office properties provide car-parking spaces sufficient to attract users. This may vary from the minimum required by planning regulations to a space for every employee (which may form part of each employee's salary package). Associated with most office premises, senior management has spaces provided whilst other managers and operatives are required to find and fund their own car parking. ACF will need to consider the formulation of a car parking policy having regard to the dichotomy between market acceptance and environmental best practice.

Ownership/tenure

The main types of tenure for commercial office space are either leasehold or freehold. The ownership of business premises provides security of tenure and an associated investment opportunity. However, it ties up capital that might otherwise be applied to the business concern and it requires the owner to face the risks of obsolescence. The leasehold provides all of the rights of ownership but for a limited term. However, the ability of a tenant to obtain high environmental and ecological standards in leased premises is entirely dependent upon a sympathetic landlord. A preference for freehold ownership has been articulated so that the ACF has full control of the building design, configuration and operation, and the opportunity to gain the benefits of capital appreciation.

Location

In respect of the location of the accommodation, it has been decided that the building should ideally be:

- in the central area of Melbourne,
- on a site with excellent public transport access,

- in a prominent location.

The efficiency of individual access to public transport has necessitated a concentration of effort in certain localities of the central area of Melbourne. For example, the present location requires a transfer of public transport modes (in some cases two transfers) for many of the ACF staff and this has resulted in their preference for car access. Accordingly, the search for a suitable location is concentrated in localities within walking distance (a few hundred metres) of the Melbourne underground rail loop.

Inner city sites are usually constrained by land area, shape and surrounding buildings that will affect thermal performance and access to natural light. In order to make the best use of solar energy and natural light, the ideal site would be oriented to have a northern frontage and, with the exception of the western elevation, avoidance of overshadowing by adjoining buildings.

Disruption, relocation and risk

If a decision is made to remain at the present premises, the ACF operation will face substantial disruption due to construction site operations unless it relocates temporarily. This disruption would be avoided if the ACF decides on a new building as it would relocate on completion of construction or refurbishment. It could also be avoided by moving out of the existing property for the duration of the construction period and moving back in on completion.

Assuming that the optimum option is to move to alternative premises, the ACF will dispose of its present property. Given the cyclic nature of the property market, the ACF would wish to avoid a potential problem where it acquired a new property in one market and disposed of its existing property in another market. If it is considered that it would be better to sell in the present market, the ACF would need to consider the costs of two relocations (as for the option to remain in the existing premises). Ultimately, there would be a trade-off between the (potentially) reduced price in the sale and leaseback scenario and the additional costs associated with two relocations.

ENERGY

Energy use in buildings may be classified as embodied energy, operational energy and transport energy.

Embodied energy

Embodied energy is the energy associated with the production of the materials used in the building structure, services and finishes. A new building will have a relatively high embodied energy component where a recycled building will have a relatively low embodied energy component as the energy associated with the existing structure and retained components is not counted. In addition, there will be energy associated with the disposal of the building. Some broad studies in respect of embodied energy have been undertaken (Aye *et al.* 1999).

Operating energy

Operating energy is that associated with the running of the building systems such as heating and ventilation, air conditioning, lighting and power and vertical transportation. An industry partner, Lincolne Scott Australia, has undertaken some analyses to demonstrate the potential savings in operational energy. These show that substantial savings may be made in both energy use and life cycle cost terms when comparing a typical building design with an energy efficient building design (in the order of $500 per sq m over 25 years) (Lincolne Scott Australia 1998).

Transport energy

Transport energy is that energy associated with the location of the premises. If a location with good access to public transport is selected, then the transport energy will be lower than a location requiring a large proportion of the staff and visitors to arrive by private car. Whilst the present location is close to public transport (trams and buses), its relative lack of convenience makes it a higher energy location than, say, a building close to the underground rail loop. However, due to the required central location, it has been assumed at this stage that the transport energy costs are equivalent for all options.

