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GHG Performance in UK University Accommodation Retrofits

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Abstract

To address growing demand, refurbishing existing student accommodation has become a preferred approach, driven by the need to modernise aging properties and improve energy efficiency and sustainability. Despite this trend, there is a notable lack of academic research specifically focused on its environmental impact. This study addresses that gap by employing a comparative case study approach to assess greenhouse gas (GHG) performance across four student accommodation refurbishment projects in the Northwest region of the UK. The research explores the use of multiple metrics for quantifying GHG emissions during refurbishment and offers evidence-based recommendations on their effective application. Findings indicate that conventional indicators such as project cost and duration are insufficient to reliably predict GHG performance. Instead, factors such as gross internal floor area and the number of rooms provide a more consistent basis for estimating emissions. This paper contributes to a more nuanced understanding of how GHG performance can be assessed in refurbishment contexts, offering practical guidance for developers aiming to improve sustainability reporting. The insights gained may also be transferrable to refurbishment projects in the broader domestic housing sector.

Introduction

Climate change is widely recognised as the most pressing environmental challenge of our time, with a growing scientific and political consensus highlighting its urgency. Central to this issue is the well-established relationship between greenhouse gas (GHG) emissions and rising global temperatures [1]. The built environment in the UK is a significant contributor to national GHG emissions, accounting for approximately 25% of the total [2]. Moreover, emissions generated during design, material production, transportation, and on-site construction can constitute up to 18% of a building's whole-life carbon footprint [3]. Notably, the UK Green Building Council (UKGBC, 2024) has introduced new guidelines for measuring and reporting Scope 3 embodied carbon, aimed at stakeholders within the built environment [4] report that Scope 3 emissions represent a significant portion of an organization's indirect embodied carbon, accounting for up to 80-95% of its total value chain footprint.

Thus, improvements driven by the construction industry will be essential to decarbonizing the sector. Given that around 80% of current UK buildings are expected to still be in use by 2050 [5], future efforts will largely focus on upgrading existing stock. It is therefore suggested that initial capital investment during the construction phase critically influences a building's environmental performance across its lifecycle. Lower expenditure on insulation or plant systems, for instance, may result in higher operational and maintenance emissions and costs [6]. Consequently, if the UK is to meet its legally binding climate targets without undermining the construction sector's vitality, it must adopt low-carbon construction practices, with a particular emphasis on refurbishment and retrofitting.

Notably, the benefits of refurbishment and maintenance in improving energy efficiency and reducing GHG emissions are well documented [7-9]. From minor retrofits such as external wall insulation [10] to comprehensive refurbishments replacing outdated systems with high-performance technologies [11], such interventions offer considerable potential. Furthermore, construction management practices strongly influence project-level emissions, as shown by [12], who demonstrated the significance of strategic decision-making on GHG outputs. Although the UK has introduced various policy instruments and calculation schemes, such as more recently: the UK Net Zero Carbon Buildings Standard [13], and the RICS Whole Life Carbon Assessment Standard [14], their success in driving sector-wide improvements has been mixed and inconclusive.

Meanwhile, in 2024, investment in the UK's purpose-built student accommodation (PBSA) sector reached approximately £3.87 billion, marking a 14% increase from the £3.39 billion invested in 2023 [15]. This growth reflects the sector's resilience and attractiveness to investors, driven by strong demand from both domestic and international students. The sector increasingly involves the refurbishment of existing stock and repurposing of non-domestic buildings to meet evolving student expectations. Despite this growth, limited research has examined the GHG implications of refurbishment projects within this niche sector.

Thus, this paper seeks to address the current research gap in understanding GHG emissions associated with student accommodation refurbishment. To do so, it begins by evaluating a series of exemplar refurbishment projects using a comparative case study approach. This methodology allows for a detailed exploration of the varied project characteristics and their impact on GHG emissions. A central focus of the analysis is the examination of GHG emission profiles in relation to key project features such as gross internal floor area, the number of rooms, and contract duration. By correlating these variables with emission data, this study aims to identify more accurate and consistent indicators of environmental performance within refurbishment contexts. Building on this analysis, the paper offers well-founded recommendations for effective methods of measuring

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and reporting GHG emissions in student accommodation projects. These recommendations are intended to enhance the reliability and comparability of emissions data across the sector.

