

Building Services & Energy

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1. General Introduction

This report has been produced to analyse a buildings whole life cycle, as well as critiquing its past and present uses, characteristics, its chosen internal and external design materials, its economic and social values and as well as analysing its environmental impact in relation to its energy usage. The embodied carbon and energy, costings of the construction and its end-of-life plans will also be detailed in this report. Supporting diagrams, photographs and plans will aid in the analysing and critiquing. To conclude this report, a discussion will be raised to highlight the buildings approach to manufacturing and evaluating how and why alternative approaches may have been beneficial.

1.1 Building introduction & History

The University of Wales Trinity Saint David is in the small market town in the Teifi Valley, or as it was originally known in 1822, St David's College, Lampeter. This building was established by Mr Thomas Burgess who became the principal founder



Figure 1 External shot of whole building--Author

and benefactor (*Discover Ceredigion, 2016*). On 21 September 1964 this building entered the listed building records and became a protected grade II* listed building, this listed status enabled the building to be adequately protected and retain its educational history and significant within the local town and community.

The initial reasoning of its listed status is down to the building being a part of a remarkable collection of educational structures with great architectural value and national historic significance. It is known for the connections to two prominent architects as issued by (*CADW, 2012*).

If we were to consider this building and make amendments to its structure and alternative exterior and interior aspects, it would pose some difficulty likewise if we were to consider this building was constructed in the past 10 years with no listed status, it would enable less difficulty and more flexibility for adaptations to meet the needs of modern times.

1.2 Purpose and current usage

The building is currently occupied by the University of Wales Trinity St David, previously it had been the place of higher education and study as well as obtaining the name of the oldest University in Wales (*UWTSD, 2022*). The building has shown its significance to educational studies and term time residences with recent student halls. Given its current and past uses, for the majority time, the building is occupied and exercised by many different users throughout different periods of the day.

1.3 Building characteristics

In 1822 when the building itself was founded during the post medieval period, it was firstly designed by C R Cockerell who was described as the “pre-eminent neo-classical architect of the early/mid 19th century” as explained by (Coflein, 2010). The design was based on the 17th century colleges situated in the Cambridge area of oxford, which display a simpler version of Tudor gothic.

