

Student Name: Tomos Williams

Student ID number: 2319571

Programme: HND Quantity Surveying

Module: Construction Technology 2

Module Code: ACBA5019

Lecturer: Hannah Williams

Assignment Title: Sustainability Evaluation

Introduction

This report builds on the original proposal for a medium-to-high-rise student accommodation development in the SA1 urban area by taking a closer look at its sustainability and long-term viability. The initial design offered a variety of living arrangements—including both shared and private units—to meet the diverse needs of the student population. Shared facilities such as study spaces, social areas, and a student union were also planned to encourage academic success and foster a strong sense of community.

Key structural choices—like using a reinforced concrete frame, a raft foundation, and a modern steel-and-glass façade—were made to respond to the challenges of building in a dense urban environment, while ensuring safety, stability, and visual appeal. These features also improve functionality by supporting efficient service distribution and sound insulation (Glover, 2020).

This follow-up analysis shifts the focus toward sustainability. It evaluates how material selection, construction methods, and building operations affect environmental performance. Measures such as passive solar design, energy-efficient glazing, and the use of recycled or low-emission materials are considered to reduce energy consumption and carbon output. Green features like SUDS, green roofs, and vertical planting support stormwater control, improve biodiversity, and enhance the building's visual presence (Jones and Patterson, 2019).

Lastly, the design has been developed with future flexibility in mind. Structural choices and adaptable internal layouts make it easier to repurpose the building over time, helping to extend its lifespan and contribute to long-term sustainable urban development.

Environmental Impact

Orientation

How the building is positioned plays a major role in both energy efficiency and resident comfort. In the original concept, a modern steel-and-glass façade was proposed to allow more natural daylight into the living spaces. Expanding on that idea, this section explores how orientation can also support better ventilation and passive solar heating and cooling.

The building is mainly aligned east to west, which is ideal for managing solar gain throughout the year. This setup helps limit heat buildup during summer, especially on the east and west sides where sunlight tends to be more intense in the mornings and evenings. Additional features like shading fins,

overhanging roofs, and vertical louvers on the southern and western façades are incorporated to reduce overheating and glare, particularly in study areas and communal zones, while still allowing natural light in (Lechner, 2015).

The layout also encourages natural ventilation. Many units are positioned to benefit from Swansea's prevailing south-westerly breezes. By placing operable windows on opposite walls, air can flow freely through rooms, helping cool the interior naturally and cutting down on the need for fans or air conditioning. This approach suits the region's mild coastal climate, where passive cooling can be effective for much of the year (Yeang, 2006).

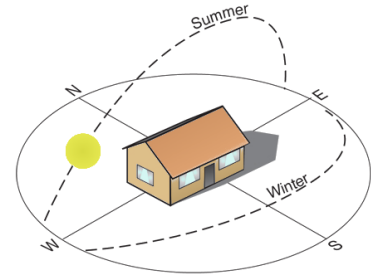


Figure 1. Building Orientation for Optimum Energy (International Association of Certified Home Inspectors, n.d.)

High-performance glazing—specifically low-emissivity glass—plays a key role in temperature regulation. It helps control heat loss in winter and heat gain in summer, while still letting in plenty of daylight. Combined with the façade design, this reduces the need for artificial lighting and climate control systems.

Altogether, the orientation strategy helps lower energy use, reduces carbon emissions, and creates healthier, more enjoyable spaces for students to live and study in.

Life Cycle

Looking at the entire life cycle of the building, the use of steel and reinforced concrete as the primary structural materials offers considerable long-term sustainability benefits. These materials are known for their exceptional durability, which reduces the need for frequent repairs or replacements over time. Steel provides flexibility and tensile strength, while reinforced concrete delivers high compressive strength and resistance to environmental degradation, making it particularly suitable for urban environments. This longevity translates into fewer resource requirements and lower maintenance costs throughout the building's life (Addis and Schouten, 2004).



Figure 2. Understanding Whole Building Life Cycle Assessment for a Better Architecture (Arch Daily, 2023)

Both concrete and steel are recyclable at the end of their useful life. Concrete can be crushed and reused as aggregate, minimizing the need for new materials and helping divert waste from landfills. Steel, on the other hand, is highly recyclable and can be reused repeatedly without any degradation in quality, contributing to a circular economy model (Kibert, 2016).

