USING EARLY-STAGE ASSESSMENT TO REDUCE THE FINANCIAL RISKS AND PERCEIVED BARRIERS OF SUSTAINABLE BUILDINGS

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ABSTRACT

For sustainable buildings to become mainstream they must demonstrate not only improved environmental performance but also financial performance, benefiting both end users and investors. The perceived financial constraints and risks are often major barriers to sustainable design. This paper discusses the application of a new tool that formalizes the traditionally intuitive-based early-stage decision making processes and assesses the potential for creating a financially feasible best-practice sustainable building across a range of environmental, social and economic parameters, using the limited data available at the outset of a project. It considers the total cost of ownership, demonstrating the link between the recurrent and capital costs. A detailed feasibility assessment of those areas where greatest potential for improving environmental and financial performance exists can then be carried out, saving a considerable amount of time, money and effort otherwise spent on looking at all possible strategies for achieving a sustainable outcome. This approach also identifies areas where incorporating environmental strategies might be financially risky, reassuring investors and developers by reducing investment risks. By reducing some of these risks and perceived barriers to sustainable building development, it is hoped that clients and investors will be further encouraged to adopt a more sustainable approach to their building projects.

KEYWORDS

sustainable buildings, environmental performance, financial performance, life cycle approach, early stage assessment

INTRODUCTION

Over the last two decades there has been an increasing global awareness of the effects of climate change, resource depletion, and environmental degradation caused by human activities. Studies carried out in the past show that buildings are responsible for 40–50% of global energy consumption, the release of up to 40% of global greenhouse gas emissions, consumption of significant quantities of natural resources, 20% of fresh water consumption and production of up to 40% of the waste disposed of in landfill (UNEP 2007).

Growing interest and enthusiasm among all parties involved in the construction industry and the tightening of environmental legislation through building codes has resulted in an increasing demand for buildings with a reduced environmental impact yet that provide a high level of occupant comfort and wellbeing. Integrating the principles of sustainable design has been the construction industry's response to minimising the environmental impacts of the built environment.

There is increasing demand for sustainable building development but there are significant challenges; predominantly financial driven, to its implementation. One of the major obstacles of sustainable building design has been the general perception that sustainable buildings cost more to design and build. A life cycle approach is needed to understand the environmental benefits and the financial savings of a sustainable building as many of these benefits are spread across the many decades of a building's life.

The potential capital cost premiums and risk of long-term investment return, particularly in the

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current global economic climate can be an enormous challenge in convincing investors and property developers to invest in sustainable buildings. Only a limited number of tried and tested cases exist to illustrate the benefits and risks of sustainable buildings over the long term. The use of a conventional linear design approach for the sustainable building design process can lead to poor financial outcomes for sustainable buildings. A more integrated design approach that considers the interrelationships between building components and the broader life cycle implications of decisions can lead to much improved project outcomes.

The cost of incorporating environmental strategies can vary significantly from project to project. Due to the limited information available at the project inception stage, selection of the right group of environmental improvement strategies can be a challenging task. However, there is hardly any systematic method available for designers to identify and prioritise project specific opportunities that aim to simultaneously maximise both environmental and financial performance.

This paper presents the application of a web based software tool—the Sustainable Innovation Feasibility tool (SIFT)—that can be used to assess financial feasibility of taking an environmentally sustainable approach to a building project based on the limited information available at the project inception stage. The aim of this paper is to demonstrate the usefulness and application of this tool which attempts to formalise the traditional decision-making processes of building design professionals and reassure all the parties involved that a sustainable building approach may provide equivalent or better net financial returns than a conventional building design.

To demonstrate this, the tool has been applied to several building projects across a range of building typologies to identify and prioritise opportunities for achieving a built outcome optimised for both environmental and financial performance. Ultimately, by facilitating the decision-making process this will help the design team to assess and minimise the perceived financial risks associated with sustainable building development and by doing so, lead to improved confidence for investors when taking a sustainable approach to building developments.

BACKGROUND

Buildings are expensive to build and operate, and cause significant environmental impacts during their lifetime (UNEP 2007). Those involved in the building procurement process should strive to design buildings with maximum resource efficiency and minimal environmental impact throughout the building's life to ensure that problems faced with the current building stock are not repeated.

Sustainable building design has been met with many barriers including the widespread perception that this approach leads to greater up-front capital costs (Yudelson 2008). Investors are often reluctant to invest in sustainable buildings due to the perceived increased capital cost they have to bear to incorporate environmental strategies whilst tenants benefit from the potential long-term operational savings (Myers *et al.* 2008). Therefore, if sustainable buildings are to become mainstream, the environmental performance of buildings should be improved without adversely affecting their financial performance.

The sustainable building design process by its nature requires an integrated approach to reap the full benefits of sustainability (NIBS 2008). The integrated building design approach is different from the linear approach that is usually adopted in the traditional building design process. Designing for sustainability in the traditional way might be one reason for the perceived increased costs of achieving a sustainable building outcome.

The Traditional Building Design Process

Vallero and Brasier (2008) and Mazza (2007) describe the traditional building design process that has been in place for decades as a linear process with distinct phases guiding the process from project conception to completion. In the design development phase experts work on different systems in the building such as structural, electrical and mechanical systems independently of each other and finally layer these into the final design. Benefits from enhancing environmental performance in one area may not lead to design changes in other areas due to this segmented approach. The traditional design approach aims to create a building representing best possible value for money from a capital cost perspective.

An emphasis on the up-front capital cost and the segmented linear approach are the two main characteristics of the traditional design process. In the traditional design process a whole-of-life approach is rarely taken or considered warranted. With a strong emphasis on short-term financial return and the minimisation of up-front capital costs, reducing environmental impacts is usually not a major project goal although many designers would consider some measures to lessen these impacts (Reed and Gordon 2000).

The sustainable building design process that has been gaining momentum over the last decade aims to overcome some of the shortcomings associated with this traditional design process.

The Sustainable Building Design Process

A sustainable building supports an increased commitment to environmental stewardship and conservation, and results in an optimal balance of cost, environmental, societal and human benefits while meeting the function of the intended facility or infrastructure (NIBS 2008).

Whilst sustainable buildings are generally considered to cost more to design and construct than conventional buildings (Williams 2004), many recent studies have shown that it is possible to design a sustainable building that costs no more to develop than a conventional building (Davis Langdon 2007a). However, depending on the degree of environmental features incorporated into the project the additional cost of a sustainable building can vary from 2% to more than 20% of a conventional building (Kats 2003, GBCA 2006, Tunstal 2006, Davis Langdon 2007b, McCartney 2007, MCC 2008). Net return on investment and other benefits can also vary accordingly and the financial savings from reduced operational costs and other benefits over the life cycle can be ten fold (Kats 2003, GBCA 2006).

The design of buildings that take a more sustainable approach to the way in which the resources required for their construction and operation are consumed requires that clients and design teams take a more holistic approach. A sustainable building will by its nature, have consideration for the life cycle impacts associated with its construction and operation. Increases in capital costs are often a result of the specification of more durable, longer-lasting materials that may be offset by reduced maintenance and replacement costs over the life of the building (McCartney 2007).