Finally, the paper highlights a series of transferable lessons and best practices derived from the case studies. These insights are intended not only to improve sustainability outcomes in the student accommodation sector but also to inform refurbishment practices more broadly within the construction industry. The study contributes to an emerging discourse on sustainable retrofit practices, with a specific focus on projects delivered under JCT Design and Build Contracts [16], which uniquely position the contractor as both designer and builder. By establishing practical GHG performance benchmarks, this research offers valuable insights for industry practitioners, policymakers, and academics aiming to advance low-carbon construction strategies within the higher education and wider residential sectors.

Quantifying GHG Emissions

A wide range of methodologies have been developed to quantify greenhouse gas (GHG) emissions from construction activities, each varying in its calculation approach and the metrics used to estimate emissions. These metrics may include factors such as transportation distances, material types, project costs, and energy usage. Among the most widely cited methods are: (1) quantitative approaches that identify predefined emission sources within construction processes [17]; (2) detailed analyses of the relationships between direct and indirect energy consumption and associated emission factors for individual components of a construction project [18]; and (3) advanced optimisation techniques such as particle swarm optimisation (PSO), used to model and evaluate optimal construction pathways that minimise carbon emissions [19]. Many existing models have been criticised for their heavy reliance on overall project cost, often operating under the assumption that lower cost equates to better outcomes. The maxim "cheapest is not always best" underscores the inadequacy of using cost alone as a reliable indicator of environmental performance. To address this limitation, the present research advances current methodologies by incorporating a more nuanced analysis of greenhouse gas (GHG) emissions across all relevant scopes, while also integrating internal organisational Key Performance Indicators (KPIs). This more holistic approach enables a deeper and more accurate assessment of emissions performance, particularly within the context of student accommodation refurbishment projects.

Methodology

This study collaborated with a privately owned construction management firm headquartered in the North West of the UK, operating extensively across the region with a well-established portfolio in student accommodation projects. The company demonstrates a robust commitment to environmental sustainability, which is embedded within its operational frameworks, including a comprehensive carbon management action plan aligned with the principles of ISO 26000 [20]. A central component of the company's business model involves the coordination and oversight of construction projects, encompassing both contractors and subcontractors. This positions the firm as an ideal partner for providing benchmarking data related to the environmental performance of refurbishment projects, particularly in relation to greenhouse gas (GHG) emissions generated both on- and off-site during construction activities.

Four comparative case studies were selected, each representing typical UK-based student accommodation refurbishment projects. These included two long-duration projects (exceeding four months) and two short-duration projects, offering a diverse set of data for analysis. The projects varied in terms of client requirements, scope, and specific design needs. A summary of the key characteristics of each case study is provided in [Table 1]. All refurbishment works were delivered under the JCT Design and Build Contract framework, where the contractor is responsible for both design and construction, supporting a streamlined approach to project delivery and emissions reporting.

Project GHG Emission Datasets

Comparative datasets on greenhouse gas (GHG) performance for each of the 4 case study projects were collected on-site through a variety of sources, including organizational daily signing-in sheets for internal staff, subcontractor attendance records, delivery logs, and operational data for machinery and equipment consuming fuels such as petrol, diesel, and gas. Additionally, data on other GHG-emitting activities and processes related to the projects were recorded. All measured GHG emissions were converted into CO2 equivalent values, following the methodology outlined by the National Atmospheric Emission Inventory [21]. Emission data for each project was collected monthly and analysed periodically, with results reported by the organization's Environmental Manager. An example of the emission data sheet for one of the projects is presented in [Figure 1]. The GHG emission data collection and analysis for each comparative case study project were informed by the Greenhouse Gas Protocol for Project Accounting [22], the three-tier GHG classification framework, and organisational key performance indicators (KPIs) reflecting five themes: distance, duration, gross internal floor area, number of rooms, and project value, as summarised in [Table 2]. These five KPIs form the foundation of the

Table 1: Summary of Case Studies.

