International Journal Of Latest Technology In Engineering & Management (IJLTEM)
Volume 11 - Issue 4 {July-August 2026} {Page: 01-09}

ASSESSMENT OF THE THERMAL COMFORT AND MOISTURE REGULATION PROPERTIES OF BURNT BRICKS IN CLASSROOM ENVIRONMENTS AT LASUSTECH, IKORODU

[1]Ojo Abdul Azeez, [2]Nwagbo Deidra, [3]Omodubu Joy, [4]Adeniyi Daniel, [5]Asaju Opeyemi, [6]Ibitoye Obafemi

[1]0009-0002-7040-2112[2]0009-0003-3792-9198 [3]0009-0006-4810-1750[4]0009-0003-3587-2554[5]0000-0003-4108-2471

Department of Architecture, Caleb University, Lagos

ABSTRACT: *This study assesses the thermal comfort and moisture regulation properties of conventional burnt (fired clay) bricks in naturally ventilated classrooms at Lagos State University of Science and Technology (LASUSTECH), Ikorodu (tropical Lagos climate). The research examines how clay-brick walls influence indoor temperature, humidity, and occupant comfort compared to standard benchmarks. Keywords: Machine-Pressed Earth Blocks, Moisture Regulation, Indoor Thermal Comfort, Sustainable Building Materials, Tropical Climate, Earth Construction, Humidity Control, Energy Efficiency. Field experiments will be conducted in multiple LASUSTECH classrooms. Continuous monitoring of indoor air temperature and relative humidity will be paired with students' thermal comfort surveys. Statistical analysis will relate environmental data to comfort ratings and compare conditions to recognized thermal comfort standards.Based on prior Nigerian studies, it is hypothesized that classrooms with high-mass clay brick walls will exhibit lower peak temperatures and dampened humidity swings, leading to higher comfort levels (as reported by occupants) than those with conventional block walls.The results will clarify the passive cooling performance of burnt clay bricks in tropical school environments, informing design strategies for more sustainable, healthy classrooms. This research will contribute empirical data on classroom microclimate and support use of indigenous materials to improve energy efficiency and student well-being (consistent with recommendations by Asamoah et al., 2023).*

KEYWORDS: *Thermal Comfort, Hygrothermal Properties, Burnt Clay Brick, Classroom Environment, Tropical Passive Design.*

INTRODUCTION

1.1 Background of study

Nigeria's climate is predominantly tropical, with Lagos (including Ikorodu) characterized by a hot, humid climate and minimal seasonal temperature variation. Daytime outdoor temperatures often approach 32 – 34 °C on the coast, accompanied by very high humidity. In such environments, indoor thermal conditions in schools tend to be challenging overheated classrooms are commonplace in Nigeria and other tropical regions, leading to discomfort and health risks for children. Children spend a large portion of their day (often one-third or more) in school buildings, and elevated indoor temperatures can impair concentration, learning outcomes, and well-being (e.g. increased fatigue, heat stress). Research in Nigerian school settings has shown that students' comfortable temperature in naturally ventilated classrooms is often well above standard cooling thresholds (e.g. up to ~31.6 °C was reported as acceptable by Munonye&Maduabum, 2024). However, even if occupants adapt to higher heat, extreme heat remains "of great concern" in naturally ventilated buildings.

Building materials and architectural design strongly influence classroom microclimates. In Nigeria, hollow sandcrete blocks and reinforced concrete are common, but traditional fired-clay bricks (burnt bricks) are also used in some structures. Clay bricks are known for high thermal mass and hygroscopic properties, which can dampen temperature swings and buffer indoor humidity. International literature indicates that clay masonry can rapidly absorb and release moisture from the air, greatly mitigating indoor humidity variations. For example, McGregor et al. (2014) demonstrated that unbaked clay block walls can buffer up to 84% more moisture than conventional gypsum or cement-plaster walls. Similarly, recent Nigerian field data show that homes built with