Barriers to sustainable building design

Although a strong business case can be made for sustainable building development based mainly on operational cost savings, there are many barriers to adopting a sustainable design approach over conventional design. Other than the perceived higher initial cost, which is cited as the biggest barrier by those involved in the construction industry (Cassidy 2006, GBCA 2006), amongst other barriers are the risk of reduced long-term investment returns and building performance, lack of tried and tested data on life cycle costs and benefits over the long-term, hidden costs and split incentives (Sorrel *et al.* 2004). There are conflicting interests between those providing the capital outlay and those paying the ongoing operational costs. For example, while the developer may pay the capital cost of incorporating many operational efficiency measures, they may not result in increased profits, as many of the operational savings will accrue to tenants by way of reduced occupancy costs (WBCSD 2007, Myers *et al.* 2008). Another concern in the construction industry is the longer design time needed for adopting the integrated design approach, which is crucial to the sustainable building design process (Reed and Gordon 2000, Yudelson 2008).

These perceived barriers are predominately financially driven, and as such any attempt to promote sustainable building design must address the sometimes conflicting financially based considerations associated with building development. Particularly in light of the current global economic situation, increased up-front financial investment is more likely if the benefits are distributed fairly amongst all stakeholders.

A life cycle approach to building design

According to McCartney (2007) and Wasiluk (2008) capitalising on the full benefits of a sustainable building can only be achieved if a whole of life design approach is taken. By taking a life cycle approach to building design and development, a client or investor is able to capture the many benefits that are associated with a sustainable building. While developers may be reluctant to invest additional capital into a project if they don't stand to benefit once it is complete, they may find that potential investors and tenants will pay more for buildings that will provide operational cost savings throughout the life of the building.

Whilst there is an opportunity to significantly increase return on investment by capitalising on the building life cycle operational cost savings, the design teams need to ensure that the extra capital investment will be recouped within a reasonable investment cycle. By identifying the environmental strategies that have an acceptable level of return, investors and end users can be more confident about taking a sustainable approach to projects, at little to no increased risk. The risks of not taking a sustainable approach can be expensive, particularly for retrofitting to comply with tighter environmental legislation, and the risk of obsolescence due to a shift in market attitude towards greater economic and environmental awareness can also be exacerbated. Potential tenants are beginning to demand buildings with reduced operational and maintenance costs as well as reduced environmental impacts.

Integrated project design

In product and manufacturing engineering the term *concurrent engineering* has been introduced as a strategy in which tasks are performed in parallel with a focus on the early consideration for every aspect of a product's development process. A similar approach used within the building construction industry, called *integrated project design* has been gaining acceptance in the last decade as a means of achieving better outcomes from building projects.

According to Harrison (2008) and Reed and Gordon (2000) a collaborative or integrated design approach is essential if a building is to be designed and operated as a sustainable building. An integrated design approach considers the interrelationship between individual building components, systems and technologies, and typically adopts a life cycle design approach. Understanding the interdependency of individual technologies on each other is crucial in optimising both the environmental and financial performance of a project. To achieve a successful integrated design, individual technologies that would be used at different phases of the life cycle of a building have to be taken into account at the early design stage (NIBS 2008). This requires a project team of investors, architects or designers, engineers and end users to collaborate at a very early stage of the design process to consider different environmental strategies, share their knowledge to envisage the whole building and find solutions to anticipated problems.

The main goal of sustainable buildings in the past was to reduce environmental impacts. With the traditional design process, environmental strategies in different areas such as energy, water, indoor air quality and waste were drawn and layered into the design to maximise environmental performance. Without an integrated approach, where benefits from one system are considered in the design of other systems, individual strategies might add a significant capital cost premium. The key differences between the sustainable integrated design process and the traditional design process are shown in Table 1.

TABLE 1. Comparison between the sustainable integrated design process and traditional design process (after Perkins and Stantec 2007).

Integrated design process	v	Traditional design process
Inclusive from outset		Involve team members only when it is essential
Front loaded—time and energy invested early		Less time, energy and collaboration exhibited in early stages
Decisions influenced by broad team		More decisions made by fewer people
Iterative process		Linear process
Whole-systems thinking		Systems often considered in isolation
Allows for full optimization		Limited to constrained optimisation
Seek synergies		Diminished opportunities for synergies
Life cycle costing		Emphasis on up-front cost
Process continues through post-occupancy		Typically finished when construction is complete

To maximise the benefits of a sustainable design, an integrated project approach should be taken from the earliest stage of a project.

Early Stage Assessment

The decisions made during the early design stages of a building project have the greatest influence on the potential for achieving improved financial and environmental performance at least cost and disruption (Figure 1) (Reed and Gordon 2000, WBCSD 2008). The sustainable building design process requires an integrated approach from the project inception stage and during the design stage this approach may involve a considerable amount of work across different areas of the project, which might be costly and time consuming. The financial performance of a sustainable building is as equally important as the environmental performance and an integrated approach has greater potential to lead to a financially feasible outcome. Selecting the right group of environmental strategies that are also financially viable within the project constraints can be a challenging task for designers due to the limited availability of necessary information.

The construction industry lacks a systematic method of assessing the financial potential of a sustainable building proposal at project inception. If areas where the potential financial feasibility and risks are likely to be high can be identified and prioritised at the pre-design stage, this information can direct the design teams' focus where the project goal is to create a financially viable sustainable building outcome. This can help to avoid the common practice of looking at all possible environmental strategies across all areas, saving valuable time, effort and money.

OPTIMISING BUILDING ENVIRONMENTAL AND FINANCIAL PERFORMANCE

In order to convince investors and clients to invest their money and time into a sustainable design approach, they need to have a thorough understanding of the risks and benefits involved in doing so. The lack of data on built sustainable buildings has provided great uncertainty and resulted in reluctance to be involved (Bartlett and Howard 2000).

There are a number of factors that influence the feasibility of sustainable buildings including demographic location, local construction climate, local and regional design standards, project goals and values, climate, building size and the different technologies used in building construction (Morris 2007). A designer needs to be able to make an informed judgement on the potential for achieving a significantly improved environmental outcome based on the above factors whilst maintaining the financial feasibility of the project.

Traditionally, the assessment of the potential feasibility of taking a sustainable approach to a building project has been done on an intuitive basis, based on the knowledge held by a limited number of senior design professionals, gained through past experiences. Selecting environmental strategies that would prove financially beneficial to investors and end users alike can be a challenging task for any designer and especially for those who are not familiar with local conditions.