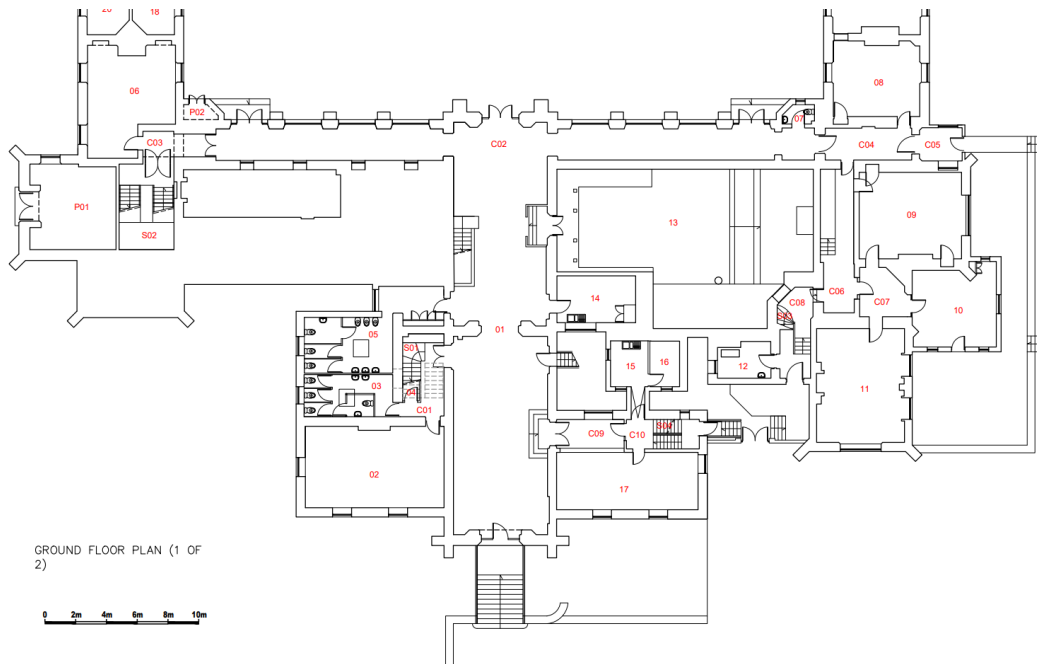


Figure 2- Showing ground floor plan - UWTSD

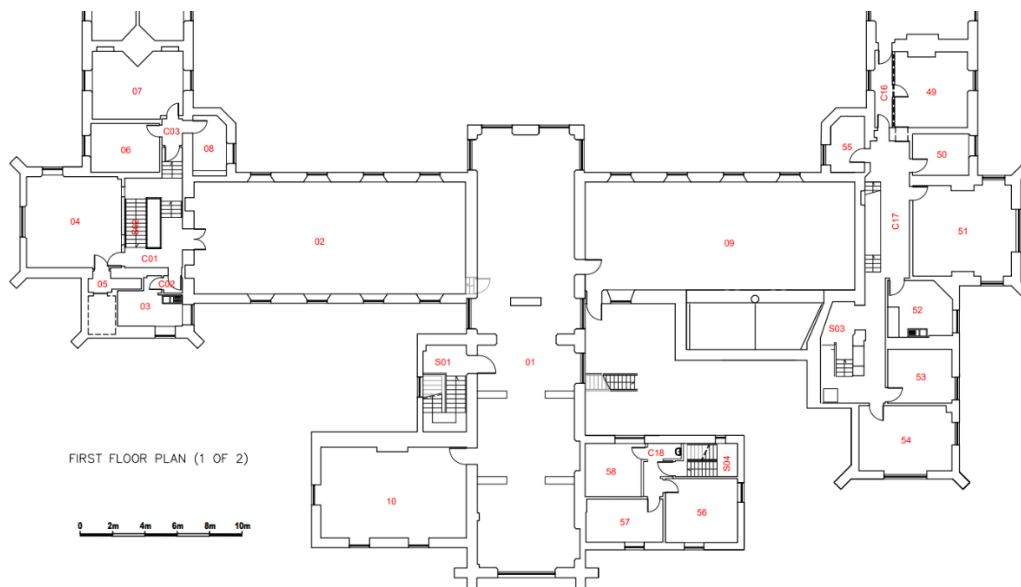


Figure 3- Showing first floor plan – UWTSD

1.4 Buildings social and economic values

The Public service act 2012 came into force in 2013, putting in place a requirement for government organisations to think about how the services they commission could enhance the social, economic, and environmental well-being of a region rather than only focusing on the contract's financial cost as indicated by (*Building.co.uk*, 2021). As cited by (*CLM Fireproofing*, 2015) the social values of new buildings will incorporate these following social value needs:

- A focus on its priorities, this ultimately means focusing efforts on what will impact the community the most whether this is the creation of jobs or providing facilities for the local community.
- Building social value into every aspect of the build and its bid, this is ensuring full communication to all affected parties, providing clear guidance in next steps and the reassurance that any parties affected have been considered and alternative steps have been made to reduce as much disturbance as possible.
- Identifying accountability, fully educating teams to ensure they are understanding of the goals of the project and always sharing risks and responsibilities.
- Highlighting the achievements that will be made from the build in relation to its social value, this means to consider what was effective and to learn from mistakes of build from both the company and the community side of things which should encourage inspiration for future projects.

The social value of Lampeter University is to create a positive impact on society by ensuring there are programmes and activities that suit the needs and priorities of society. The University of Lampeter currently offers several diverse university courses meaning the social value has become greater by encouraging a wide variety of students from all different cultures and interests to both study and live at Lampeter itself as well as widen the social value for the local community and amenities. This building also provides the community of students a centre of skills development and opportunities leading to possible regional regeneration.

The economic values are that the Lampeter University building has been able to create more jobs for the local community and town, encourage local trade in the town from growing amounts of studying students. All economic benefits that the university provides enables wider scope for development and success leading to overall economic growth for the small town.