Details	Case Study 1 (CS-1)	Case Study 2 (CS-2)	Case Study 3 (CS-3)	Case Study 4 (CS-4)
Project Brief	Refurbishment of 346 student accommodation units, 45 office spaces, 14 communal lounges, a student bar, the main foyer, and associated courtyard landscaping works.	Redevelopment of 495 residential units into modern student flats, featuring en-suite shower rooms, fully fitted kitchens, and integrated lounge areas.	Phase 1 (CS-3) and Phase 2 (CS-4) refurbishment of existing accommodation, including upgrades to study rooms, kitchen facilities, bathrooms/ensuites, and block entrance areas.	
Distance from Site to Head Office (km)	92	168	264	264
Project Duration (weeks)	49	57	10	9
Gross Internal Floor Area (GIFA) (m^2)	15,645	17,805	5,100	5,850
Rooms	324	495	210	258
Project Value	£4.77m	£4.10m	£1.16m	£1.17m
Estimated Overall Project Emissions ($kgCO_2e$)	76,510	76,021	25,233	28,173

analysis in this research.

The comparative case study project datasets are presented in [Table 3], showing performance data for each GHG emission scope category and corresponding organisational KPIs. Emission data for the first four weeks and the last two weeks of the long-duration projects (CS-1 and CS-2), as well as for the first and final weeks of the shorter-duration projects (CS-3 and CS-4), has been excluded. This approach ensures a more accurate and representative assessment of the emissions profile associated with the core activities of each project, facilitating improved comparisons across the different datasets.

Evaluation of GHG Emission Scope Data

A comparative analysis of the GHG emission scope datasets presented in [Table 3] reveals distinct variations in the emissions profiles of the case study projects. The breakdown of emissions across the different GHG classification scopes correlates closely with the unique characteristics of each project. For instance, despite both CS-3 and CS-4 being located in the same city, their emission profiles differ significantly. Notably, Scope 3 emissions for CS-3 are over 30% higher than those for CS-4, while a larger proportion of CS-4's emissions are attributed to Scope 1. This disparity can be traced back to the higher proportion of subcontracted work involved in CS-3, which results in outsourced emissions. Conversely, the Scope 1 and 2 emissions for CS-1, CS-2, and CS-3 are more similar, reflecting their comparable use of subcontractors.

Scope 2 emissions, which represent indirect emissions from purchased energy, show more consistency across the projects. Notably, CS-3 and CS-4 exhibit the lowest Scope 2 emissions, likely due to their shorter on-site work durations, which translate to less energy consumption. The differences in Scope 2 emissions between CS-1 and CS-2 (both of which had longer refurbishment durations) can be attributed to the implementation of a new carbon action plan prior to CS-2, which enhanced the focus on energy-saving practices and

Table 2: Case Study Project Data Classifications.

	Classification	Description
Greenhouse Gas Protocol for Project Accounting – GHG Scopes	GHG Scope 1 (Direct Emissions)	Emissions from sources that are owned or controlled by the organisation, such as fuel combustion in on-site equipment, company vehicles, and other direct operational activities.
	GHG Scope 2 (Indirect Emissions)	Emissions resulting from the generation of purchased electricity, steam, heating, or cooling consumed by the organisation. Although these emissions occur off-site, they are attributed to the organisation's energy use.
	GHG Scope 3 (Other Indirect Emissions)	Emissions that are a consequence of an organisation's activities but occur from sources not owned or directly controlled by the organisation. This includes emissions from supply chains, business travel, waste disposal, transportation and distribution, and outsourced activities such as sub-contracted construction work. Scope 3 typically represents the largest share of a project or organisation's total carbon footprint.
Organisational KPIs	KPI 1 - Distance	The return distance from Head Office to project site in kilometres.
	KPI 2 - Duration	The project duration from start to finish in weeks.
	KPI 3 - GIFA	The gross internal floor area of the project site in meter square.
	KPI 4 - Rooms	The total number of rooms, which includes study rooms, kitchen areas, bathrooms, ensuites, offices, etc.
	KPI 5 - Value	The final value of the project after final accounts.

Table 3: Estimated GHG Emission Data.