Sustainable Innovation Feasibility Tool (SIFT)

The Sustainable Innovation Feasibility Tool (SIFT) is a simple, easy to use web based tool (Figure 2) that provides an indication of the financial feasibility of

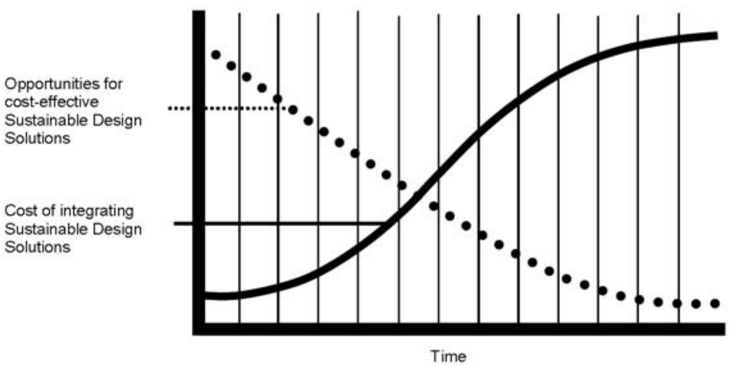
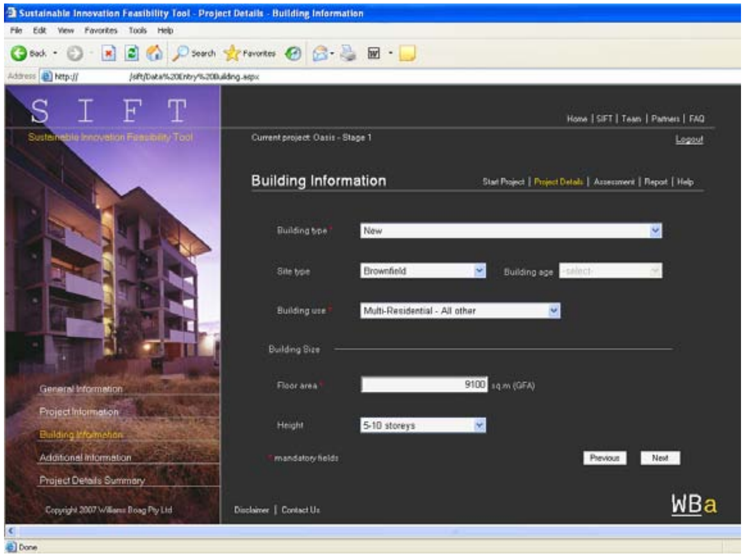


FIGURE 1. Relationship of cost and sustainable design opportunities (after Reed and Gordon 2000).

FIGURE 2. Screen shot of SIFT user interface.



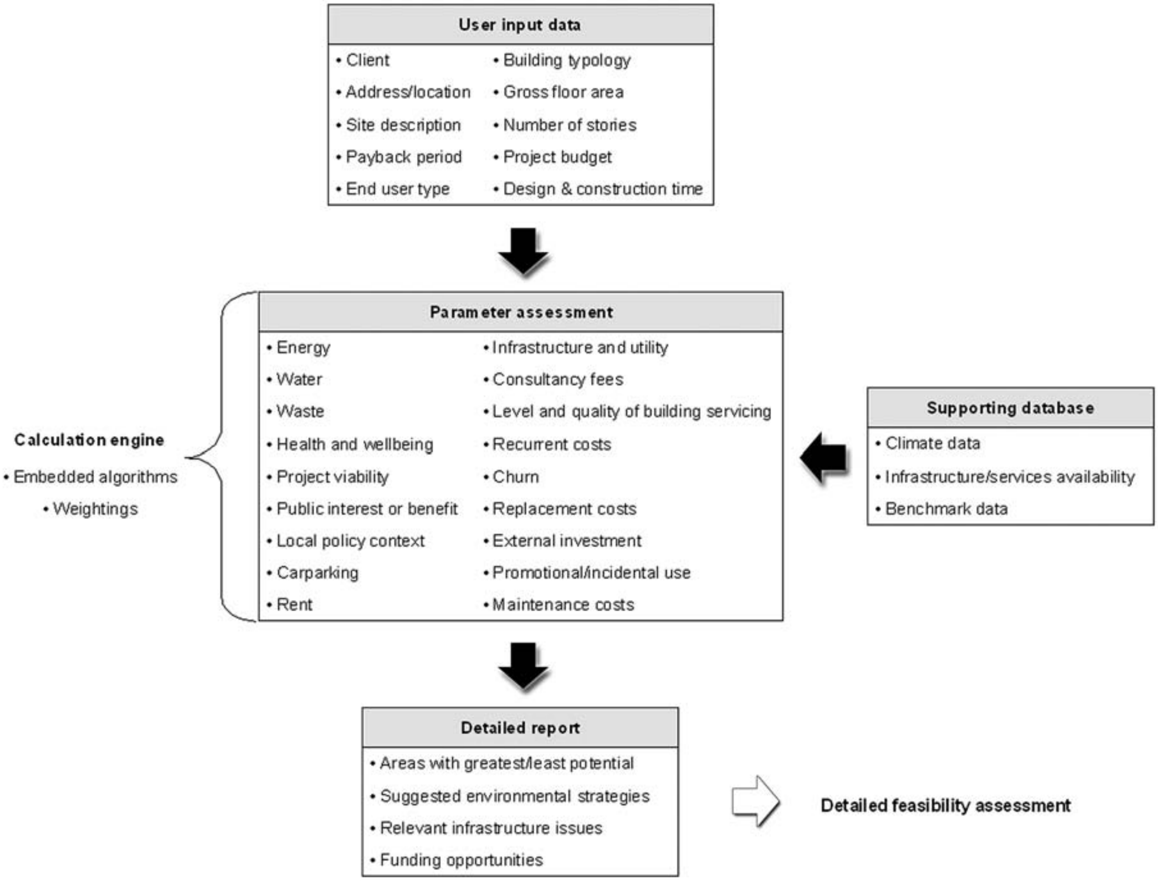
achieving a high aspiration sustainable built outcome. SIFT formalises the traditionally intuitive decision making process with objective data where ever possible, and with time captures data and knowledge from other building projects and public domain data to enhance this process. The strength in this approach is that it does not replace the intuitive knowledge held within the design team, but captures this knowledge that has been gleaned from numerous previous projects and formalises it for future use in new projects. This also helps to alleviate the problem of key knowledge being held by only a select number of senior design professionals and makes it available to the broader design team.

SIFT is fundamentally different to existing green rating and assessment tools such as LEED, Greenstar or BREEAM, that assess the level of sustainability a particular project has achieved. SIFT assesses the financial potential of a high aspiration sustainable building proposal using limited information available at the earliest stage of the project, before any design work is carried out. The information gleaned can then be used by the design team to optimise the sustainable design outcomes of the project, ensuring that financial performance is, at the very minimum, maintained. This tool is useful for initial scoping only and does not assess designs or design options for the level of sustainability attained. No other tool currently exists, to the author's knowledge that allows this type of early-stage assessment and comparison of building proposals.

A key to this assessment is the ability to identify and incorporate the potential life cycle financial benefits of a sustainable design approach into the feasibility assessment. For example, the tool enables the design team to identify the likely scale of maintenance and recurrent operating costs and choose possible design solutions that may minimise these based on their significance.

