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LIFE-CYCLE COSTING AND THE PROCUREMENT OF NEW BUILDINGS
– The Future Direction of the Construction Industry

JEMIMA HIGHTON

Traditionally, building procurement was undertaken without further consideration as to the costs which would be incurred from acquisition to disposal. For all intents and purposes, such buildings were, amongst other things, to provide occupants with safe and secure shelter and deliver positive revenue streams and returns to the developer/registered proprietor/landlord. The registered proprietor/landlord has an obligation to ensure the building is maintained to an acceptable standard, which would require operation, maintenance, and repairs or replacement to building components and materials that had depreciated, failed and/or become obsolete. On the basis that buildings are long-term assets, attending to regular operation, maintenance and repairs or replacement was not only time consuming, but affected potentially favourable returns (Ellingham & Fawcett 2006; Kelly, Morledge & Wilkinson, 2008). As technology progressed and conventional issues arose, such as climate change, scarcity, wasting of resources and the like, closer attention was given to lowering the known financial, economic and environmental impact that buildings have on the triple bottom line (Angel, 2008; Holper & Torok, 2008; Ashworth, 2010). This, to date, has delivered a paradigm shift towards considering alternative procurement methods that provide scope to embrace the use of sustainability principles (Boussabaine & Kirkham, 2004). This would improve overall efficiency, performance, dependence on non-renewable resources and the like (Ashworth & Hogg, 2007; Angel, 2008, Ashworth, 2010). In turn, this mitigates the need for regular maintenance, repairs and unnecessary outlays, which impact on the overall life cycle costs of a building (Ashworth, 2010). Despite this new paradigm not being a formality, it is generally aligned with societal norms and legislation, which will shape how buildings will be procured into the future.

LIFE-CYCLE COSTING

Today, to consider the economic benefits and viability of a proposed building at the feasibility and design stage of procurement is essential. Assessment can be on the basis of Life-Cycle Costing (LCC), being 'the sum of acquisition cost and ownership cost for an asset over its life-cycle from design stage, manufacturing, usage, maintenance and disposal (ANAO, 2001, p.7). For this reason it is most important to make accurate decisions at the design stage, as such decisions will inevitably impact on the life cycle costs of the building (Flanagan & Jewell, 2005; Ellingham & Fawcett, 2006; Ashworth, 2010). LCC evaluates various cost elements, in particular materials and components used, energy, water consumption and the asset's overall performance (Kelly & Male, 1993; Ellingham & Fawcett, 2006; Ashworth & Hogg, 2007). Prior to undertaking this evaluation process, the type of procurement method needs to be determined.

The chosen procurement method will provide a fairly accurate indication at the onset, of the degree of operation, maintenance and repair costs throughout the life of the proposed building. Traditionally, procurement was based on the cheapest and quickest solution, which encouraged corner cutting and resulted in undesirable consequences such as higher capital expenditure in due course. The reason for this was that there was a lack of innovation, poor design and modest workmanship (Kelly & Male, 1993; Boussabaine & Kirkham, 2004; Ashworth & Hogg, 2007; March, 2009). Cheap, inferior materials and components that were not environmentally friendly, durable or built for longevity were used (Flanagan & Jewell, 2005; Ellingham & Fawcett, 2006). Thus, buildings produced serious negative externalities. Components and materials deteriorated and failed within a short timeframe and, subsequently, had to be maintained, replaced or frequently repaired. Today, it is a question of value, which must be balanced against the risk of quality and price, thus alternative procurement methods have been introduced. These methods include Design and Construct, Build Operate Transfer, Public Private Partnerships and alliancing, all of which take a collaborative approach, favour integrated design, and provide scope for innovation and new technology (sustainability features) (Boussabaine & Kirkham, 2004; Cartlidge, 2004; Kelly, Morledge & Wilkinson, 2008; Ashworth, 2010). Most importantly, these methods take a holistic approach to project delivery and its life

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thereafter (Kelly & Male, 1993; March, 2009). Alternative procurement methods can apply to all sorts of buildings and, regardless of their nature, LCC can indeed provide a good indication of the building's viability.