Project	GHG Emission Scope	Organisational KPI Data									
		Distance ($kgCO_2^{eqv}$ / per km)		Duration ($kgCO_2^{eqv}$ / per week)		GIFA ($kgCO_2^{eqv}$ / per m^2)		Rooms ($kgCO_2^{eqv}$ / room)		Value ($kgCO_2^{eqv}$ / £100K)	
		WLC	RP	WLC	RP	WLC	RP	WLC	RP	WLC	RP
CS-1	Scope 1	133.0	111.6	249.6	209.6	0.8	0.7	37.8	31.7	2.6	2.2
	Scope 2	59.3	46.9	111.3	88.1	0.4	0.3	16.8	13.3	1.1	0.9
	Scope 3	639.4	483.7	1200.5	908.1	3.8	2.8	181.6	137.3	12.3	9.3
	Overall	831.6	642.2	1561.5	1205.8	4.9	3.8	236.1	182.4	16.0	12.4
CS-2	Scope 1	82.1	77.6	242.0	228.8	0.8	0.7	27.9	26.3	3.4	3.2
	Scope 2	12.3	11.2	36.3	33.0	0.1	0.1	4.2	3.8	0.5	0.5
	Scope 3	358.1	336.6	1055.4	992.2	3.4	3.2	121.5	114.3	14.7	13.8
	Overall	452.5	425.5	1333.7	1254.0	4.3	4.0	153.6	144.4	18.5	17.4
CS-3	Scope 1	16.3	12.1	431.3	318.8	0.9	0.6	20.5	15.2	3.7	2.8
	Scope 2	1.1	0.8	28.2	20.8	0.1	0.0	1.3	1.0	0.2	0.2
	Scope 3	78.2	56.5	2063.8	1492.6	4.1	2.9	98.3	71.1	17.8	12.9
	Overall	95.6	69.4	2523.3	1832.1	5.0	3.6	120.2	87.2	21.8	15.8
CS-4	Scope 1	52.1	39.3	1529.6	1151.6	2.4	1.8	53.4	40.2	11.8	8.9
	Scope 2	1.3	1.0	38.5	29.7	0.1	0.1	1.3	1.0	0.3	0.2
	Scope 3	53.3	41.5	1562.3	1216.7	2.4	1.9	54.5	42.4	12.0	9.4
	Overall	106.7	81.8	3130.4	2397.9	4.8	3.7	109.2	83.7	24.1	18.5
WLC	:	Estimated emissions reflecting the whole lifecycle of the case study projects (kgCO2eqv.).									
RP	:	Estimated emissions reflecting the refurbishment phase of the case study project's lifecycles (excluding project start-up and move-out) case study projects GHG levels emissions analysis (kgCO2eqv.)									

Table 4: Best and Worst Performing GHG Case Studies.

KPI	Distance	Duration	GIFA	Rooms	Value
WLC GHG Emissions					
Best Performing Project	CS-1	CS-4	CS-1	CS-1	CS-4
Worst Performing Project	CS-3	CS-2	CS-2	CS-4	CS-3
RP GHG Emissions					
Best Performing Project	CS-1	CS-4	CS-2	CS-1	CS-4
Worst Performing Project	CS-3	CS-1	CS-2	CS-1	CS-4

Table 5: Statistical Correlation Between Project KPI Characteristics and Estimated Whole Life Cycle (WLC) and Refurbishment Phase (RP) Construction Emissions.

	Case Study Project KPI Characteristics				
	Distance (km)	**Duration** (week)	**GIFA** (m^2)	**Rooms** (room)	**Project Value** (£100K)
Estimated Whole Lifecycle Construction Emissions	-0.930	0.989	0.990	0.815	0.990
Estimated Refurbishment Phase Construction Emissions	-0.840	0.996	0.998	0.911	0.943

technologies on-site. The refurbishment phase data (RP) presented in [Table 3] further supports the consistency observed in the datasets. By excluding estimated emissions associated with project start-up and move-out activities, the data offers a more accurate representation of the GHG impact of the core refurbishment works.

Evaluation of KPI Data

The case study projects can be grouped into two distinct categories based on their project characteristics, as illustrated in [Table 2]. Projects CS-1 and CS-2 are characterised by larger project durations, higher project values, larger internal floor areas, and a greater number of rooms. In contrast, CS-3 and CS-4, although located farther from the organisational head office, are smaller in both size and value, with shorter on-site refurbishment durations. The KPI emissions data, as shown in [Table 3], can be analysed to explore the relationships between project characteristics and their emissions profiles.