SIFT indicates the likely opportunities that may lead to a more sustainable outcome. Being able to conduct such an assessment at the outset of a project is crucial to ensuring that both financial and environmental performance is optimised and time and money is not spent unnecessarily. This assessment directs the design team's focus to areas where employing environmental strategies would be financially beneficial from a life cycle perspective. There is an underlying assumption that the design team has the expertise and drive to implement best-practice. Some areas may have very high potential while other areas may have moderate or low potential. It is up to the design team to pursue particular strategies for capturing this potential based on project goals. Professional experience and judgement is still as critical as before, in this case to interpret the findings of the

FIGURE 3. The SIFT assessment process.



assessment and to further identify and explore possible design solutions. The assessment process is shown in Figure 3.

The first step of the assessment involves the design team entering the basic information available at the outset of a project (such as the location details, the project budget, floor area and building function) into a web-based user interface (Figure 2). Using these very basic details, additional information can be gleaned, for example the climate is known based on the site address and usage patterns can be assumed from the building's function. A range of eighteen assessment parameters form the basis of the SIFT evaluation process. They have been identified as key factors influencing sustainability and also as having an economic impact, either as a cost or potential for income. Each of these parameters is then divided into several sub-parameters as shown in Appendix A. For example, the potential for energy conservation, the potential for greenhouse gas emissions reduction and the ability to generate power on-site from alternative sources are considered key factors influencing the financial feasibility of incorporating energy-based environmental strategies. These sub-parameters are assessed and rated on a scale from zero to ten (as demonstrated in Table 3) with a score of ten representing a maximum long-term financial benefit to be gained from implementing a high aspiration sustainable solution in each of these areas. These sub-parameter scores are weighted according to their importance and combined to give specific parameter scores for the project. These parameter scores are then weighted and combined into an overall score for the project.

To determine the particular importance weightings of the individual sub-parameters, the weighting process was performed by an expert team consisting of engineers, architects, financiers and projects managers using the Analytic Hierarchy Process (Saaty 1999). This involved each expert ranking the importance of each sub-parameter against each and every other sub-parameter using a judgement matrix. The sub-parameter considered most important for the greatest number of comparisons is then ranked as the most important. The sub-parameter considered most important the second highest number of times is ranked as the second most important and so on. The number of times each sub-parameter is considered to be more important than another sub-parameter is then used to determine the relative sub-parameter weightings relative to each other. For example, if one sub-parameter was considered the most important twice as many times as another sub-parameter, then its weighting would be twice that of the other sub-parameter. For the purpose of this initial study, *Project viability* was rated as the most important criteria in terms of achieving a financially feasible sustainable outcome, followed by *Rental return*, *Recurrent costs*, *Level and quality of servicing*, *Energy* and *Maintenance costs*. These weights are fixed for particular locations so that they can't be altered by the user, thus ensuring better comparability of results between projects. These weightings may differ from one country or region to the next as particular issues will be either more or less pronounced due to localised climatic, economic, environmental or social priorities. These weightings would need to be reassessed for each geographic location and also over time as certain issues become more or less important. For example, the increasing importance of water availability and use over the last decade due to drought conditions across certain regions of the world has heightened the importance of water conservation against many other issues of sustainability.

The tool contains benchmark data specific to particular building types and locations gathered from various industry and government sources. This benchmark data is used to make the connections between each of the key inputs and the subsequent relationships with each of the assessment parameters. Also, additional data gleaned from completed projects can be fed back into the database capturing the knowledge of the design team.

The outputs of the tool include a detailed report that is used to inform the project team of the possible environmental outcomes that can be achieved at minimal risk and maximum return, whilst also identifying those areas where potential for a financial return is unlikely or risky. Key opportunities or constraints specific to the project are also identified by the tool at this stage (Figure 4). This may include information relating to problems with availability of infrastructure at the specific site that may influence the ability to provide innovative, feasible design solutions, or give descriptions of relevant industries in close proximity which might identify air quality or noise issues. It may also include the identification of funding available for implementing otherwise cost prohibitive technological solutions. By identifying the areas with greatest sustainability potential, time and effort is saved by design teams, who can focus on those areas where greatest financial return can be achieved.

The initial validation of the SIFT tool was performed by comparing the tool's outputs to the opinions of expert design team members for more than ten projects. This process showed a close correlation between the opinions provided by the team of the likelihood for creating a best-practice, financially feasible sustainable outcome, and the outputs of the tool. Crawford (2008) has also demonstrated the usefulness of the tool as applied to a case study building, comparing the SIFT tool assessment results to the actual built outcome, again showing a close correlation.

Calculation of SIFT sub-parameter scores

To illustrate the calculation procedure used within the tool, the process for calculating the *Energy: Use* sub-parameter is described below.

Energy consumption data per square metre of gross floor area (GJ/m^2) is used to determine the potential for integrating innovative energy saving

FIGURE 4. Extract from SIFT report used to detail project opportunities and restrictions.

The following indicates the potential opportunities that exist for maximising the financial feasibility of a sustainable building solution for this project. The areas where these opportunities are restricted are also identified.

Energy

- The potential to reduce greenhouse gas emissions is low due to the small quantity of greenhouse gases traditionally associated with the energy consumed and the typical fuel mix of this type of building

Water

- The potential for process water reuse is high due to the large quantity of water consumed and suitable for reuse
- The potential for taking alternative approaches to water supply is low due to the high availability and lack of known issues with water infrastructure in the chosen project location

Building Servicing

- The potential to reduce replacement costs of services, central plant and services reticulation is high due to the high expected costs of the base building systems and significant wear and tear expected due to the environmental conditions of the chosen location

Project Restrictions

The following matters may restrict the potential for a financially feasible sustainable building outcome for this project.

- As the client will not be the occupier of the building, the likely availability of sufficient funds and time required for the analysis of a green building is reduced as capturing life cycle operational cost savings is not likely to be considered of significant importance
- Due to the chosen location, potential for energy generation on-site is restricted by the lack of access to solar and wind resources and the potential for daylighting is limited as access to natural light is restricted

External Funding Opportunities

- Renewable Energy Support Fund (RESF) (Sustainability Victoria) – for innovative application of medium-scale proven renewable energy technologies

solutions into the building. The quantity of energy consumed within a building is typically dependent on the purpose for which the building is used, the size of the space being occupied, climate in which it is located and hours of operation. To determine the approximate average energy consumption, the user inputs detailing these characteristics of the building are used. In this case the building is an A-grade office building with a floor area of 10,000 m^2, located in Melbourne (postcode 3000), Australia. The benchmark data within the tool, of which Table 2 provides a small extract, indicates average energy consumption for this type of building in this location of 0.514 GJ/m^2 (0.411 + 0.103). This equates to 5,140 GJ per annum.

Once the average annual energy consumption for the building has been calculated, a score for this sub-parameter is determined based on the scale of this value and the potential cost savings that might be possible through conservation of this quantity of energy. The higher the consumption, the greater the opportunities for cost savings from energy conservation and therefore the greater the potential for generating a net financial return on any energy conservation strategies or technologies that may be integrated into the building.