LCC & SUSTAINABILITY

The main aim of LCC is to determine how to best reduce a building's ownership costs to achieve a financially viable investment. This can be done by initially considering what the fundamental costs are that will notably impact on the cost of ownership, i.e. operation, maintenance, and refurbishment and/or replacement; this is where the issue of sustainability and LCC are interrelated (Ashworth & Hogg, 2007). Consider for a moment the current impact that the built environment already has on the triple bottom line. It contributes to 40 per cent of carbon emissions, consumes 40 per cent of global energy and consumes 32 per cent of the world's resources (natural capital) (Commonwealth of Australia, 2007). Furthermore, these resources are, in turn, being wasted, used inefficiently and causing negative externalities. This will begin to adversely influence the cost of building ownership in due course (Ashworth & Hogg, 2007). Thus, it would be a smart decision to align the proposed project with the government's vision and guidelines of sustainable development. Their political forces will be something that cannot simply be ignored, and continued resistance would be detrimental to the cost of building ownership, both directly and indirectly. Accordingly, to procure buildings using alternative methods will no doubt lower their life cycle costs and reduce their environmental, economic and social impact. Clearly, this would be a result of embedding sustainability principles, i.e. utilisation of renewable or recycled materials, drought resistant and deciduous landscaping, natural ventilation, and water and energy conservation features, into the building's design, and using more superior materials and components which are in turn, more expensive (Cartlidge, 2004; Melaver & Mueller, 2009). It is understandable that traditionally procured buildings, which have not adopted this paradigm shift from cheap and inferior materials, will indeed experience the impact of increased ownership costs in time, as sustainability is a serious issue.

The government is indeed taking the issue of sustainability seriously to ensure future generations are provided with an acceptable standard of living and quality of life. Until there is an efficient allocation of resources, and new buildings are procured on a value for money basis, the government will use its forces to reverse our unsustainable practices. Society will continue to witness and bear the consequences of such cumulative inefficiencies through the implementation of taxes, such as an emissions trading scheme, along with hostile legislation and regulation (Boussabaine & Kirkham, 2004; Flanagan & Jewell, 2005; Ellingham & Fawcett, 2006). Furthermore, these costs will be mainly borne by, for example, the resources and manufacturing sectors who will then pass the costs on to consumers through higher material, water and energy costs. These sorts of results have already been realised and will begin to have a serious impact on the cost of living and potential revenue streams and returns (Flanagan & Jewell, 2005).

TABLE 1

Bulk Water Price Increases

Area in SE QLD	Water cost increase ($) (2010-2018) *Not incl. inflation	% Increase
Brisbane	1,517 – 2,812	47%
Gold Coast	1,685 – 2,812	41%
Sunshine Coast	1,070 – 2,812	63%
Redland	932 – 2,812	67%
Ipswich	1,453– 2,812	49%
Moreton Bay	1,652 - 2812	42%
Scenic Rim	2,087 – 2,812	26%
Lockyer Valley	1,710 – 2,812	40%

TABLE 2

ENERGY Price Increases

State	Electricity cost increase % (2009-2013)
Queensland	32%
New South Wales	39%
Victoria	27%
ACT	20%
South Australia	31%
Tasmania	25%
Western Australia	45%
Northern Territory	14%

It can be seen from Table 1 that bulk water prices are predicted to increase by up to 67 per cent between 2010 and 2018 and, similarly, energy is predicted to increase by up to 45 per cent between 2009 and 2012 (Table 2) (Australian Energy Market Commission, 2011; QLD Water Commission, 2012). In addition, material prices are also increasing. For example, between December 2007 and December 2008, the cost of materials increased by 3.5 per cent per square metre, and an average building cost per square meter between 2000 and 2008 increased by 52 per cent (Building Industry Consultative Council; n.d.). Accordingly, to mitigate price volatility and lower LCC, new buildings should be procured on the basis of a whole life approach using renewable resources and embedded sustainability principles (Ashworth & Hogg, 2007). Despite the merits of a sustainable approach, this kind of approach is unfortunately coupled with higher initial capital costs.