One challenge, however, is the embodied carbon footprint of materials like concrete. The manufacturing process of concrete is energy-intensive and produces significant CO₂ emissions. To address this, the design incorporates low-carbon alternatives such as concrete mixes containing fly ash or ground granulated blast-furnace slag (GGBS), which can replace some cement content and reduce overall embodied emissions.

The use of prefabricated bathroom pods and modular units further enhances sustainability by minimizing material waste, reducing construction errors, and lowering on-site energy consumption. The controlled factory environment also ensures better quality control and fewer mistakes that require fixing or replacing.

For long-term maintenance, sustainable design choices such as modular MEP systems, accessible service routes, and interchangeable façade panels are integrated. These strategies emphasize durability and adaptability, reducing the environmental impact and making future maintenance less resource-intensive and more efficient.

Aesthetics

The design of the building is intended to seamlessly integrate into the evolving urban landscape of the SA1 district, which is increasingly defined by educational institutions, innovative technology, and cultural revitalization. The sleek glass and steel façade offers a modern aesthetic that complements the district's architectural language, symbolizing transparency, progress, and innovation. This design choice not only aligns with the surrounding academic structures but also supports SA1's broader vision of becoming a sustainable, dynamic, and forward-looking urban area (Gehl, 2010).

To create a smooth connection between the building and the surrounding environment, green terraces and landscaped public spaces are incorporated at the ground level. These areas serve multiple purposes, providing essential environmental benefits such as cooling, shade, and stormwater management, while also offering welcoming spaces for both residents and visitors. The use of native plants and a focus on biodiversity further enhances the ecological value and visual appeal of the site (Sutton, 2015).

In addition to their environmental advantages, features like rainwater harvesting systems, solar panels, and green façades are visibly integrated into the building's design. These elements not only contribute to sustainability but also serve as educational tools, promoting awareness of environmental practices among the public and students alike.

Overall, the building maintains a consistent massing, material palette, and glazing approach, ensuring that it harmonizes with the SA1 skyline and architectural rhythm, and positively influences the ongoing transformation of the neighbourhood.

Façade Greening and SUDS

Façade Greening

The building's modular design and steel framework have been cleverly used to incorporate green façades into the overall structure. By using cable trellises and modular green wall panels, vegetation can be installed on the south and west sides of the building without affecting structural stability or ease of access. These elevations receive more sunlight, making them ideal for supporting plant growth and enhancing the building's environmental performance.

From an environmental perspective, green façades provide added insulation, helping to reduce solar heat gain during hot weather and supporting natural cooling methods. This in turn cuts down on the need for mechanical cooling systems, lowering energy use and improving the building's overall sustainability rating. Additionally, plants on the façade filter pollutants and fine dust from the air, while also softening urban noise—an important feature in high-density residential areas (Ottelé et al., 2011).

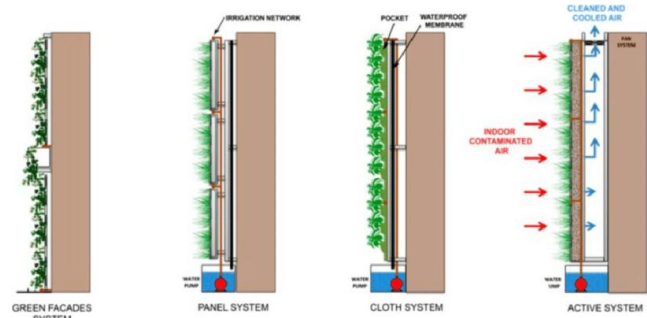


Figure 3. Ventilated Green Facades as A Passive Design Strategy (Research Gate, 2022)

The presence of greenery also boosts urban biodiversity by attracting birds and pollinators like bees and butterflies, contributing to the ecological well-being of the SA1 district and supporting larger city-wide greening efforts.

Beyond environmental benefits, the inclusion of greenery has mental health advantages. Inspired by biophilic design principles, having visual and physical access to nature has been shown to ease stress, lift mood, and support mental wellness—an especially important factor in student housing, where cognitive performance and emotional health are key (Kellert et al., 2008).

To ensure the system's longevity, the green walls are equipped with pre-installed drip irrigation and automated nutrient systems. Maintenance is made safe and straightforward through the inclusion of accessible walkways and service areas within the façade, helping to keep the green walls functional and attractive over time.

SUDS (Sustainable Urban Drainage Systems)

Given the site's urban setting and moderate groundwater levels, it is essential to incorporate Sustainable Urban Drainage Systems (SuDS) into the design of the student accommodation. These systems are implemented not only to manage stormwater effectively but also to enhance environmental performance and ensure long-term site resilience.

