Sustainability Portfolio Assignment

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Executive Summary

The current project examines sustainable design in light of its principles and the economic value that it may bring to owners Ash Developments of Unit 19 building a 4 storey office premises. The report devised uses the case study of Unit 19 to analyse if sustainable design principles are applicable to the repair and renovation of the building. In doing so, various sustainable design principles were examined with overlapping features found in each of the different literature reporting on the principles. The overlapping principles were then used to devise a specific set of sustainable design principles that needed to be followed through the design process and implementation of the unit 19 repairs and renovations.

Unit 19 was facing various repairs which included some of the following;

1. Localised repairs on the asphalt roof coverings.
2. Redecoration of fourth floor extension and plant room structure on roof level.
3. Exposure of steel reinforcement bars with signs of corrosion on the concrete cills, lintels, and piers of the windows.

These repairs along with extensive list of repairs mentioned in the current report were fixed using sustainable design. For the current study, sustainable design is defined as ecological designs that make sure that the actions that humans carry out and the decisions that are made in the present do not constrain the opportunities of future generations to come. Using this foundation the entire design for the renovation was developed to ensure the practical use of ecological methods to build a financially viable investment for the owners, comfortable work environment for the occupants, and making the building a key aspect in the eco-system of Liverpool.

1 INTRODUCTION

Ash Developments is looking for consultation on the matter of incorporating sustainable design into one of the office properties unit 19, Liverpool Innovative Park, Edge Lane, Liverpool. The property itself is made up of four storeys which has been extended into a partial fifth floor over the roof area. The property is primarily for office premises and has been built into an “L” shape with a curved bull nose detail to the north east. The property has been fitted as office space with both open plan and cellular office arrangements. Based on the property’s inspection found in the case study, the property is generally in a reasonable condition based on its age and use. However, there is a need of various repairs to the building in which the landlords would like to know if sustainable design is feasible to them.

The current report aims to examine sustainable design choices in light of the major fixtures that are required from the inspection of unit 19. The analysis of sustainable design will be undergone using a set of sustainable design principles which will be researched. The sustainable design principles chosen will be used as guidance to propose a strategic plan that is able to encompass all the repairs that have been recommended from the inspection.

1.1 RESEARCH AIMS

The current report aims to propose a programme that tackles external repairs;

- Spalling concrete to the elevations which poses a surmountable health and safety risk
- Repairs on roof coverings
- Repairs on parapet walls and windows
- All repairs being made need to be environmentally friendly by using sustainable design in regards to process, material, and implementation.

The research also aims to investigate various sustainable designs that are best suited for the requirements set out by Ash Developments. This will include the use of green technology or construction if it is proven that sustainable design will have a beneficial impact on the unit 19 building. Other aims of the research include;

- Investigating the research questions; *what is sustainable design and green construction? How can sustainable designs be implemented into the case study's unit 19 building?*
- Examine the financial aspects which includes the advantages and disadvantages of using sustainable design.
- Examine and scrutinise the various proposed strategies and recommendations to repairing unit 19.

1.2 Research Objectives

The current report proposes to reach its aims through the following objectives;

- Analysing solutions to the immediate repair problems that are being faced in terms of eco-friendly designs and non-eco-friendly options.
- Analyse the financial concerns of the client in relation to the use of sustainable designs on the existing unit 19 building.
- Analyse the current trends and technologies that are available of sustainable design within construction and architecture industry that can be implemented to unit 19, the building under question for repairs.

2 Sustainable Design Principles

2.1 Overview of Sustainable Design

According to DeKay and Brown (2014), sustainable architecture and construction aims to mitigate the negative environmental impact that buildings may have through means of efficiency and moderation in terms of the type and amount of material used in construction, along with the energy and development space need to construct it. Furthermore, the heart of sustainable architecture keeps in mind that there is a need to use sentient methods to energy and ecological conservation in the design of the built environment (DeKay and Brown 2014). The whole purpose of sustainability philosophy or ecological design is to make sure that the actions that humans carry out and the decisions that are made in the present do not constrain the opportunities of future generations to come.

There are various architectural design principles and processes that are used to become the foundation of sustainable building design. For example, Van der Ryn and Cowan (1996) set out five principles which embodied the view that transformation into a more sustainable world needs to use a more renewed approach to the design of buildings and products by incorporating the basic level of understanding of ecological principles. Vale and Vale (1991) described six principles as the foundation for the *green* design process which they practically implemented through the Hockerton Housing project. While Roaf (2004) focuses mainly on the continuous climate change issue and places emphasis on designing resilient buildings that can minimise further damage to the environment focusing on a building's longevity and low use of energy.