1.5 Building environmental Impact

Given that the building was constructed several decades ago, the considerations back in that time of construction were not considered at all compared to these current times. The building itself is a gothic Tudor style of architecture, meaning that the building is prone to damp, rot, and insect infestation if the building is not correctly maintained, preserved, and looked after. To ensure the building is free from damp it is recommend that it is regularly investigated, heated well, and ventilated, all of which use a large amount of fuel and energy to do so. Currently the building is

heated by gas Boiler housed in a plant room, the current output of this boiler is 40kW.

2.0 Construction of the building

2.1 Key principles used in construction

In relation to the key principals used in the construction of this building, it could be considered if the building had been built within the past 10 years, it could have met the five principals of constructions. The five principals of the construction are:

- Environmental Protection,
- Safety,
- Speed,
- Economy,
- Aesthetics

(GIKEN LTD, 2023)

2.2 Past and present functions of the buildings

The building has always been used for its current function and has not been a part of any other functions other than for educations purposes. The only past function of a small section of the building is the entrance hall which was initially designed for external use however until the early 20th century, it was altered with construction to completely cover this section with a roof.

2.3 Structural approach

The structural approach is define by (*T. Editors of Encyclopaedia, 2020*) as the consideration of “assembling and constructing the structural elements of a building so that they support and transmit applied loads” and providing a structure that can withstand all applied loads without failing for the course of its planned life is the fundamental goal of structural analysis and design. The University’s St Davids building was built with considerations to its functional uses of an initial college building to now a higher education building. During the times that the building was constructed and identified as a college building it would have been considered as an example of best practise with regards to its structural design as buildings regulations came into force during 1963 from the buildings act 1959 ‘published by (*Manco, 2009*)’ and with building still standing it should not be considered a bad structure. This building has been constructed from stone however was later rendered with a material called ‘Stucco’ which is a fine plaster used to coat external walls (*Dictionary.com, LLC, 2023*).

2.4 Internal and external materials

2.4.1 Exterior

The design is a simpler version of Tudor Gothic, with ridge stacks and slate roofs that have been reconstructed using black brick instead of ashlar in 1991 where previous to this, it had become disused for many years. The front features a flush entrance tower showing a Tudor arch with a decorative figure centred above the



Figure 4 Showing the External Entrance Tower- Author

open way. Above the decorative figure is a white cast-iron framed bay arched sash window, the same construction of window has been used above the bay however this window is not arched just rectangle flat embedded window. Below the decorative turret is the detailed UWTSD's logo framed within the black brick exterior. The building is a wide building containing 10 cast iron windows each side of the entrance tower. Towards the sides of the building, it corners out give the building a more defined look. Looking at the property from the grassed area, the building highlights its significance and history by its evident square and circular turrets in the shadows of the building. As you appear under the first entrance

archway, you are greeted by an internal landscaped area with a circular walkway around its water feature centre and shortly after displays this large façade with two large white cast iron windows with small mullions separated by an embedded statue, topped with two columns and a sharp looking gothic arch and topped with a decorative cross. Each side of the internal area of the building looks slightly different with the use of cast iron arched windows one side and flat edged white cast iron windows on the other side. The lower windows are large cast iron windows overlooking the internal grassed landscaped area.

2.4.2 Interior

As you enter through the main building doors, you are greeted by a long corridor with beige coloured walls and a red patterned carpet, this corridor leads you to multiple rooms, those including a beautiful place of worship, the St. David's University Chapel which was first opened in 1827. The chapel consists of original listed pews with decorative ceilings and dark wooden shrine, the chapel has been cleverly designed with void below its suspended floors, allowing a passive air movement through vents, aid by ceramic fan fitted to the ceilings. The main corridor has been fitted coil radiators. The main corridor has been lit with four individual light pendants, aged within the era of the building. A solid stone Staircases are simple dog-leg staircases with bottom newels that have finials in the Jacobean style. Each of the wings with entrances from the main corridor continue around the entirety of the building.