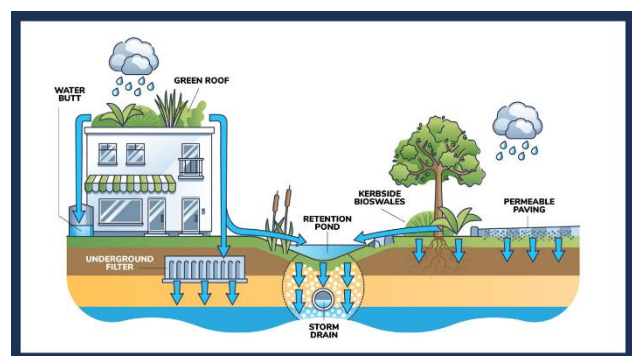


Figure 4. The Natural Approach: Sustainable Drainage Systems (SuDS) (MRMS, 2024)

Flat roof areas have been designed to support green roofs, which offer thermal insulation benefits and reduce stormwater runoff. By absorbing rainfall, they help to delay water discharge into the drainage system, which is particularly useful during peak rainfall events. In addition to improving energy efficiency, green roofs support biodiversity and contribute to the visual quality of the built environment (Berndtsson, 2010).

Permeable paving is used throughout pedestrian areas and courtyards to allow rainwater to infiltrate through the surface and into sub-surface layers, reducing runoff and flood risk. This method also

improves the quality of water entering the drainage network by filtering out pollutants and aiding groundwater recharge.

Bioswales and rain gardens have been carefully integrated into lower-lying areas and the site's perimeter. These features slow and capture surface water, using vegetation and soil to filter out contaminants before water percolates into the ground. As well as supporting natural water treatment processes, they enhance the site's ecological and visual appeal (Woods-Ballard et al., 2015).

Rainwater harvesting systems are also built into the infrastructure, collecting water from roof surfaces for non-potable uses like landscape irrigation and toilet flushing. This reduces reliance on mains water and supports sustainable resource use.

All SuDS components are designed in line with best practice guidance from CIRIA's SuDS Manual (C753). The overall strategy not only enhances the ecological and aesthetic aspects of the site but also reduces the burden on public drainage systems, mitigates flood risk, and builds resilience to the increasing frequency of extreme weather events associated with climate change.

Flexibility in Design and Use

Flexibility

The building has been thoughtfully designed to support long-term use and adaptability. Its reinforced concrete frame and the use of non-load-bearing internal walls make it easy to reconfigure room layouts with minimal disruption. This approach allows shared spaces to be converted into private rooms or studios as student needs or accommodation trends change (Gibb and Pendlebury, 2006).

To further support flexibility, mechanical, electrical, and plumbing systems are routed through suspended ceilings and raised floors. This layout provides easy access for repairs, upgrades, or reconfigurations without interfering with the building's structural integrity. It also simplifies the integration of new systems and technologies over time, making the building more resilient to future change.

Multi-use areas such as common rooms and student hubs are designed with open-plan layouts, making them easily adaptable to various functions—such as wellness centres, co-working spaces, or event venues—depending on shifting institutional priorities and student behaviours. These flexible environments allow the building to evolve alongside new modes of learning, socialising, and collaboration (Brand, 1994).

Smart building technologies further enhance adaptability. Features like occupancy sensors, programmable lighting, and HVAC zoning enable the internal environment to respond dynamically to how spaces are used. In addition to improving comfort, these systems help to reduce energy consumption in areas that are used less frequently, supporting sustainable operation.

Altogether, this design strategy ensures that the facility remains relevant, versatile, and ready for future demands—accommodating changes in student life and institutional growth without the need for major renovations.

Future Alternative Uses

The student housing development has been intentionally designed to remain functional and relevant, even if its original purpose changes over time. Thanks to its flexible layout, the building can easily adapt to shifts in student populations, institutional priorities, or broader market trends.

One future use could be transforming the complex into co-living accommodation aimed at young professionals. The current configuration—offering private rooms alongside shared kitchens, lounges, and study areas—already aligns well with the principles of co-living, making this transition efficient and cost-effective (Crommelin et al., 2018).

Another viable option would be reconfiguring existing units to form compact micro-apartments. This approach would respond to the rising demand for affordable, space-saving urban housing, particularly among single occupants or young renters in city centres.