Initial capital costs are also considered when undertaking an assessment of the cost of a building over its lifetime. Logic dictates that to achieve low initial costs for a proposed project would be deemed a 'bargain', thus value for money. It is natural to be attracted to cheaper alternatives in anticipation that the acquired building would perform, to its entirety, in the same manner as an ecologically sustainable building. This however is not the case and, according to the US Green Building Council, ecologically sustainable buildings perform 50 per cent better than traditionally procured buildings (USGBC, 2008). Despite having the same function in terms of purpose, traditionally procured buildings have a higher rate of capital expenditure throughout an asset's lifetime (Cartlidge, 2004; Ashworth & Hogg, 2007). Perhaps operation, maintenance, repair/ replacement and disposal may not have been contemplated in the first instance, which in turn makes the building subject to environmental, political, economic and social forces and, furthermore, subject to the risk of obsolescence, volatile utility prices, deterioration and depreciation (Boussabaine & Kirkham, 2004; Flanagan & Jewell, 2005; Ellingham & Fawcett, 2006; Ashworth & Hogg, 2007; Ashworth, 2010). Thus, greater emphasis needs to be placed on ecologically sustainable buildings whereby initial capital costs are proportionately higher and capital expenditure in due course is lower. This has been seen with both the Council House 2 (CH2) in Melbourne and The Solaire in New York, incurring $11.3 million and $17.25 million respectively in sustainability features (Natural Resources Defense Council, n.d.). CH2 included (but was not limited to) shower towers for cooling, water tanks, low flow devices, a micro-turbine co-generation system and a vaulted concrete ceiling (Holper & Torok, 2008; Commonwealth of Australia, 2011). Similarly, The

Solaire has photovoltaic panels, a green roof, lighting control system and low-e windows (Natural Resources Defense Council, n.d.). Both buildings were obviously procured using an alternative procurement method in order to achieve value for money. Each building has rendered significant savings based on their efficient functional capabilities and achievement of exceptional performance benchmarks, and these savings will continue.

Sustainable buildings attract substantial savings due to their ability to perform efficiently and effectively. The CH2 achieved savings of $1.2 million, reduced potable water consumption by 72 per cent and minimised energy consumption to 515.5kWh per annum (Commonwealth of Australia, 2011). The Solaire, equally, saw comparable savings due to a significant reduction in energy and water demand to 35 per cent and 50 per cent respectively (Natural Resources Defense Council, n.d.). These sorts of results are aligned with McLennan's (2006) view that '[w]hen just one per cent of a project's up-front costs are spent, up to 70 per cent of its life-cycle costs may have already been committed; when seven per cent of a projects costs are spent, up to 85 per cent of life cycle costs have been committed' (p.198). High initial capital expenditure inevitably increases savings and lowers life-cycle cost, thus making the investment more economically viable; this is an investor's/developer's main intention. It is essential to note that high initial expenditure is not wasted money, as it, in conjunction with savings and lower LCC (ownership costs), decreases the payback period of the investment.

Pay back periods are shortened when sustainability principles are embedded into the building design. This period of time is based on how long it takes for the initial capital investment, which in this instance would be sustainable (i.e. durable and renewable) materials and components, to pay for themselves (Cartlidge, 2004; Ellingham & Fawcett, 2006). It functions on the basis that due to improved efficiency (less demand for energy, water, and the like) and exceptional performance, the building is not as susceptible to volatile utility prices, regular operation, maintenance, and repair or replacement costs (Boussabaine & Kirkham, 2004). Cartlidge (2004) clearly demonstrates this theory by using a wooden framed window and comparing it with a PVCa framed window. The latter frame costs $65.00 more than the former frame, but has no maintenance costs and is expected to last an additional 3 years. Clearly, the PVCa frame would be a more viable option in the circumstances, as it would only take 3 years to repay its initial capital cost. Also, with respect to volatile utility prices, it is interesting to note that operation costs account for 20 to 35 per cent of same, so to employ renewable technologies and resources at a higher initial capital cost, the investment will indeed be future-proofed and savings will be generated (Kelly & Male, 1993, March, 2009). The Solaire, for example, has achieved exceptional payback periods for installing photovoltaic panels, low-e windows and a lighting control system for an additional $17.25 million (as aforementioned). Due to a significant saving on operation costs, in particular energy and water, payback periods of four, seven and four years respectively were achieved (Natural Resources Defense Council, n.d.).