Figure 5 Showing Stairs Within Interior Entrance Hall- Author

2.4.2 Foundations

During a desktop study for this information, there has been no readily available information for this and can imagine due to the age of the building, these details would have been missed. Although, despite significant improvements in 19th-century technology, most foundations remained shallow and unfit for anything taller than a few stories. All of this was altered in the 20th century with the widespread usage of slab and raft foundations a 'stated by (*Capital Piling*, 2023).

2.5 Heating and lighting strategies

This building is currently not equipped with heating strategies that are suitable for the building of its size and purpose, on several occasions the gas central heating boiler has broken down and due to its age and condition, it would be very costly to change or adapt the overall heating systems, Currently the building hosts a plant room in the basement of the building which means that an experienced person must be present to control these systems.



Figure 6 Showing Entrance Hall Lighting - Author

The lighting strategies as of now are not advanced and can be considered as quite basic, currently the lighting involved is from single light pendants with incandescent and halogen bulbs, these types of bulbs have now been phased out due to their poor quality and energy consumption.

In terms of changing these heating and lighting strategies to fit today's climate emergency and improving energy consumption, this building is located on a secluded area of land therefore there is a lot of potential to incorporate more energy effective ways to lighting and heating the building. UWTSD could utilizes solar gains by implementing large south facing windows and capturing these additional solar gains and convert them using Solar PV panels fitted strategically placed to capture most of the solar gains. Quick and easy methods for energy efficiency methods would be to start with changing light bulbs to LED's.

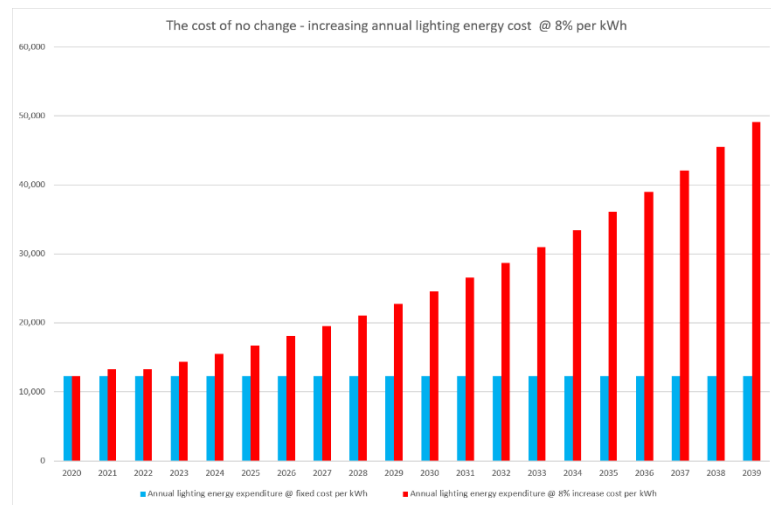


Figure 7 Showing the increase of annual lighting costs @8 per kWh - Reference: UWTSD

In terms of heating the building, it covers a lot of floor space with numerous educational rooms with different occupancy levels. To heat this building in the most cost effective and energy efficient way, it would be beneficial to fit the building with a ground source heat pump with use of large radiators within communal areas and individual classrooms which can be controlled in accordance with timetables for each classroom, this would prevent overheating and underheating unnecessarily with rooms are not in use, preventing occupants tampering with controls and possibly overworking systems for no reason.



Figure 8 Showing Radiators- Author

2.6 Airtightness & thermal bridging

In its current condition, with the age of the building, airtightness and thermal bridging is vast throughout the whole of the building and this is not down to poor workmanship but due to the age and its traditional construction. Airtightness and thermal bridging can be seen as the most significant improvements that are required to improve the overall efficiency, The term 'Fabric First' is becoming a more of a common term as we progress into net zero, the basic principles of this term is quite self-explanatory, it simply means to ensure that the fabric of the building is constructed to a high level, with great attention to prevention of airtightness and lower the amount of thermal bridging, as suggested by (*Institute For Sustainability, 2012*). This should be considered with all new buildings however, in terms of retrofitting, adapting the fabric first method can be that little bit more tasking but can

still be done by just ensuring that the walls are adequately insulated, and any thermal bridging areas are eliminated.