LIFE CYCLE COSTING

Life cycle costing methods have been used in decisions about property and construction options for many years (Flanagan and Norman 1983; Stone 1980). Robinson (1984) has expounded on levels of complexity of life cycle costing: the experiential, the feasible and the technical. The present study is at the feasible level, i.e., a broad analysis. The more detailed technical study is illustrated elsewhere (Robinson 1996b). Each of the options is costed to take into account the following life cycle costs and benefits:

the value of the property (either the purchase price of an alternative or the value of the existing property in the do nothing option) (normally this would include an assessment of the transport energy associated with the location).

the cost of any building or renovation works (including the embodied energy in the building materials specified). Building costs have been adopted using published data (Rawlinsons 1998) at $1,500 per m^2 for new construction and $1,700 per m^2 for a regenerated structure (both including an allowance for tenancy fitout).

- the operating costs of the building which are classified into variable costs (energy, maintenance, cleaning) and fixed costs (insurance, rates and taxes). Energy costs have been assessed in detail and other variable and fixed costs at $50 per m^2 per annum have been allowed in all options,
- energy prices are assumed to be constant at current prices over the life of the buildings,
- all options (except do nothing) meet the typical energy design target for offices in Melbourne (Building Owners' and Managers' Association (BOMA) 1994).
- the life cycle CO_2 calculation is based on 1.2 kg/kWh for brown coal and 0.56 kg/kWh for natural gas (Sligar 1995).
- disposal (demolition) costs/recycling benefits. The disposal costs depend on the building materials used and the method of the disposal (demolish, reuse, recycle). In this preliminary analysis costs of disposal have been allowed at $50 per m^2 for all options.

Rental income from tenants has been ignored.

In commercial feasibility studies, all future costs are discounted to reflect the time value of money and this has been undertaken for operating costs excluding energy costs. However, where non-renewable energy sources are contemplated, a current theory is that these costs should not be discounted as discounting implies replacement. Since energy prices are substantially discounted, the theory goes on to suggest that consideration should be given to compounding energy costs in comparative life cycle cost studies. This issue will be taken up during the production of detailed feasibility studies of the short listed properties. For the purposes of this report, future energy costs have not been discounted but all other future costs have been discounted (capitalized) at 10%.

OPTIONS

The choice of business premises is invariably reduced to the classic rent versus buy decision (Robinson 1996a). Various approaches and opportunities are researched and compared with the "do nothing" or "status quo" base case. The ACF requires premises with a floor area of approximately 1,200 m^2 and this includes expansion space.

The options examined are:

- remain in the existing property and renovate,
- acquire an existing building and renovate,
- acquire land and construct a new building.

For the purposes of this initial study, details of two properties that were available for sale in a city fringe location have been obtained. The location has been chosen because of its superior accessibility to public transport and to the central activities district of Melbourne. One of these properties has a two-storey building that would need substantial refurbishment and the addition of a third level. The other one has a relatively modern but lightweight structure on the site that would need to be demolished before a suitable new building could be erected. These are detailed below. The two sites have been used as typical sites to model the options, not because they are final recommendations.

As a benchmark, the true "do nothing" option has been analysed together with the acquisition of an "ideal" site (mentioned above) and the construction of a new building.

The five options are compared using life cycle cost methods over 25 years at Tables 1 and 2. The assumptions used are outlined below.

EXISTING PROPERTY: DO NOTHING

The existing property comprises a two-storey load bearing brick building. The land area is approximately 1,100 m^2 and the building area is approximately 2,200 m^2. ACF occupies the top floor with office space and most of the ground floor with car parking and storage. A tenant occupies the remainder of the ground floor and some kindred organizations rent some of the first floor offices. The floor area occupied by ACF is under-utilized.

It is presently valued at $1,500,000 to $1,700,000. Having regard to the very strong demand for inner city development sites, a figure of $1,600,000 is adopted. A do nothing scenario and a refurbishment scenario are modelled.

Table 1: Life cycle costs and values

Option	Do nothing	Refurbish existing	Buy & refurbish	Buy & build	Buy & build "ideal" site
Initial property cost	$1,600,000	$1,600,000	$1,100,000	$900,000	$1,000,000
Floor area (sq m)	1173	1173	1350	2500	2500
Building cost per sq m					
new building			$1,500	$1,500	$1,500
refurbishment		$1,700	$1,700		
Building cost total	$0	$1,994,100	$2,160,000	$3,750,000	$3,750,000
Electricity per year	$7,360	$7,500	$8,000	$14,000	$12,000
Gas per year	$4,060	$1,400	$1,600	$2,500	$2,000
Total energy costs	$285,500	$222,500	$240,000	$412,500	$350,000
Other Recurring costs	$526,500	$586,500	$675,000	$1,250,000	$1,250,000
Costs of disposal	$117,300	$117,300	$67,500	$125,000	$125,000
Total Life Cycle Costs	$2,529,300	$4,520,400	$4,242,500	$6,437,500	$6,475,000
Costs per sq m	$2,156	$3,854	$3,143	$2,575	$2,590
Value per sq m	$1,600	$2,400	$2,500	$2,600	$2,750

