# Retrofitting Existing Housing with Sustainable Construction Materials in Greater Manchester, UK and Lagos, Nigeria: A Comparative Study Protocol

**Chidubem Blessing Okogwu[1], Chinonso Job[2]**

**[1]Civil Engineering, School of Built Environment, Engineering, and Computing, Leeds Beckett University, Leeds, United Kingdom**

**[2]Computer Science, School of Built Environment, Engineering, and Computing, Leeds Beckett University, Leeds, United Kingdom**

**DOI: https://doi.org/10.51584/IJRIAS.2026.11100095**

**Received: 25 September 2026; Accepted: 30 September 2026; Published: 16 November 2026**

## ABSTRACT

Buildings account for approximately 37% of global energy- and process-related CO2 emissions, making retrofitting of existing housing stock a significant lever for climate mitigation. This paper is a study protocol, not a report of completed research: it sets out the rationale, research questions, study area, and a proposed mixed-methods design, including a multi-criteria material evaluation framework and a structured cross-case comparison matrix, for a planned comparative study of housing retrofit practice in Greater Manchester, UK, and Lagos, Nigeria. Greater Manchester has an estimated 880,000 homes requiring some form of energy retrofit by 2038, with a current regional target to retrofit at least 60,000 homes between 2025 and 2030; Lagos State's own housing deficit is separately estimated at approximately 3.3 to 3.4 million units, distinct from Nigeria's national housing deficit of approximately 15 million officially, or up to 28 million when structurally substandard homes are included. The protocol proposes purposive sampling of practitioners in each city, case study review of completed retrofit projects against an explicit multi-criteria evaluation matrix, and thematic analysis of interview and survey data, with the explicit aim of identifying which UK retrofit materials and practices could transfer to Lagos's tropical climate and weaker regulatory environment, and which cannot. No data collection has yet occurred; the contribution of this paper is the verified background and a proposed, reviewable, and now more fully specified method.

**Index Terms:** building retrofit, sustainable construction materials, multi-criteria decision analysis, circular economy, energy efficiency, comparative study, SDG 11, SDG 13.

## INTRODUCTION

### Background

The global buildings and construction sector was responsible for approximately 37% of global energy- and process-related $CO_2$ emissions in 2022, alongside 34% of global energy demand [1]. Residential buildings are a substantial part of this share, and since people spend the large majority of their time indoors, the residential sector is significant for both energy policy and occupant health outcomes [2]. Retrofitting, upgrading existing buildings with more efficient materials and systems rather than demolishing and rebuilding, preserves embodied carbon already invested in a structure, reduces construction and demolition waste, and aligns with circular economy principles [3]. Evidence from England indicates that home energy efficiency interventions are associated with measurable health benefits for occupants, not only energy savings [4].

### The UK and Nigeria as Contrasting Cases

The United Kingdom has invested substantially in social housing retrofit through mechanisms such as the

Social Housing Decarbonisation Fund (SHDF). In Greater Manchester specifically, SHDF Wave 2.1 allocated approximately £37 million to retrofit 5,482 social homes across the city-region, announced in March 2023 [5], and Manchester City Council separately secured over £21 million in SHDF and Home Upgrade Grant funding to retrofit approximately 1,600 council-owned and 500 privately-owned homes, as part of a target to retrofit at least a third of the city's 67,300 social rented properties by 2032 [6]. At the city-region level, Greater Manchester Combined Authority (GMCA) estimates that over 880,000 homes will need some form of renovation by 2038 to meet the region's carbon-neutrality target, and its current five-year environment plan (2025-2030) sets a target of retrofitting at least 60,000 homes over that period [7], [8]. Nigeria presents a contrasting policy and climate context. Nigeria's national housing deficit was revised in 2025-2026 to approximately 14.9 to 15 million units on official government data, rising to an estimated 28 million when structurally substandard or defective homes are included; this is a national, not city-specific, figure [9]. Lagos State's own housing deficit is separately and more specifically estimated at approximately 3.3 to 3.4 million units against a population of over 17.8 million [9], [10]. Nigeria's tropical climate, weaker enforcement of building energy codes, and more limited availability of manufactured insulation materials mean that UK retrofit solutions, largely developed for a temperate, sealed-building paradigm, cannot be assumed to transfer directly [11].

## RESEARCH PROBLEM AND RATIONALE

Retrofitting has documented potential to reduce construction waste, improve energy efficiency, and lower operating costs, but Nigeria's implementation faces distinct constraints: weak regulatory enforcement, limited manufactured material availability, and climate conditions requiring passive cooling and ventilation rather than the sealed insulation strategies common in UK retrofit practice [11], [9]. There is a gap in comparative research examining which specific UK retrofit strategies, materials, and delivery models could transfer to a climate and regulatory context like Lagos's, and which require substitution with locally available alternatives such as compressed earth blocks or natural insulators [12]. A further gap, raised in review of an earlier version of this protocol, is that existing comparative discussions of retrofit materials rarely specify the criteria against which transferability should be judged; this revised protocol addresses that directly in Section V-C. This protocol proposes a study designed to address both gaps, rather than assuming transferability in either direction.