Conversely, traditionally procured buildings would not reap these sorts of savings or payback periods due to the use of inferior materials and components, deficient workmanship, and a lack of innovative design and adoption of new technologies. Accordingly, the building's components and materials will decay quicker, will fracture, become obsolete, perform at a sub-optimal standard and, subsequently, need to be maintained or replaced on a more regular basis (Ashworth & Hogg, 2007; March 2009). To mitigate the risk of having to outlay these sorts of costs, 'sinking funds' (Kelly & Male, 1993; Cartlidge, 2004) are often created and administered by a body corporate if the building is, for example, a high-rise, low-rise, gated community or the like. These funds function on the basis that lump sum instalments are made regularly, for example on a quarterly basis, in anticipation of having to attend to unforeseen operation, maintenance or repair/replacement of building components within the subsequent 10 years (Dept. of Justice & Attorney-General, 2011). Thus, further costs, in addition to appreciating utility prices, would be incurred; so life cycle costs and payback periods will increase, which decrease the attractiveness of the investment. Obviously, if in the circumstance this were a short-term project, i.e. built and sold within a short period of time, the associated risks such as financial, political, environmental, operational and residual would then be transferred to the new registered proprietor. Not only are greater savings and earlier payback a result of exceptional efficiency and performance, they can also result in tenancy security.

Higher tenancy rates can improve savings and payback periods, and lower ownership costs. Buildings, particularly commercial, that are ecologically sustainable, attract higher tenant demand due to:

- Corporate responsibility,
- Lower operating costs, and
- Higher worker productivity (Cartlidge, 2004; Ellingham & Fawcett, 2006; Melaver & Mueller, 2009).

Commercial tenants have a corporate responsibility to ensure they are 'doing the right thing'. This means aligning their actions in accordance with what is now seen as a societal norm, i.e. being sustainable. By

leasing sustainable buildings, they are indeed seen to be making a positive contribution to sustainability (Angel, 2008). Higher tenant demand has been evident in, for example, Green Square North Tower in Brisbane. All 12 storeys of this building were tenanted three months ahead of schedule (GBCA, 2010). Reasons for this would not have been simply a result of corporate responsibility, but also the understanding that operation costs, particularly utilities, to be outlaid in the future would be substantially lower compared to a traditionally procured building. Furthermore, sustainable buildings are also increasing worker productivity. Improved performance is a benefit of working in an aesthetically pleasing and comfortable work environment with exceptional indoor environmental quality (Cartlidge, 2004; Melaver & Mueller, 2009). Tenants would be more likely to lease a building that is sustainable, particularly when they will directly benefit from worker satisfaction and improved performance. This was seen in the case of CH2, whereby worker productivity increased by 10.9 per cent (Commonwealth of Australia, 2011). Tenants would therefore experience a lower staff turnover, a greater amount of work being produced, and higher returns. In return, tenants would be more willing to pay higher rent and continue to exercise their lease option, thus lowering ownership costs and providing certainty to the landlord. Consequently, the landlord would have the opportunity to forward-plan, knowing they will be receiving higher yields for a prescribed period of time. Additionally, landlords are more likely to gain a competitive advantage over those landlords who own traditionally procured buildings, as these buildings are, for example, becoming obsolete (Cartlidge, 2004). In any event, lower ownership costs, savings and quicker payback will certainly be contributed to by higher tenant demand. The registered proprietor of CH2, due to a 10.9 per cent increase in worker productivity, generated savings in the order of $2 million (initially $1.2 million) with a reduced payback period of seven years (initially 10 years) (City of Melbourne, 2008; Commonwealth of Australia, 2011).

CONCLUSION

As this article illustrates, LCC provides an opportunity to embed sustainability principles at the design stage of building procurement. It is a valuable tool used to assess potential long-term ownership costs of an asset. Depending on the type of procurement method used, i.e. traditional or alternative, life-cycle costs will either be at one end of the spectrum or the other. Lessons learnt throughout this article include the need to consider an alternative approach to building procurement, not just supposing that the cheapest and quickest solution will always be a worthy choice. By taking a holistic approach to the procurement of new buildings, and focusing on achieving value for money, the trade-off between time, quality and price can be mitigated. As can be seen with CH2 and The Solaire, taking a more sustainable approach does indeed increase initial capital expenditure, however significant savings and quicker payback periods are proven. This is because operation and maintenance costs are lower, tenancy demand and lease continuity is higher, the buildings are less dependent on non-renewable resources, are not as susceptible to volatile utility prices, and have a lower impact on the triple bottom line. Unlike traditionally procured buildings, they are future-proofed against unforeseen political, environmental, social and operational events that are and will continue to shape how the built environment is developed. It is necessary to make a positive contribution to sustainability, in particular through the built environment, as it is a major contributor to climate change, resource scarcity and associated externalities. A sustainable approach to developing the built environment will indeed be beneficial for all parties concerned (developers, end users and future generations), as valuable built assets will be constructed and positive yields will be received.

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