Table 3 is used to determine this potential based on particular ranges of energy consumption. The figure of 5,140 GJ/m^2 represents significant potential for achieving a highly financially feasible sustainable outcome in the energy conservation area (based on a score of nine out of ten).

Similarly, sub-parameter scores for *Energy: Greenhouse gas emissions* and *Energy: On-site generation* are

TABLE 2. Quantity of energy use by building use and location (GJ/m^2 per annum).

	Building use					
	Office—Grade A		Residential		Educational	
Energy type	Electricity	Gas/other	Electricity	Gas/other	Electricity	Gas/other
Postcode						
3000	0.411	0.103	0.302	0.076	0.369	0.092
3515	0.409	0.115	0.214	0.054	0.378	0.095
3527	0.417	0.104	0.176	0.044	0.372	0.093

TABLE 3. SIFT *Energy: Use* sub-parameter score range.

Energy usage (GJ/annum)	Score
0–124	0
125–249	1
250–374	2
375–499	3
500–624	4
625–1249	5
1250–2499	6
2500–3749	7
3750–4999	8
5000–6249	9
>6250	10

calculated and a weighted average of all three sub-parameters is determined, representing the total score for the *Energy* parameter. The price of energy, which depends on factors like location or type of energy used would be factored into these weightings, so that if energy prices rise, then weightings can be adjusted to reflect any increased importance of energy conservation (from both a financial and environmental perspective). A similar process is used to determine the scores for all other assessed sub-parameters.

While parameter scores and sub-parameter scores are used to determine the scope and nature of further detailed feasibility studies for the project, the total SIFT score of a certain project is useful as it provides an initial indication of the likely financial feasibility of achieving a high aspiration sustainable outcome for the project. Using the total project score, certain variations to the project can then be compared, such as alternative locations, building use or size, in an attempt to improve the project's ultimate financial and environmental performance. A project with an overall score of seven or above can be considered as having the potential of achieving greatest financial performance by incorporating environmental solutions whilst a score below three can mean a project has considerably less potential for achieving a financially feasible sustainable outcome. However, a project with low overall financial potential may have some areas where employing environmental strategies would yield high financial benefits.

DEMONSTRATING THE USE OF SIFT FOR PROJECT DECISION-MAKING

In order to demonstrate how SIFT can be used as a decision support tool for designers, investors and clients at the project inception stage, it was applied in retrospect to a number of building projects across varying building typologies: offices, residential and educational institutions. Some of these projects have been built with high sustainability aspirations while others are more conventional building projects. These projects were assessed by SIFT as if they were unknown proposals, using only the key details assumed to be available at the project outset. It was assumed that every project would strive to achieve best practice sustainability within the project constraints. The details of the projects are given in Table 4. All the projects assessed are located in urban areas in Victoria, Australia.

The following assessment of the 14 case study projects demonstrates how a tool such as SIFT can be used by designers to identify and prioritise opportunities for a given project and also to compare alternative locations for a particular project.

Project	Building type	Gross floor area (m^2)	Budget (A$/$m^2$)
PO1	Office	1,700	3,823
PO2	Office	7,150	6,993
PO3	Office	10,304	4,464
PO4	Office	12,536	3,989
PO5	Office	18,750	1,707
PO6	Office	49,500	7,070
PR1	Multi-residential	3,390	2,064
PR2	Multi-residential	6,750	2,074
PR3	Multi-residential	9,100	4,945
PR4	Multi-residential	12,000	1,667
PE1	Educational—private	1,255	4,780
PE2	Educational—primary	2,285	2,625
PE3	Educational—tertiary	3,811	1,637
PE4	Educational—tertiary	4,238	3,232

TABLE 4. Project details for case study buildings.

Identifying and Prioritising Opportunities

An assessment of 14 case study projects has been performed to demonstrate the benefits of conducting an assessment of the potential for integrating financially feasible sustainable strategies across various parameters. Figures 5 to 7 show the assessment results for the case study projects, by building use.

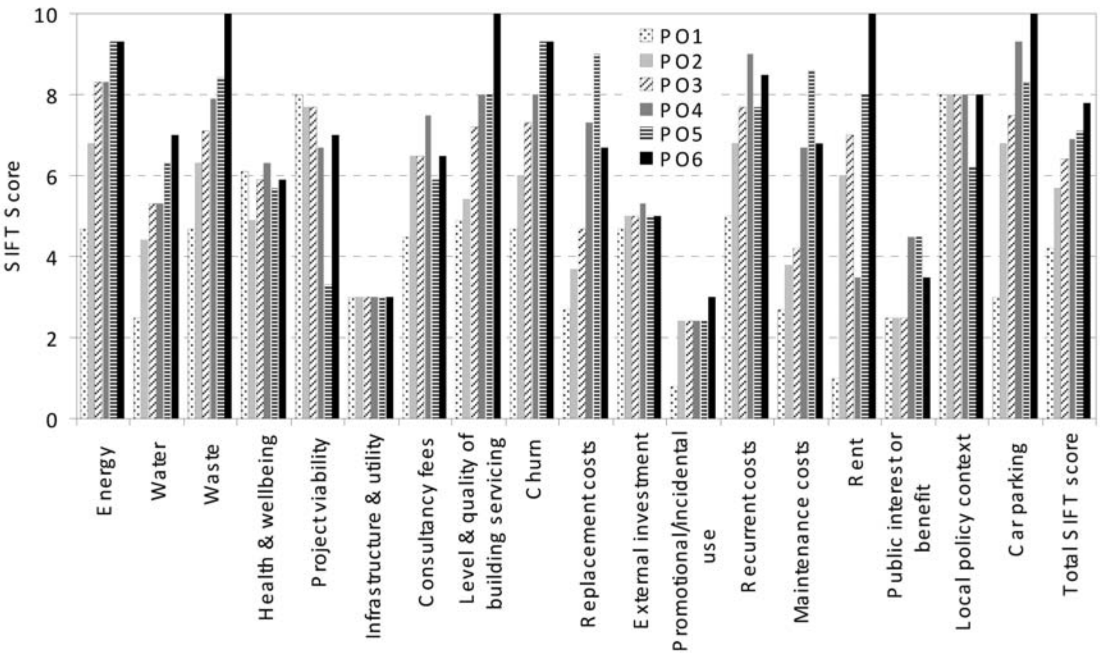
The total score, which indicates the overall potential for developing a financially feasible best practice sustainable building project is shown for each project on the far right of the respective graphs. The 18 assessment parameter scores for each project show the potential across each of the different areas. While there are some parameters, such as *Energy*, *Water*, *Project viability* and *Rent* that have a significant influence on the overall financial feasibility of the project, some other issues such as *Local policy*, *Public interest or benefit* and *Promotional or incidental use* generally have only a limited influence.

Even though the overall potential for financial feasibility of a particular project to be developed as a sustainable building may be low, by examining the assessment parameter scores it is possible to identify areas in which may exist considerable potential for integrating particular environmental strategies. Similarly, within a project with a high overall score, there may exist particular areas with low potential for achieving a financially feasible sustainable outcome. Clients and design teams may then choose to avoid spending excessive time and money on addressing these areas to minimise the possible financial risks that could be involved.