## RESEARCH QUESTIONS AND OBJECTIVES

RQ1: Which sustainable construction materials are reported as most effective for improving energy efficiency in UK residential retrofit practice, and to what extent do these depend on a temperate climate?

RQ2: To what extent can retrofitting with sustainable construction materials reduce environmental impact and operating costs in Lagos's housing sector, given its climate and material-availability constraints?

RQ3: How are circular economy practices for construction waste, specifically material reuse and salvage, implemented in UK retrofit projects, and what would be required to adapt comparable practices in Lagos given the current preference for demolition over reuse [13]?

Corresponding objectives are: (1) to identify materials and practices reported as effective for energy efficiency in each context, scored against the multi-criteria framework in Section V-C; (2) to assess, through case study and stakeholder data, the extent of energy and cost impact achievable through retrofitting in Lagos specifically, using the quantitative indicators specified in Section V-D; and (3) to identify material reuse and salvage practices that could be introduced into Lagos's retrofit sector.

### Study Area

### Greater Manchester, UK

Greater Manchester is a metropolitan county in North-West England comprising ten local authority areas, with an estimated population of approximately 2.9 million and a temperate maritime climate [14]. Its housing stock

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue X October 2026

includes a substantial proportion of pre-1980 terraced and social housing [15], against which the retrofit targets described in Section I-B apply.

### Lagos, Nigeria

Lagos is a coastal metropolitan area in South-West Nigeria with a tropical climate and a population exceeding 17.8 million [9]. Housing types range from informal settlements to mid-rise apartments with limited insulation, alongside a state-specific housing deficit of approximately 3.3 to 3.4 million units described in Section I-B [9], [10]. The Lagos State Building Energy Code, introduced in 2017, provides a regulatory basis for energy-efficient construction, though enforcement is widely reported as weak [11].

## PROPOSED METHODOLOGY

### Design

A mixed-methods design is proposed, combining case study review of completed retrofit projects with qualitative interviews and quantitative surveys of practitioners, consistent with established mixed-methods guidance for studies requiring both contextual depth and comparability across sites [16]. The design has been revised following initial review to specify, in Sections V-B through V-F, exactly how participants will be selected, how materials will be scored, which quantitative indicators will be extracted, and how the two cities will be systematically compared.

### Population and Sampling

The target population is architects, retrofit practitioners, and housing agency staff in each city with direct professional experience of sustainable retrofit projects. Inclusion requires a minimum of three years of relevant professional experience and involvement in at least one documented retrofit or energy-efficiency project. Initial contacts will be purposively recruited through professional bodies, specifically the Chartered Institution of Building Services Engineers and the Royal Institute of British Architects in Greater Manchester, and the Nigerian Institute of Architects and the Council for the Regulation of Engineering in Nigeria in Lagos, with subsequent snowball referral from these initial contacts [16]. A target of 15 to 20 participants per city is proposed, split approximately evenly between public-sector (local authority or housing association) and private-sector practitioners, which supports thematic saturation for exploratory, interpretive analysis; this sample size is explicitly not intended to support statistical generalisation to either city's retrofit sector as a whole, as noted in Section VII.

### Multi-Criteria Material Evaluation Framework

To compare retrofit materials and practices systematically rather than impressionistically, this protocol adopts the sustainability assessment criteria developed by Akadiri and Olomolaiye [17] and operationalised in the multi-criteria evaluation model of Akadiri, Olomolaiye and Chinyio [18], which groups building material sustainability into six weighted criteria: environmental impact, resource efficiency, waste minimisation, life-cycle cost, performance capability, and social benefit. Table I adapts these six criteria into concrete, measurable sub-indicators for the retrofit comparison proposed here. The weighting of these criteria was originally derived from a survey of UK architects and designers [17]; applying the same weights unmodified to the Lagos context would not be justified, so this protocol proposes re-eliciting criterion weights separately for each city's practitioner sample during the interview phase, rather than assuming the UK-derived weights transfer.