2.2 SUSTAINABLE DESIGN PRINCIPLES USED

Regardless of the various principles of sustainable design that are found extensively through literature there are certain principles that overlap. As a building surveyor it is essential to analyse the various sustainable design principles that are common among the practical application of them. Therefore, from extensive research of the literature the following principles were highlighted and will be used throughout the current report.

1. Use of low impact materials.
2. Use of manufacturing processes which are able to produce products from less than required energy.
3. Design that is able to incorporate concepts of reuse and recycle.
4. Incorporation of impact measures that are able to reduce total carbon footprint and the use of life-cycle assessment for resources that have been used.
5. Preparation of design using sustainable design standard and guides which enable the design to incorporate new methods of sustainable science into the design of a building.
6. The concept of renewability in which materials should be sourced from local vendors and managed in a way that resources are composted once their usefulness has been exhausted.

At first glance it may seem that sustainable design is out of the realm of many contractors and property owners. However, the various and related building systems that form a relationship as whole are elemental to the building's overall functionality. For example, maximum energy efficiency can be achieved within a building through various building systems such as the controllability of lighting systems on an individual and overall building system level, reduction of light pollution, and efficiency of light fixtures to be able to optimise the entire building's energy performance.

2.3 Economic Benefit of Sustainable Design

There is mounting evidence that sustainable buildings are able to provide their owners, operators, and occupants with a plethora of benefits or rewards. First and foremost sustainable buildings have lower annual costs for energy, water, maintenance/repair, the need for reconfiguring space from changing needs, and other operating expenses that are associated to commercial buildings. It is not necessary that the reduced long term costs come at a higher expense of first time costs. According to Jennings (1995) and Dekay and Brown (2014), through the use of integrated designs and innovative uses of sustainable materials and equipment, the first time costs of a sustainable building can be considerable the same or even at times lower than traditional building methods of design and construction.

Aside to the direct cost savings, buildings built or renovated from sustainable design are able to provide indirect economic benefits to the building owner and the society at large. For example,Kim (1998); DeKay and Brown (2014); Bejan (2015) all state that sustainable buildings can promote better health, increased comfort and well-being, and productivity of the building occupants. This in turn is able to reduce the levels of absenteeism within a working environment and increase the productivity of the individuals that are active in the workplace environment. There are also substantial economic benefits to the owners of the buildings which includes lower risks, longer building lifetimes, improved ability to attract new customers, reduced expenses of dealing with complaints, less time and lower costs for project permitting value. For the society at large, sustainable buildings offer, economic value as well through reduced costs from air pollution damage and lower infrastructure costs.

Many of the principles outlined above can be incorporated into the sustainable design for unit 19 which will be discussed in length in the strategic plan section.

3 STRATEGIC PLAN

Sustainable design will begin with the conceptual stage in order to build on ideas to later realise the full benefits of the design. The first step that needs to be taken is building up a design team. This design team will include the owners (Ash Development), architects, engineers, sustainable design consultants, landscape designers, health, safety, and security experts, the general contractors, cost consultants, and considerable key subcontractors.

3.1 DESIGN GOALS

The composed team will conduct a series of 15 day workshops and meetings to discuss the project goals for unit 19 keeping in mind the owner's wishes and the repairs required as extracted from inspection report.

4. Localised repairs on the asphalt roof coverings.
5. Redecoration of fourth floor extension and plant room structure on roof level.
6. Exposure of steel reinforcement bars with signs of corrosion on the concrete cills, lintels, and piers of the windows.
7. Vertical cracking of low level brick work most likely caused from thermal movement.
8. Repair glazed units on extension and other window repair.
9. No provision for smoke/heat detection to the office areas.
10. No disabled parking space within close proximity to main entrance.
11. In strong need of external repairs particularly to the issue of spalling concrete to the elevations with remedial work needed on the roof covering, parapet wall and windows.

These eight points of repairs need to be taken as key in repair and renovation of unit 19. All of the repairs mentioned above can be achieved through sustainable design. Along with immediate repairs it is also necessary to reduce the overall use of energy in the building to make it a more ecological building. There is also need to improve the overall ecology of the building site.