Alternatively, the building could serve as an innovation hub or a postgraduate research centre. The private rooms could be converted into live-work units, while shared spaces could be adapted into office areas or collaborative labs. This would encourage interdisciplinary cooperation and entrepreneurial development (Langston, 2012).

All of these adaptive reuse options support the ideals of the circular economy by extending the building's life, reducing construction waste, and limiting the demand for new materials. This forward-thinking adaptability ensures that the building continues to contribute positively to the urban environment well into the future.

Conclusion

The sustainability study complements the original engineering and architectural designs for the student housing complex, aligning them more closely with long-term goals for social, economic, and environmental sustainability. Key strategies that improve energy efficiency and reduce carbon emissions over the building's lifespan include passive design elements, the use of long-lasting and recyclable materials, and optimal building orientation (Cabeza et al., 2014). The integration of green infrastructure, such as vertical gardens and Sustainable Urban Drainage Systems (SUDS), not only enhances the aesthetic appeal of the SA1 regeneration area but also boosts its environmental quality and supports ecological resilience (Francis and Lorimer, 2011). In addition, the building's flexible internal layout and its potential for future adaptations ensure that it can meet changing functional needs and demographic shifts, helping to avoid early obsolescence. Together, these approaches form a comprehensive and innovative strategy for sustainable urban development. The result is a highly adaptable, energy-efficient student housing complex that promotes resident well-being, encourages environmental responsibility, and positively contributes to the broader urban landscape.

Reference List

Addis, B. and Schouten, J. (2004) *Designing for Sustainability: A Guide for Building Designers*. London: CIRIA.

Berndtsson, J.C. (2010) 'Green roof performance towards management of runoff water quantity and quality: A review', *Ecological Engineering*, 36(4), pp. 351–360.

Brand, S. (1994) *How Buildings Learn: What Happens After They're Built*. New York: Viking.

- Cabeza, L.F., Rincón, L., Vilariño, V., Pérez, G. and Castell, A. (2014) 'Life cycle assessment (LCA) and life cycle energy analysis (LCEA) of buildings and the building sector: A review', *Renewable and Sustainable Energy Reviews*, 29, pp. 394–416.
- Crommelin, L., Troy, L., Martin, C. and Pettit, C. (2018) 'Is "Co-Living" a Solution to Our Housing Crisis?', *The Conversation*, 12 June. Available at: <https://theconversation.com>
- Francis, R.A. and Lorimer, J. (2011) 'Urban reconciliation ecology: The potential of living roofs and walls', *Journal of Environmental Management*, 92(6), pp. 1429–1437.
- Gehl, J. (2010) *Cities for People*. Washington, DC: Island Press.
- Gibb, A.G.F. and Pendlebury, M. (2006) *Design for Adaptability — A Guide for Building Designers and Planners*. Watford: IHS BRE Press.
- Glover, J. (2020) *Structural Design for Urban Buildings: Materials and Methods*. London: Routledge.
- Jones, P. and Patterson, D. (2019) *Sustainable Architecture and Urban Design: Principles and Practices*. 2nd edn. Oxford: Wiley-Blackwell.
- Kellert, S.R., Heerwagen, J. and Mador, M. (2008) *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life*. Hoboken, NJ: John Wiley & Sons.
- Kibert, C.J. (2016) *Sustainable Construction: Green Building Design and Delivery*. 4th edn. Hoboken, NJ: John Wiley & Sons.
- Langston, C. (2012) *Life-Cost Approach to Building Evaluation*. Oxford: Elsevier.
- Lechner, N. (2015) *Heating, Cooling, Lighting: Sustainable Design Methods for Architects*. 4th edn. Hoboken, NJ: John Wiley & Sons.
- Ottel , M., van Bohemen, H.D. and Fraaij, A.L.A. (2011) 'Quantifying the Deposition of Particles on Building Facades Covered with Green Walls', *Ecological Engineering*, 37(6), pp. 824–832.
- Sutton, R. (2015) *Green Roof Ecosystems*. 1st edn. Cham: Springer.
- Woods-Ballard, B., Kellagher, R., Martin, P., Jefferies, C., Bray, R. and Shaffer, P. (2015) *The SuDS Manual (C753)*. London: CIRIA.
- Yeast, K. (2006) *Ecodesign: A Manual for Ecological Design*. London: Wiley-Academy.

Word Count: 2,318 words (excluding reference list)