**TABLE I** Proposed Multi-Criteria Retrofit Material Evaluation Matrix (Adapted From Akadiri And Olomolaiye [17]; Akadiri, Olomolaiye And Chinyio [18])

| Criterion | Measurable sub-indicator (proposed) | Proposed data source |
|---|---|---|
| Environmental impact | Embodied carbon (kgCO2e/m2); operational carbon savings post-retrofit | Product EPDs; case study reports |

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue X October 2026

| | | |
|---|---|---|
| Resource efficiency | Proportion of recycled/reclaimed content; local material availability | Supplier data; practitioner interview |
| Waste minimisation | % construction/demolition waste diverted from landfill | Project waste management records |
| Life-cycle cost | Capital cost/m2; maintenance cost; payback period (years) | Project cost reports; practitioner interview |
| Performance capability | Thermal performance (U-value or equivalent); durability/service life; constructability | Technical specifications; practitioner interview |
| Social benefit | Reported occupant comfort; maintenance burden on occupants | Occupant survey where accessible |

**Data Collection**

Proposed data sources are: (1) case study review of documented retrofit projects, including SHDF-funded schemes in Greater Manchester and comparable projects in Lagos where documentation exists, scored against the Table I criteria; (2) semi-structured interviews with practitioners, structured in three parts, an opening section on professional background, a core section mapped directly to RQ1 to RQ3 and to the Table I criteria, and a closing section eliciting criterion weights for the respondent's own context; (3) surveys of energy use and occupant comfort where accessible; and (4) secondary data extraction from project reports, architectural plans, and sustainability certifications. Where case study documentation permits, the quantitative indicators listed in Table II will be extracted for each project: these are the specific, measurable data points the analysis in Section V-E is designed to use, not results already obtained.

**TABLE II** Proposed Quantitative Case-Study Indicators (To Be Extracted Where Documentation Permits; Not Yet Collected)

| **Indicator** | **Unit** |
|---|---|
| Pre-retrofit energy consumption | kWh/m2/year |
| Post-retrofit energy consumption | kWh/m2/year |
| Energy consumption reduction | % change |
| Retrofit cost | GBP or NGN per m2 |
| Payback period | Years |
| CO2 reduction | kgCO2e/year |
| Construction/demolition waste diverted from landfill | % or tonnes |

**Analysis**

Interview and survey text data will be coded using Braun and Clarke's six-phase thematic analysis: familiarisation, initial code generation, theme searching, theme review, theme definition, and report production [19], applied independently within each city's dataset before cross-case comparison. Secondary project data and the Table II quantitative indicators, where available, will be analysed descriptively (means and ranges per material or practice type) rather than through inferential statistics, consistent with the proposed sample size. Material and practice scores against the Table I criteria will be compiled into a structured Greater Manchester-versus-Lagos comparison matrix, with one row per material or practice and one column per city, allowing transferable and non-transferable items to be identified by direct, criterion-by-criterion inspection rather than narrative impression alone.

**Ethical Considerations**

The proposed study requires informed consent from all interview and survey participants, assurance of anonymity in reporting, and institutional ethical approval prior to data collection [20].

**Expected Outcomes**

If carried out, the study is intended to produce: a completed Greater Manchester-versus-Lagos comparison matrix scoring retrofit materials and practices against the Table I criteria; a quantitative summary of the Table II indicators where case study data permit; identification of climate-appropriate alternatives, such as compressed earth blocks or breathable wall systems, for materials that do not transfer; and a set of practice-level observations on construction-waste reuse that could inform Lagos-specific guidance. These are anticipated outcomes of a proposed study, not results already obtained.

## LIMITATIONS

As a protocol, this paper reports no findings; the limitations below concern the proposed design rather than data quality. Access to project-level data in Lagos may be more limited than in Greater Manchester given weaker documentation requirements, which could constrain both the case study component and the completeness of the Table II indicators asymmetrically between sites. A purposive sample of 15 to 20 practitioners per city supports thematic, interpretive analysis but does not support claims generalisable to either city's retrofit sector as a whole. The Table I evaluation criteria and their original weighting were derived from UK practice [17], [18]; re-eliciting weights for the Lagos sample, as proposed in Section V-C, mitigates but does not eliminate this bias, since the underlying six criteria categories themselves were not independently derived from Nigerian practice. The study's climate-transferability question is necessarily context-specific to Lagos's tropical setting and Greater Manchester's temperate setting; conclusions should not be assumed to extend to other UK or Nigerian cities without separate verification of local climate and regulatory conditions.

## CONCLUSION

Retrofitting existing housing is a documented lever for reducing construction-sector emissions, but the UK and Nigerian contexts differ enough in climate, material availability, and regulatory enforcement that transferability cannot be assumed. This revised protocol sets out a comparative mixed-methods design, grounded in verified figures for each city's retrofit need and housing deficit, and now specifies an explicit multi-criteria material evaluation framework, concrete quantitative indicators, a defined sampling and coding procedure, and a structured cross-case comparison matrix, addressing the specificity concerns raised in review. The next stage of this work is ethical approval and pilot recruitment; no claims about retrofit effectiveness in either city should be drawn from this paper until that data collection has occurred.