mud/brick walls had significantly better seasonal thermal comfort than sandcrete-block houses. Indeed, Owolabi et al. (2025) found that "traditional materials (mud/brick, thatch/slate) optimize passive regulation in tropical climates, reducing energy dependency". In educational facilities, passive cooling measures (orientation, shading, ventilation, thermal mass) have been shown to improve comfort and reduce energy use in Nigeria.
Despite this potential, the specific performance of burnt clay bricks in Nigerian classrooms is poorly documented. Past Nigerian studies have focused more on concrete and block systems. The few studies that do involve clay (e.g. Maduabum et al., 2025) involve specialized earth blocks (interlocking compressed earth) rather than traditional kiln-fired bricks. Thus, there is a gap in understanding how conventional burnt brick walls moderate classroom temperature and humidity in situ. This gap is important because constructing comfortable, healthy learning environments using local materials could improve educational outcomes while lowering cooling energy use.

1.2 Problem Statement

In LASUSTECH (Ikorodu, Lagos), several classrooms have walls made of burnt clay bricks, yet their indoor thermal and moisture performance has not been assessed. Without this data, architects lack guidance on the hygrothermal benefits of such materials in tropical school design. As Nigeria strives for more sustainable buildings, it is unclear whether and how the traditional burnt brick construction contributes to or hinders thermal comfort. Potential problems include high indoor heat (leading to discomfort) and poor humidity control (risking mold or discomfort). The problem, therefore, is a lack of quantitative data on the thermal comfort and moisture regulation properties of burnt clay bricks in LASUSTECH's naturally ventilated classrooms. Understanding this is critical to determine whether burnt bricks offer passive cooling/humidity-buffering advantages over more common materials, and whether design practices should leverage these properties for better classroom environments.

1.3 Aim

To assess the thermal comfort and moisture regulation properties of conventional burnt clay bricks in naturally ventilated classroom environments at LASUSTECH, Ikorodu, Nigeria. How effective are machine-pressed earth blocks in regulating indoor moisture levels?

Objectives of the study

I. Determine occupants' thermal comfort levels in these classrooms using standardized surveys.
II. Compare the measured indoor conditions and comfort levels to established comfort standards or adaptive comfort models (noting that tropical occupants often tolerate higher temperatures).
III. Provide recommendations for passive cooling and classroom design using clay bricks, based on the collected data and analysis (e.g. implications for building codes and best practices)

1.4 Research Questions

I. What percentage of students'reports feel thermally comfortable (and under what temperature conditions) in these classrooms?
II. How do the classroom conditions compare with standard comfort criteriaand with results from other tropical classroom studies.
III. Which passive design features (e.g. brick mass, ventilation, shading) appear most relevant to improving comfort in this setting?

LITERATURE REVIEW

2.1 Conceptual Framework

The conceptual framework of this study is centered on the relationship between building materials and indoor environmental comfort within educational spaces. Burnt clay bricks have increasingly gained recognition as sustainable construction materials due to their thermal insulation properties, durability, and ability to regulate indoor moisture conditions (Oti et al., 2010; Makrygiannis &Grafakos, 2023). In tropical regions such as Lagos State, where high temperature and humidity significantly affect indoor comfort, the selection of appropriate walling materials plays an important role in enhancing the learning environment.

Burnt clay bricks are produced by molding natural clay and firing it at high temperatures in kilns. This process improves the strength, durability, and resistance of the bricks to environmental conditions. Unlike conventional sandcrete blocks commonly used in Nigeria, burnt clay bricks possess higher thermal mass, which enables them to absorb, store, and gradually release heat (Oti et al., 2010). This characteristic contributes to reduced indoor temperature fluctuations and improved thermal comfort within occupied spaces (Makrygiannis &Grafakos, 2023).