Table 1- Principles and Process Summary of Unit 19 Sustainable Design

Principles	**Process**
Ecological Design- designs made with nature in mind. The need for ecological accounting to take place on unit 19.	Environmental Brief- overview of carbon reduction, energy efficient, creation of flexible working environment.
Green Architecture- working with climate change conditions. The need to ensure that there is a conservation of energy or at least the reduction of energy consumption. Respecting the building site and encouraging that respect to future occupants. Minimising the use of new resources to repair the site.	Parameters- Enable the newly renovated site to be at least a "B" listed building. Ensure that the budget laid out is not over strained. Although no construction project is void of cost creep.
Adapting Building for climate change- Through a good design there need to be little energy use as possible. There needs to be a reduction in waste within the operations of construction and demolition. Ensure that future occupants and current workers of the project are comfortable and can survive the extremities of weather.	Environmental Strategies- passive design is to be used for unit 19 to achieve natural ventilation and improve thermal performance. There needs to more landscape work on the site to promote biodiversity.
	Evaluation methods- BREEAM measure 'excellent' on renovated site. There needs to be constant monitoring of water, energy, and CO_2.

3.2 Strategy for Reduction in energy consumption

Reduction of energy consumption is top priority of the design goals for unit 19 in addition to the repairs that are required by inspection. It is essential to establish the use of natural light in the building without overheating the interior or making the use of natural light uncomfortable which often happens from glare. The strategies developed for energy consumption reduction were evaluated based on their life cycle costs which include evaluating the equipment functionality, maintenance, repair, and replacement costs of the building throughout its life time. Various modification to components will be analysed for their implications in overall operational energy consumption which will allow for a combination to be formed of all the modifications.

The strategy that is used for choosing and implementing insulation in the building must take into consideration the comfort of occupants which will analyse the ways in which energy is transmitted based on its direction and intensity. Since there are changes of usage of energy from day to night and season to season, the use of materials become a high ranking priority in reduction of energy consumption.

4 RESULTS

4.1 TECHNOLOGIES USED FOR SUSTAINABLE DESIGN

- HVAC- Based on the current case study, the building does not seem to have an adequate HVAC system which led to the need of installing an HVAC system to increase ventilation level and brought forth the opportunity to install economisers. For this purpose, direct digital controls were place which will allow the building operators to set heating and cooling levels through a computer network connection. The system will have the ability to monitor interior temperatures and monitor load shedding which will allow any occupants of the building to save money on peak demand rates that are usually set on a seasonal basis (Robert 2003).
- Envelope- The north and east facing interior will have a Mylar film curtain wall system. This Mylar curtain wall will enable the reduction of glare and reflect about 60 per cent of the heat on sunnier days. During winter season, the Mylar film will reduce heat loss by reflecting the internal heat back into the office spaces (Grierson and Moultrie 2011; Emmanuel and Baker 2012).
- Lighting- This includes the installation of 32-watt T-8 lamps which have high-efficiency electronic ballasts. Just with this installation alone, the building will be reducing lighting energy consumption by 40 per cent and will be able to pay for itself in the next three years (Bejan 2015).

- Daylighting- The installation of super-efficient ballasts on the fifth floor which will include photocell sensors that will enable the dimming of lights when the sensors pick that adequate daylight is present. The cellular office arrangements will be fitted with translucent wall panels which will enable the interior office spaces to receive natural daylight. The fourth floor and the floors with open office spaces will have the installation of window share screens which will aid in the control of light and adjustment of glare levels while at the same time reduce heating gain and loss (Finnegan and Ashall 2014).

4.2 Energy Performance

Through the installation of innovative technology unit 19 building will be an electrical building with the occupants using utility bills to track their energy usage. A similar project was undertaken for the Alliance Centre through the Alliance of Sustainable Colorado a non-profit organisation with the aim of advancing sustainability. The organisation had purchased a 100-year old warehouse for major renovations. However, since its sustainable renovation the building has seen an increase by double in its occupancy while it still continues to reduce the energy that it is using through conservation measures (NBI, n.d.). Based on the same renovations being made on the unit 19 building it is hypothesised that unit 19 will be able to reduce the consumption of energy by 22 per cent making the use of energy 55 per cent less than the average offices in the UK of 42 kBtu/sf/yr (Pearce *et al*. 2012). The average of all offices in the UK is a good basis for comparison of buildings of the same class.