## REFERENCES

1. UN Environment Programme (UNEP) and Global Alliance for Buildings and Construction (GlobalABC), *Global Status Report for Buildings and Construction: Beyond Foundations*. Nairobi, Kenya: UNEP, 2023, doi: 10.59117/20.500.11822/45095.
2. United States Environmental Protection Agency, *Indoor Air Quality*. [Online]. Available: https://www.epa.gov/report-environment/indoor-air-quality (Accessed: 29 August 2026).
3. U.S. Environmental Protection Agency, *Sustainable Management of Construction and Demolition Materials*. [Online]. Available: https://www.epa.gov/smm/sustainable-management-construction-and-demolition-materials (Accessed: 29 August 2026).
4. I. Hamilton, J. Milner, Z. Chalabi, P. Das, B. Jones, C. Shrubsole, M. Davies, and P. Wilkinson, "Health effects of home energy efficiency interventions in England: a modelling study," *BMJ Open*, vol. 5, no. 4, art. e007298, 2015, doi: 10.1136/bmjopen-2014-007298.
5. GM Green City, "Social Housing Decarbonisation in Greater Manchester." [Online]. Available: https://gmgreencity.com/projects-and-campaigns/social-housing-decarbonisation-in-greater-manchester/ (Accessed: 29 August 2026).
6. Manchester City Council, "£20m secured by Manchester City Council for energy efficiency retrofits," 23 March 2023. [Online]. Available: https://www.manchester.gov.uk/news/article/9251/20m_secured_by_manchester_city_council_for_energy_efficiency_retrofits (Accessed: 29 August 2026).

7. Greater Manchester Combined Authority (GMCA), *retrofitGM: Accelerating the Renovation of Greater Manchester's Buildings*. [Online]. Available: https://www.greatermanchester-ca.gov.uk/media/5954/gmca-retrofit-action-plan.pdf (Accessed: 29 August 2026).
8. edie, "From hydrogen to retrofitting: Greater Manchester plots pathway to net-zero by 2038," 9 December 2024. [Online]. Available: https://www.edie.net/from-hydrogen-to-retrofitting-greater-manchester-plots-pathway-to-net-zero-by-2038/ (Accessed: 29 August 2026).
9. Channels Television, "Nigeria's Housing Deficit May Hit 28 Million Units — Lagos Govt," 2026. [Online]. Available: https://www.channelstv.com/2026/05/26/nigerias-housing-deficit-may-hit-28-million-units-lagos-govt/ (Accessed: 29 August 2026). [Reports Lagos State Government figures: Nigeria's official national deficit of 14.925 million units, an effective national figure near 28 million including substandard housing, and a Lagos State-specific deficit of over 3.3 million units.]
10. A. Ekpo, "Housing deficit in Nigeria: issues, challenges and prospects," *CBN Economic and Financial Review*, vol. 57, no. 4, pp. 177–188, 2019.
11. A. E. Oke and A. J. Ogungbile, "Sustainable facility management practices in public buildings in Nigeria," in *Proc. 2nd NIQS Research Conf.*, 2015.
12. D. Eksi Akbulut and R. Naz Alibeyoglu, "Rammed earth construction: from tradition to a sustainable future," IntechOpen, 2025, doi: 10.5772/intechopen.1010217.
13. A. Mollaei, B. Byers, C. Christovan, A. Olumo, C. De Wolf, C. Bachmann, and C. Haas, "A global perspective on building material recovery incorporating the impact of regional factors," *Journal of Cleaner Production*, vol. 429, art. 139525, 2023, doi: 10.1016/j.jclepro.2023.139525.
14. Visit North West, "Greater Manchester Map – County in North West England." [Online]. Available: https://www.visitnorthwest.com/counties/greater-manchester/ (Accessed: 29 August 2026).
15. Shelter England, "Loss of Social Housing." [Online]. Available: https://england.shelter.org.uk/support_us/campaigns/social_housing/loss_of_social_housing (Accessed: 29 August 2026).
16. J. W. Creswell and C. N. Poth, *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*, 4th ed. Thousand Oaks, CA, USA: SAGE Publications, 2018.
17. P. O. Akadiri and P. O. Olomolaiye, "Development of sustainable assessment criteria for building materials selection," *Engineering, Construction and Architectural Management*, vol. 19, no. 6, pp. 666–687, 2012, doi: 10.1108/09699981211277568.
18. P. O. Akadiri, P. O. Olomolaiye, and E. A. Chinyio, "Multi-criteria evaluation model for the selection of sustainable materials for building projects," *Automation in Construction*, vol. 30, pp. 113–125, 2013, doi: 10.1016/j.autcon.2012.10.004.
19. V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology*, vol. 3, no. 2, pp. 77–101, 2006, doi: 10.1191/1478088706qp063oa.
20. Loughborough University, "Informed Consent," *Research Ethics and Integrity*. [Online]. Available: https://www.lboro.ac.uk/internal/research-ethics-integrity/research-ethics/guidance-investigators/informed_consent/ (Accessed: 29 August 2026).