With a total score of just above four, project PO1 is considered to have relatively low potential to be developed as a financially feasible sustainable building whilst project PO6, with a total score of eight, is considered to have high potential for achieving a financially feasible sustainable outcome (Figure 5). The four remaining office building projects lie in between these.

In general, the potential for incorporating environmental strategies associated with energy conservation in office buildings was found to be high. Office buildings typically consume significant quantities of energy for heating, cooling and lighting and thus the potential to conserve energy and reduce greenhouse gas emissions is generally high. With the *Energy* parameter score of over nine out of a possible ten, projects PO5 and PO6 are considered to have high potential for incorporating environmental strategies that other projects may find to be too risky a capital investment, without risking the overall financial feasibility of the project.

FIGURE 5. Potential for achieving a financially feasible best-practice sustainable outcome across 18 assessment parameters for case study office building projects.

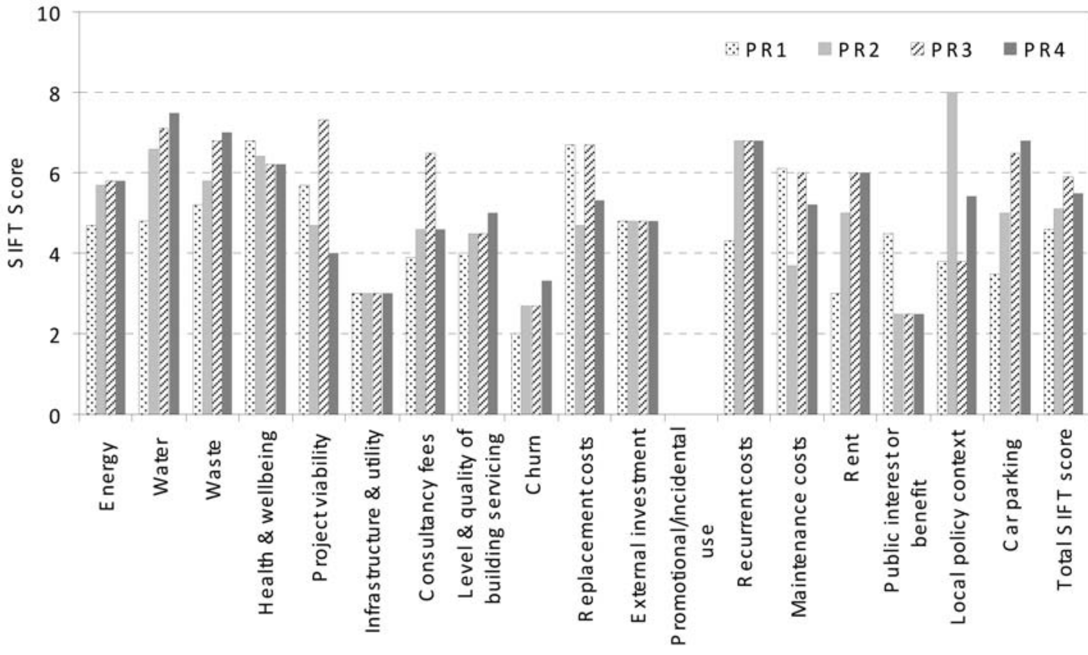


The viability of a sustainable building project is heavily dependent on the budget and to a lesser extent the design and construction time that is needed to incorporate environmental strategies into the project. If the available budget is considered to be higher than the average construction cost for a building of this type and size, then there may be significant scope to invest in environmental strategies that may have a higher up-front capital cost. A longer design time is usually desirable for designing sustainable buildings due to the integrated design approach necessary and the need to conduct detailed feasibility assessments for a range of environmental strategies. The below average budget is the main reason for the low *Project viability* score for project PO5.

The projects with large lettable areas such as buildings PO5 and PO6 that are not owner occupied have increased potential to benefit financially through increased rental income as shown in Figure 5. The parameter *Rent* considers the potential for increased rental income for the building based on the market attractiveness of a sustainable building and assesses the rental returns for each building function based on the net lettable space available in the building, as well as its location. Building PO4, being an owner occupied building has limited potential to benefit in this area.

For the residential building projects assessed, the total score varies between four and six, indicating that each of these projects had medium potential for achieving a financially feasible sustainable outcome (Figure 6). Multi-residential buildings show high potential for incorporating financially feasible environmental strategies in the area of water. In residential buildings, a large quantity of water is used for bathing, washing, cleaning and cooking and thereby the potential for water conservation is high. Due to the potentially large quantity of grey water available and the number of opportunities, such as toilet flushing or garden watering, present for reusing treated water, any investment in wastewater reuse or treatment systems should provide a net return on their investment within a reasonable period of time. Water price will be a key factor affecting the timeframe in which these returns can be achieved.

FIGURE 6. Potential for achieving a financially feasible best-practice sustainable outcome across 18 assessment parameters for case study residential building projects.



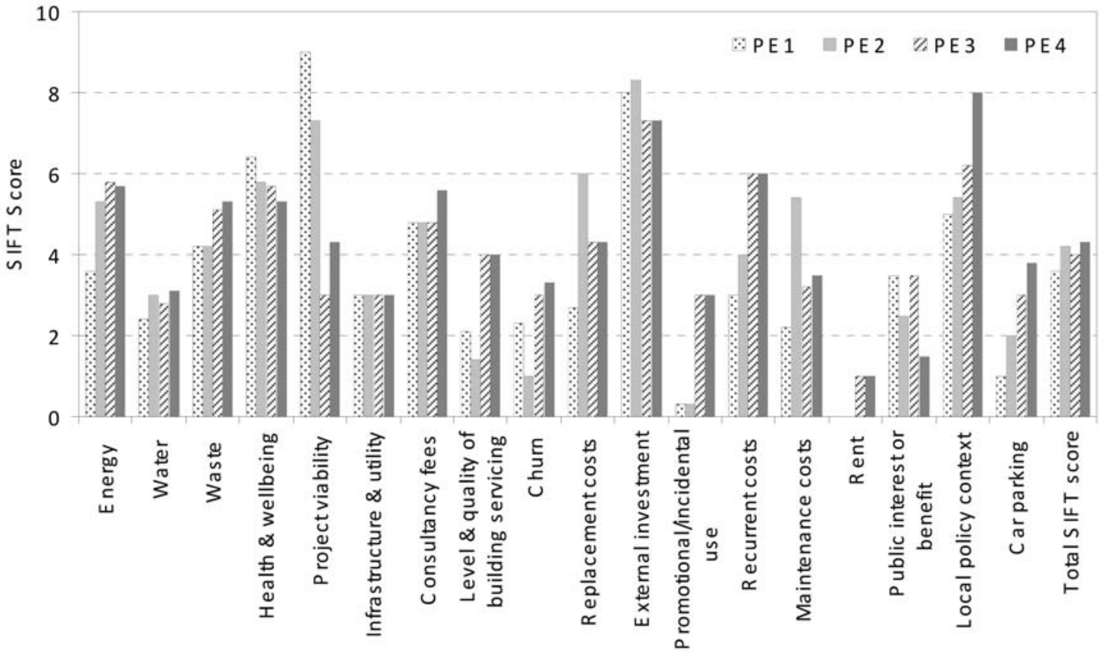
For each of the educational building projects assessed the total score is close to four in each case (Figure 7). This indicates that these educational buildings have limited potential to be developed as a financially feasible sustainable building. Particular building types may have greater or lower potential than other building types due to numerous factors, such as the level of resources and servicing required for the particular function, hours of operation, scale or adaptive reuse opportunities. The educational buildings in general are limited by their smaller size and hours of operation, factors that limit the resource consumption and hence the potential to benefit financially by incorporating environmental strategies.