The distance KPI data reveals that, despite CS-3 and CS-4 being located further from the head office, projects CS-1 and CS-2 generate more emissions. This suggests that distance from the organisational head office may not be the most significant KPI for predicting a project's GHG emissions. Further analysis of the duration and value KPIs uncovers a trend where projects CS-3 and CS-4, despite having shorter durations and lower project values, generate higher emissions compared to CS-1 and CS-2. This anomaly can be better understood when considering that short-term projects still require similar start-up and move-out resources, such as equipment, transport, and support, as longer projects. Additionally, short-term projects often require a higher number of operatives on-site to meet tight schedules. This is corroborated by comparing the whole life cycle (WLC) emission data with the refurbishment phase (RP) data for these KPIs in [Table 3]. When the estimated emissions associated with project set-up are excluded (by comparing RP data instead of WLC), the discrepancy between the datasets is significantly reduced, allowing the duration and value KPIs to provide a more accurate reflection of the emissions. However, the shorter-duration projects still exhibit proportionally higher emissions compared to longer-duration projects. This suggests that tighter schedules and larger teams are correlated with higher GHG emissions.

An analysis of the emissions data for the Gross Internal Floor Area (GIFA) and room KPIs reveals additional trends. The room KPI data shows that projects CS-1 and CS-2, which involve a larger number of rooms, generate proportionally higher GHG emissions than CS-3 and CS-4, which have fewer rooms under refurbishment. This indicates that the room KPI could be a useful predictor of GHG emissions, particularly in projects such as student accommodation, which typically have a large number of small, cellular rooms. However, since room sizes can vary significantly, the GIFA KPI may provide a more accurate reflection of a project's overall characteristics and, by extension, its GHG emissions potential. The GIFA emission data in [Table 3] shows only marginal differences in GHG emissions across the case study projects, and these differences are further reduced when comparing the RP data alone.

It can be assumed that organizations working on multiple projects, applying consistent work practices across sites, will generate similar emissions from project to project, with variations driven primarily by the extent of work undertaken, rather than changes in approach. Longer duration projects may perform better in terms of emissions due to factors such as economies of scale (e.g., reduced transportation, improved staff learning curve, and minimized fixed environmental costs). The least variation in emissions profiles across the case study projects is seen in the GIFA KPI datasets, suggesting that GIFA may be the most reliable indicator of a project's characteristics and, consequently, the level of emissions likely to be generated when the same organization applies consistent practices across different sites.

Evaluation of KPI Performance of GHG Impact

A further stage of analysis involves investigating the ability of each KPI to accurately reflect the GHG performance of the different case study projects. Each KPI provides a distinct insight into the project's GHG emissions, allowing for benchmarking and comparison across projects.

Table 4 illustrates significant variability in the GHG performance of the case study projects when assessed against the various KPIs. For example, according to three KPIs—distance, GIFA, and rooms—CS-1 emerges as the project with the highest whole life cycle GHG impact. In contrast, other KPIs, such as the distance KPI, highlight CS-4 as having the greatest impact. The refurbishment phase (RP) data further complicates this assessment, with the GIFA KPI identifying CS-2 as having the highest GHG impact during the refurbishment phase.

The analysis also reveals contrasting trends when determining which projects exhibit the best GHG performance. Projects CS-2, CS-3, and CS-4 each emerge as the best performers under different KPIs, showcasing the nuanced relationship between project characteristics and their environmental impact. These findings underscore the complexity of using individual KPIs to comprehensively assess a project's GHG performance, suggesting the need for a more integrated approach to evaluating emissions across multiple indicators.

In summary, the analysis reveals significant variability in the effectiveness of different KPIs to accurately reflect the GHG performance of projects. This underscores the importance of consistently using the same KPI when comparing the performance of multiple projects. Additionally, certain KPIs may provide a more representative measure of GHG performance than others, depending on the specific characteristics of the project.

To further explore this relationship, statistical correlation analysis was conducted to assess the connection between the KPI characteristics of the research projects and their associated whole life cycle (WLC) and refurbishment phase (RP) emissions. As shown in [Table 5], a strong correlation exists between all the KPIs and GHG performance, indicating that each KPI, when used independently, can offer a reliable indication of a project's GHG performance. Notably, a negative correlation was observed between the distance KPI and GHG performance, reflecting lower proportional GHG emissions with shorter distances for the case study projects. In contrast, other KPIs—such as project duration, gross internal floor area (GIFA), room numbers, and project value—demonstrated a positive correlation with GHG performance, meaning that as these factors increased, so did the proportional GHG emissions.