Table 2: Life cycle costs (energy and greenhouse gas emissions)

Option	Do nothing	Refurbish existing	Buy & refurbish	Buy & build	Buy & build "ideal" site
Floor area (sq m)	1173	1173	1350	2500	2500
Electricity (kWh/yr)	43,000	43,800	46,700	81,790	70,110
Gas (MJ/yr)	446,000	153,800	175,760	274,630	219,700
Gas (kWh/yr)	123,888	42,720	48,822	76,282	61,028
Life cycle energy (kWh)	4,172,200	2,163,000	2,388,050	3,951,900	3,278,450
Energy per sq m (kWh/sqm)	3,557	1,844	1,769	1,581	1,311
Life cycle CO2 (kg)	3,024,432	1,912,080	2,084,508	3,521,704	2,957,692
CO2 per sq m (kg/sqm)	2,578	1,630	1,544	1,409	1,183

The current electricity usage is about 36 kWh per m^2 per annum and the gas usage is about 379 MJ per m^2 per annum. It should be noted that the gas usage (for heating purposes) is about three times higher than the typical design target for offices in Melbourne (BOMA 1994).

EXISTING PROPERTY - REFURBISH

The assumed level of refurbishment for the existing property is to upgrade the office area of 1173 m^2 on the first floor to provide a virtually new building whose efficiency and image will be equal to a new building. This includes:

- total re-design and replacement of facade with only the basic structure retained,
- re-planning and upgrading of entry,
- new state of the art and energy efficient services,
- a lift installation.

BUY AN EXISTING BUILDING AND REFURBISH

A property in inner Melbourne is used as a case study of the purchase and refurbishment of an exiting building. The total land area is 450 m^2 and the total building area is 900 m^2 over two floors. A planning permit has been issued for a third floor to be added which would increase the building area to 1,350 m^2. Some car parking can be provided on the ground floor.

This property was passed in at auction with a reserve of $1,200,000 and a price of $1,100,000 is possible.

The assumptions made on this option are:

- to construct another story on top of the existing building,
- to install standard finishes,
- to have air conditioning (i.e. energy efficient electric cooling and gas heating),
- to install a lift.

BUY A SITE AND BUILD A NEW BUILDING

Another property nearby is used to analyse the acquisition of a site and the construction of a new building. This property constitutes a motor service station with associated parts supply and office. For the purposes of this study, it is assumed that these improvements would be demolished.

The total land area is 1031 m^2 and it is expected that a new 3-storey building of 2,500 m^2 would be erected to achieve the highest and best use of the property. A price of $900,000 was achieved and this reflected the lease and rental from the existing tenant on the property.

The additional assumptions are:

- standard finishes,
- to have air conditioning (i.e. energy efficient electric cooling and gas heating),
- a lift installation.

IDEAL HYPOTHETICAL BUILDING AND LAND

An additional scenario comprising a new building on an "ideal" site is also assessed. An allowance of $1,000,000 is made for land acquisition. It is similar to the option to buy land and build a new building.

CONCLUSION

The life cycle cost results first show that the construction of a new building on a cleared site is only marginally more expensive per sq m than the do nothing option. They also show that the refurbishment of an existing building is substantially higher in cost than the construction of a new building. Second, the costs are compared with the market values. This comparison shows that the best financial life cycle alternatives are in order of preference:

- Buy and build,
- Buy and refurbish,
- Do nothing,
- Refurbish the existing building.

It is also shown that substantial life cycle energy and CO_2 emission savings can be made in all options when compared with the do nothing option (see Table 2). It is stressed that these are the results of broad calculations and these details will need to be refined for the short-listed properties. The value of all options is based on market rental values for comparable properties capitalized at 10%.

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