The educational buildings in general, show high potential to benefit from external investment, with the assessment parameter scores above seven in each case. Educational building projects are often more likely to have access to local or state government and philanthropic funding to reduce the extra costs that might occur in employing certain environmental measures.

Across all three building types, *Energy*, *Water* and *Waste* parameters show increased potential with an increasing floor area. The main reason for this is that resource consumption and waste generation are closely linked to the building size; large buildings consume more energy and water and produce more waste. The higher the quantity of resource consumption the higher is the potential for resource conservation. Investing in environmental strategies to reduce resource consumption, minimise environmental impacts or reduce waste generation in these areas has significant potential to yield a net financial return. This is also based on the premise that larger buildings will provide greater economies of scale when integrating environmental systems into a building design, despite their potentially greater complexity and cost. However, the potential savings or benefits will come down to the specific strategies chosen and smaller buildings with simpler environmental solutions may well prove to be just as feasible.

The project location, in particular the climatic conditions of the area and the level of development in an area (classified as urban, regional or remote),

FIGURE 7. Potential for achieving a financially feasible best-practice sustainable outcome across 18 assessment parameters for case study education building projects.



are the two other factors that affect the potential for implementing financially feasible environmental strategies across the *Energy*, *Water* and *Waste* areas. For example, it is only financially feasible to integrate solar power systems or wind turbines to generate renewable energy if the area receives a high amount of solar radiation or has high wind availability throughout the year, respectively. If a project is located close to a construction waste recycling facility then there is a greater likelihood of construction waste being recycled.

The reason behind the low score for the *Infrastructure and utility* parameter for all projects can be explained by the project's location. All of the projects considered in this study are located in urban areas that have well-developed infrastructure and utility services such as roads, water and sewerage, gas, telecommunications and electricity. This avoids the necessity of increasing the current levels of infrastructure and utility to the site and reduces the financial feasibility of taking alternative approaches to providing infrastructure and utility needs.

The projects PE4, PR2 and most of the office building projects show high potential to benefit from the local policy context. The reason for high potential in this area is that these projects are located in areas where local governments promote a sustainable approach to building projects. If a project is located in an area where there are impediments due to government regulations or objections from activist groups, consideration of these implications may delay the project, subsequently increasing project costs.

Comparing and Selecting a Project Location

There may be instances, especially with government sector projects, where the project location is not fixed and investors will need an objective assessment to select the best location to develop a sustainable building project within their budget. An early-stage assessment can be used to compare alternative sites and evaluate the potential for creating a best-practice sustainable built outcome in different areas. To show how this can be achieved, project

PO5 was also assessed for two alternative locations; a regional location and a remote location in Victoria, Australia (Figure 8).

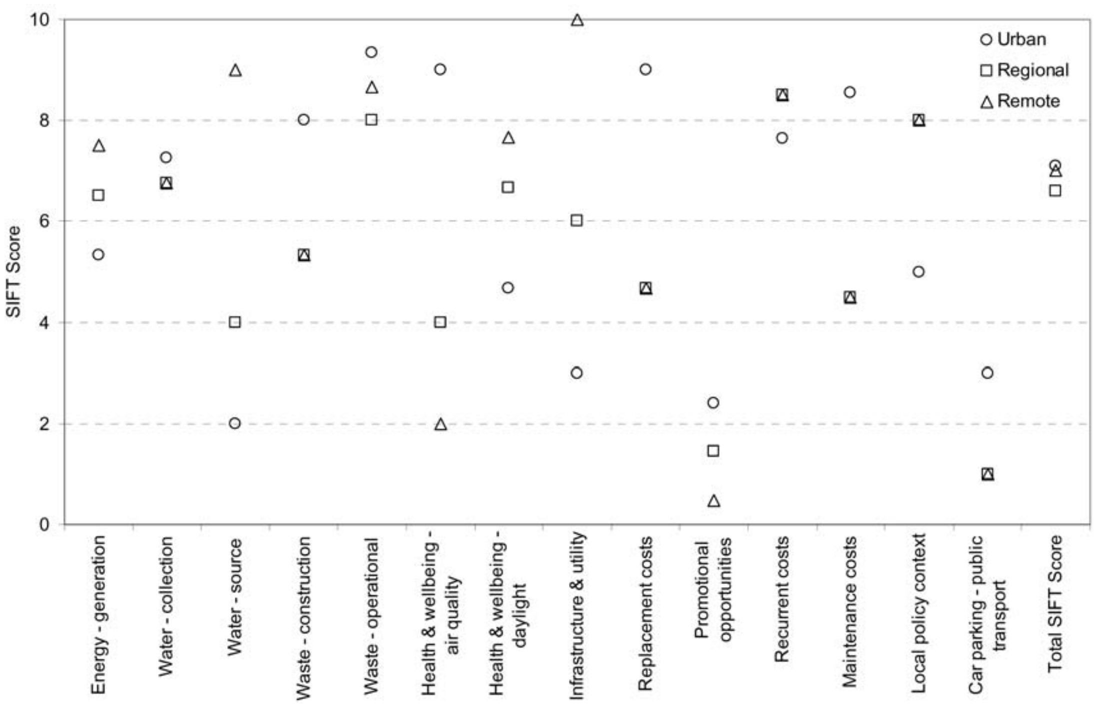
Within this evaluation some parameters show significant variation in their potential while some other parameters show no variation. For example the potential for conserving water or reusing process water does not depend on the project location while potential for on-site rain water collection can vary depending on the climate of the project location. If the project is located in a high rainfall area the potential to benefit from on-site water collection is very high.

Figure 8 indicates the score for some of the selected sub-parameters that showed significant variation when tested across urban, regional and remote locations for project PO5.

The total score does not vary significantly across the alternate locations for this project. However, some parameters show significant differences indicating a varying degree of potential to maximise financial benefits and environmental outcomes. The score for the *Energy: On-site generation* sub-parameter is high in the remote location compared to the regional or urban location. The financial feasibility of on-site energy generation (through photovoltaic systems or wind turbines, for example) depends on several factors including the availability of and access to sunshine and wind, which may be influenced by surrounding buildings and the roof area or height of the building. In remote areas hindrances from other tall buildings are generally minimal giving the building better access to these renewable resources.