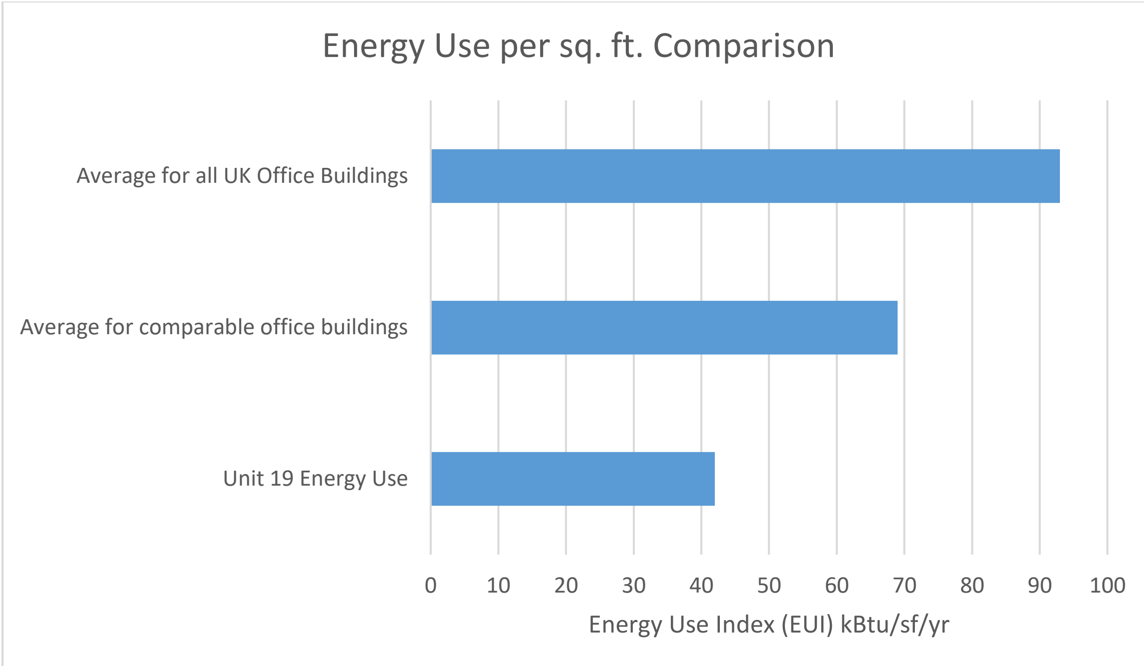

Figure 1- Energy Use per sq. ft. Comparison

A hypothetical projection of Unit 19's energy consumption was built based on the renovations concluded in the building for energy efficiency, afterwards full occupation of the office space was estimated along with its energy consumption for 45,765 sq. ft. office space using the Alliance Centre model (NBI, n.d.). Based on the assumptions made, the energy consumption of the building is compared as illustrated in figure 1. Based on figure, Unit 19 will be able to consumer 39 per cent less energy than average comparable office buildings. Furthermore, on a national scale, the unit 19 building will be able to use 55 per cent less energy than the average of all UK office buildings (Bejan 2015).

The total cost of the project for the installation of energy performance equipment will equal to £82,276 at £2.16/sf after the settlement of incentives (NBI, n.d.). Funding for the renovations can be sourced from local ecological and sustainable energy companies as well as public works that fund energy management and conservation. The total time of renovations for energy efficiency will take a total of 5 months.

5 Recommendations

From review of the sustainable design principles used a design was proposed to integrate ecological concepts to make the unit 19 building environmentally friendly and economically viable. The remainder of the repairs that are immediately needed have been highlighted in the table below to indicate the repair the recommendation.

Table 2- Recommendations to Repairs

Localised repairs on the asphalt roof coverings.	Repair roof using recycled content shingles. Are a low cost alternative with a 50 year product life.
Redecoration of fourth floor extension and plant room structure on roof level.	Implementation of green installations and expansion of plant room on roof level to mimic garden roof. Adds insulation in cooling building, cleaning the air, and reduction the amount of storm water that gathers on the roof. There may be need to have structural reinforcement to support the weight of the plants and soil.
Exposure of steel reinforcement bars with signs of corrosion on the concrete cills, lintels, and piers of the windows.	Re-cement the concrete with sustainable mixed concrete which mixes resources such as glass into the concrete without changing the composition of the mixture (Lemay *et al*. 2013).
Vertical cracking of low level brick work most likely caused from thermal movement.	Installation of bioBricks to cover up the cracking of low level brick work (bioMason 2015).
Repair glazed units on extension and other window repair.	Replacement of all windows of building with thermally insulated, solar control, and noise reduction glazing. Will allow passive solar heat, improve energy

	efficiency, reduction in condensation, and prolong the life of windows (Emmanuel and Baker 2012).
No provision for smoke/heat detection to the office areas.	Installation of smoke/heat detection alarms and sprinklers into the office areas, and lobby.
No disabled parking space within close proximity to main entrance.	Addition of disabled parking space within close proximity to the main entrance.

In addition to the recommendations made on the repairs of the building. It is also recommended that the parking area includes more ecological options such as inclusion of more green grass, tress, and flora to beautify the area but also make it more ecologically diverse. Landscaping experts will be used to devise a parking lot plan that maintains the functionality of the parking space while also beautifying the area using plants and flowers that will be able to maintain themselves in the Liverpool environment in terms of temperature and seasonal changes.

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