The correlation analysis further highlights that the duration, GIFA, and project value KPIs were the most accurate predictors of a project's overall WLC emissions. Additionally, the duration and GIFA KPIs proved to be the best indicators of emissions generated during the refurbishment phase. This analysis supports the conclusion that specific KPIs can be effectively used to assess different aspects of a project's environmental impact, depending on the phase of the project under consideration.

Discussion

This research analysed estimated greenhouse gas (GHG) emissions data from refurbishment projects carried out by an environmentally conscious organisation specialising in student accommodation. The primary objective of this study was to identify potential lessons for the broader construction industry and assess the methods used to benchmark and compare GHG performance in refurbishment projects. While the case study sample size is relatively small, the projects analysed represent a diverse range of characteristics and reflect a typical sample of UK student accommodation refurbishments. The organisation's ten years of experience in this field lend credibility to the findings and contribute valuable insights to the broader research theme.

Project key performance indicators (KPIs) were derived and used to estimate the emissions generated during the refurbishment works. The duration and value of a project were found to be significant indicators of potential emissions. However, these metrics can be misleading when comparing the GHG impact of different refurbishment projects. The research concludes that high-value and long-duration projects tend to result in larger overall emissions than lower-value, short-term projects. However, short-term projects often involve denser workloads and a higher number of workers on-site during the project's duration, leading to comparatively greater GHG impacts across all emissions scopes. This is especially true for student accommodation projects, where refurbishments typically occur during student holidays (e.g., Easter, Christmas) or in phased approaches, requiring students to relocate during ongoing work.

The research suggests that both the Gross Internal Floor Area (GIFA) and the number of rooms should, in theory, provide accurate emission benchmarks, as they reflect the scale of the work involved. However, the data analysis revealed that the number of rooms can be a misleading indicator of GHG performance in student accommodation refurbishments due to the variability in room types (e.g., student rooms, kitchens, common areas). The study found that GIFA offers a more reliable reflection of potential GHG emissions for student refurbishment projects.

The evaluation of GHG emission scopes proved to be a valuable tool for organizations to monitor emissions from various contributors throughout the project lifecycle. The organization maintained full control over Scope 1 emissions (direct emissions), which include internal staffing, business travel, and accommodation. This data allowed the organisation to effectively measure, manage, and prioritize internal resources. Scope 2 emissions, which represent the indirect emissions from purchased energy, were used as an indicator of energy consumption on-site, with lower Scope 2 emissions correlating with reduced energy use and associated costs. Scope 3 emissions, on the other hand, are less within the organization's control, as they arise from outsourced activities. However, analysing Scope 3 emissions can provide valuable insights into how the organisation can improve supply chain management, engage certified subcontractors with aligned environmental priorities, and enhance corporate social responsibility, potentially reducing costs by setting minimum environmental performance standards for subcontractors and suppliers.

Currently, most organisations focus on internal benchmarking of their GHG performance in refurbishment projects to identify areas for improvement. One significant challenge faced by organisations is the lack of standardized KPIs for GHG emissions comparison. As demonstrated by this research, the effectiveness of different KPIs in reflecting GHG performance can vary significantly. Therefore, if organizations seek to benchmark their GHG performance against competitors or partners, adopting common KPIs is crucial.

This paper presents the results of GHG emissions analysis based on four comparative case studies from a single organization. At present, there are no widely available benchmarks for emissions in the refurbishment sector in the UK, particularly for student accommodation projects. Future research should aim to compare more refurbishment projects across different organizations and incorporate elements of embodied energy in building materials. Additionally, the UK construction sector is currently engaged in extensive refurbishment of social housing projects, and the findings from this research could be adapted and applied to the housing sector.

Conclusion

The UK student accommodation sector is one of the best-performing asset classes and is projected for continued growth. The most efficient way to meet increasing demand is by refurbishing existing stock or repurposing buildings, yet the environmental impacts of these activities remain poorly understood. GHG emission data offers a valuable opportunity to measure performance, set targets, and establish benchmarks for refurbishment projects, enabling the evaluation of practices and the identification of lessons that can ultimately help reduce the GHG impact across the broader refurbishment sector. In this study, project KPIs—such as distance, duration, Gross Internal Floor Area (GIFA), number of rooms, and project value—were predetermined. The analysis revealed that these KPIs vary in their ability to reflect the potential GHG performance of refurbishment projects. Based on the findings from the case study projects, GIFA emerged as the most effective KPI for accurately reflecting the GHG impact of student accommodation refurbishment projects.

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