3.0 Positive and negative aspects of the building

The positive aspects of the building lay with its appearance and characteristics, it also holds an easy and accessible layout that optimizes its beautiful internal garden. The building does have a lot of negative aspects though, its current environmental considerations are not good, its lack of energy efficiency due to its poor or non-existing insulation and building materials also ties into its negative aspects. The building is currently fuelled by gas central heating, although it does not currently work which and leaves the building extremely cold to its visitors and everyday users.

3.1 Buildings approach to sustainability

With considerations to the buildings age, it would have been built with very much zero thought on sustainability during those times, although as times move on, almost every construction project should have sustainability at the forefront of every aspect of the build.

4 Improvements in respect to:

4.1 Operational energy use

The current operational energy use at this moment is very high due to the usage of the building being an educational space and as mentioned in the above points, educational buildings are occupied by several different occupants who require different levels of occupancy comforts. For this all aspects of the operational energy usage during the occupancy stage of the building's life cycle, there is a requirement to ensure that water heating, space heating, space cooling, lighting, and running of the equipment and appliances is all run and maintained to good working condition to avoid any dissatisfaction from its users.

If there were considerations to improvements for the operational energy usage in the current day, attention to the space heating would need to be the highest priority, this should be considered the most important especially in the future for climate change. If the attention to space heating is not controlled when climate change does take more of an effective, there could be risk of overheating or underheating leading to occupancy dissatisfaction and the increase in poor occupancy health issues.

4.2 Embodied energy/carbon

In the above states the building had been constructed in the 1800's and if we were to consider the embodied energy and carbon in the building back then, it would right to assume that there is little embodied carbon and energy due to a number of reasons, these being, the use of local materials and how little use of transportations of materials to site if the materials are sourced locally. As discussed by (*Crishna, N Et al, 2011*) Comparing stone to other building materials in the UK, it is evident that it has a lower carbon footprint. The primary effects are associated with the volume of waste stone generated, transportation to the location, and processing. It is evident

that the energy requirements for the mining and processing of granite and sandstone are lower than those for producing brick or concrete.

If we were to consider the embodied carbon and energy that may be used in this type of building during modern day construction, it should be assumed that with heightened transportation charges and local quarries becoming vastly spread however in comparison to timber, steel and concrete, the production of stone has an even lower carbon footprint over 70% less CO₂ (RIBA, 2020).

4.3 Cost of construction

The cost of construction for modern day construction of this type of building would be vastly higher than the cost of its original build and this is down to the cost of both materials and workforce costs, higher running costs all caused by inflation. There may be a cost difference if the techniques of offsite construction was to be used, this would be down to the increased speed of the overall build, leading to lower workforce costs and ultimately meaning this money saved could then be spent in other areas in need of economic support.

4.4 Cost of operations and maintenance

In relation to the cost of operations and maintenance, the building is not cost effective at this point in time, and this is down to many contributing factors such as those discussed in points 2.5 and 2.6. Recommendations for this building would be a better energy efficient lighting systems throughout and optimization of the buildings heating. It would also be worth considering the term of 'Fabric First' which is ensuring that all aspects to the fabric are adequately used and constructed to the highest quality. If Considerations are made in relation to all of these, there would be a lower cost of operation and maintenance.

4.5 End of life reuse and recycling

The materials used in this build are great in terms of its end of life and recycling. Stone material can be easily reused within either a completely new use of life or alternatively used in a repair method of a nearby building. Stone buildings can be carefully taken apart block by block or it can be completely recycled to make a new material used in construction simply by crushing the stones. This building does stand a chance of already being future- proofed as it is a large well-designed building which endless uses, the only difficulty would be changing the individual classrooms sizes as most walls are of stone construction and removing these would pose some difficulty. If we were to consider the building with the adaptations as mentioned in points 2.5 and 2.6, this building has a very good chance of being continuously reused and recycled. In order for this building to adapt with the times, it would be beneficial to start some of the repair and maintenance works immediately considering all aspects of climate change however also focusing on the environmental impacts that this building could make and improve.

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