The potential for integrating alternative water supply sources on a financially feasible basis is also higher in remote areas because these areas are typically not serviced. Projects in urban areas have easy access to mains water most of the time and as such it is not as financially beneficial to obtain water from alternative water sources. The close proximity of a particular location to mains water reduces the financial feasibility of integrating alternative sources of water supply such as water recycling systems because

FIGURE 8. Effect of project location on some of the assessed sub-parameters for project PO5.



the life cycle costs of using mains water can be less than those associated with many alternative sources. The end users of the building might be reluctant to pay an additional premium for alternative systems if they think the cost difference is too great. Due to the risk involved in ensuring a reasonable return on investment, investors might be reluctant to invest in innovative environmental strategies with high upfront costs, despite the fact that the environmental benefits of these strategies may be considerable.

Air quality in remote areas is relatively better than the air quality in urban areas. Therefore the installation of more energy efficient artificial systems in projects in urban areas is generally more likely to be financially feasible. This is the reason for the high score for the *Health and wellbeing: Air quality* sub-parameter in the urban location.

The potential to benefit from reduced car park requirements is high in urban areas because urban areas provide easy access to public transport. Easy access and frequent availability of public transport encourages workers to use public transport over cars. This helps to reduce greenhouse gas emissions by reducing individual vehicle transport and direct financial savings can be achieved by reducing the need to provide parking spaces in buildings.

A Decision Support Tool for Building Designers

Sustainable buildings, by their nature, require an integrated project approach from project inception, if they are to reap the full benefits (environmentally and financially) from employing a sustainable design approach. The general perception that sustainable buildings cost more to build is one of the biggest challenges for sustainable building design. To convince investors to invest in sustainable buildings, particularly in the current economic climate, a designer needs to be able to target the right group of environmental strategies to ensure the project's financial feasibility. Depending on the project requirements and location, the financial feasibility of achieving a best-practice sustainable building outcome can vary significantly.

Designers can benefit from a formalised early-stage assessment of a project in the following ways:

- identify life cycle environmental and financial benefits of a sustainable building proposal
- identify areas that are likely to contribute to the financial feasibility of the project
- prioritise opportunities according to the potential that they present
- identify areas where incorporating environmental strategies might be financially risky
- as the first step of an integrated project design approach suggesting alternative choices to achieve the project goals without compromising the financial feasibility of the project
- assess and compare alternative building investment choices (for example whether to build a residential or office building)
- assess and compare alternative building locations.

CONCLUSION

This paper has demonstrated how an early-stage assessment of the potential for incorporating environmental strategies into building projects whilst achieving a financially feasible outcome can help to alleviate some of the remaining financial risks and perceived barriers to sustainable building design. The formalisation of this typically intuitive and somewhat haphazard process using objective data, where available, can assist building designers and clients prioritise their efforts when striving towards a sustainable built outcome.

By addressing the environmental performance in confluence with the financial performance of building proposals, an optimal sustainable outcome can be achieved without compromising the financial feasibility of the project. Building designers are able to identify the particular areas in which greatest potential exists for taking a financially feasible sustainable approach to their design and prioritise their efforts in these areas. By identifying areas where environmental and financial potential are both greatest and least for implementing sustainable solutions, time, effort and money can be saved through the adoption of realistic and achievable project goals.

The case studies presented in this paper show that by using a tool such as SIFT at the earliest possible stage of the decision making process for a building project it might be possible to alleviate some of the remaining concerns of building investors and clients and provide further encouragement and confidence in adopting a more sustainable approach to building projects.

Limitations and Further Research

The reliability and usefulness of any feasibility assessment is only as good as the data available at the time. This is particularly the case at the earliest stage of a building project where limited information is available. SIFT provides an indication of the likely potential of achieving a financially feasible sustainable built outcome, providing direction to the design team for further exploration of environmental strategies that may be chosen to capture this potential. However, SIFT does not rate how green a development may be or identify particular environmental strategies. More detailed feasibility analyses will still be required to ensure that particular strategies provide a reasonable return on their investment.

Also, SIFT is currently only able to assess offices, multi-unit residential developments and primary, secondary and tertiary educational buildings across Victoria, Australia. Whilst this currently limits the use of SIFT a more streamlined tool is currently being developed that will enable the assessment of building proposals worldwide.

ACKNOWLEDGEMENTS

This work has been supported by an Australian Government AusIndustry Start Graduate Grant and an Australian Research Council Linkage Grant (LP0667653) and we would like to thank both of these bodies for their support of this project. A number of individuals have contributed to the project and we would like to acknowledge their input, including: Prof. Craig Langston, the late A/Prof. Graham Treloar, Peter Williams, Tom Haynes and Kerryn Wilmot. We would also like to thank the anonymous reviewers for their comments which greatly improved the paper.

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APPENDIX A. SIFT assessment parameters and sub-parameters.

Parameter	Sub-parameter	Description
Energy	Use	Potential for conserving energy
	Greenhouse gas emissions	Potential for reducing greenhouse gas emissions
	On-site generation	Potential for renewable energy generation
Water	Use	Potential for conserving water
	On-site collection	Potential for on-site rainwater collection
	Reuse	Potential for process water reuse
	Source	Potential for taking alternative approaches to water supply
Waste	Generation during construction	Potential to reduce waste generation during construction
	Generation in use	Potential to reduce waste generation during operation
Health and wellbeing	Air quality	Potential for improving air quality
	Daylight	Potential for improving access to daylight
	Artificial systems	Potential for maximising the use of natural ventilation
Project viability	Costs	Financial viability of the project that may provide scope to incorporate green initiatives
	Time	To assess the time related viability of the project that may provide scope to allow for analysis of sustainable solutions
Infrastructure and utility	Issues by site	Potential for taking alternative approaches to infrastructure and utility requirements
Consultancy fees	Ability to pay	Potential willingness of client and capacity of the budget to pay consultancy fees for the extra time and analysis required for a green building
Level and quality of building servicing	Requirements	Potential for taking alternative approaches to the quality and extent of building servicing
Churn	Cycle	Potential for minimisation of waste due to primary churn
	Costs	Potential to reduce costs associated with primary churn
Replacement costs	Services	Potential to reduce replacement costs of services, central plant and services reticulation
External investment	Funding	Potential availability of external investment opportunities (government)
	Other funding	Potential availability of other funding opportunities (non-government & philanthropic)
Promotional/incidental use	Opportunities	Potential opportunity for income producing promotional/ incidental use beyond primary function of the building
Recurrent costs	Fixed and variable	Potential to reduce recurrent costs
Maintenance costs	Services	Potential to reduce building services maintenance costs
	Finishes	Potential to reduce building finishes maintenance costs
	Fabric	Potential to reduce building fabric maintenance costs
Rent	Return	Potential for improved rental income from the intended purpose of the building
Public interest or benefit	Funding	Potential for public or philanthropic site specific funding
Local policy context	Regulatory requirements	Potential for implications associated with local regulatory requirements
	Groups	Potential for a streamlined planning process
Carparking	Requirements	Potential to reduce carparking
	Public transport	Potential to maximise the use of public transport