Moisture regulation is another important property associated with burnt clay bricks. Due to their porous structure, the bricks can absorb excess moisture from the atmosphere and release it gradually when the indoor air becomes dry. This moisture-buffering capacity helps in maintaining balanced indoor humidity levels and improving indoor air quality (McGregor et al., 2014; Diviš et al., 2022). In classroom environments, stable thermal and moisture conditions are essential because they influence students' concentration, comfort, productivity, and overall academic performance.

The use of burnt clay bricks also aligns with sustainable building practices due to their natural composition, reduced dependence on cement-based materials, and lower environmental impact during production. In recent years, researchers have increasingly emphasized the need for environmentally responsive materials in educational buildings, particularly in regions experiencing rapid urbanization and climatic challenges (Okafor, 2022).

2.2 Theoretical Framework

This study is anchored on the Building Performance Theory, which explains how building materials and components influence the comfort, health, and satisfaction of occupants within indoor spaces. The theory emphasizes that the effectiveness of a building is determined not only by its structural stability but also by its ability to provide adequate thermal comfort, moisture control, ventilation, and environmental quality.

According to the theory, walling materials significantly contribute to indoor thermal behavior by regulating heat transfer between the external and internal environment. Materials with high thermal mass, such as burnt clay bricks, are capable of slowing heat penetration into buildings, thereby creating more stable indoor temperatures (Oti et al., 2010; Makrygiannis &Grafakos, 2023). This becomes particularly important in hot-humid climates like Lagos State, where excessive heat gain often results in discomfort within classrooms and learning spaces.

The theory further highlights the importance of moisture regulation in maintaining healthy indoor conditions. Poor moisture control may lead to dampness, mold growth, and reduced indoor air quality, all of which negatively affect occupants' comfort and health. Studies have shown that clay-based materials possess significant moisture-buffering capacities that contribute to healthier indoor environments (McGregor et al., 2014; Oumeziane et al., 2021). Therefore, evaluating the performance of burnt clay bricks in relation to thermal comfort and moisture regulation provides a practical understanding of their suitability for sustainable educational buildings at LASUSTECH, Ikorodu.

2.3 Empirical Review (2017 – 2026)

Several studies have examined the performance of clay-based materials in improving indoor environmental conditions. Oti et al. (2010) reported that clay bricks possess favorable thermal properties that reduce heat transfer and contribute to improved indoor thermal performance. Similarly, Makrygiannis and Grafakos (2023) found that brick materials with higher thermal mass enhance indoor comfort by moderating temperature fluctuations and reducing overheating.

Studies on moisture regulation have also demonstrated the effectiveness of clay-based materials. McGregor et al. (2014) observed that clay masonry exhibits significant moisture-buffering capacity, helping to stabilize indoor humidity levels. Likewise, Diviš et al. (2022) reported that clay structures improve hygrothermal performance by regulating moisture movement within building envelopes. Oumeziane et al. (2021) further confirmed that clay bricks possess favorable hygrothermal characteristics that contribute to indoor environmental quality.

Within the Nigerian context, Okafor (2022) found that traditional building materials, including clay-based components, contribute to improved indoor thermal comfort when compared with some modern construction materials. The study highlighted the importance of selecting appropriate building materials for maintaining comfortable indoor conditions in hot climatic regions.

Despite the growing interest in sustainable building materials, limited studies have specifically focused on the thermal comfort and moisture regulation properties of burnt clay bricks within classroom environments in tertiary institutions in Lagos State. Most existing studies concentrate on residential buildings or general building performance assessments. Therefore, this study seeks to fill this gap by assessing the thermal comfort and moisture regulation properties of burnt clay bricks in classroom environments at LASUSTECH, Ikorodu.

2.4 Research Gap

While burnt clay bricks have been studied for thermal comfort and moisture regulation, most research focuses on residential buildings or general material comparisons. Few studies have looked specifically at classroom environments in Nigerian universities, especially at LASUSTECH in Ikorodu. There is also a lack of qualitative research on how students feel about comfort and humidity in such spaces. This study will address that gap by focusing on student perceptions of thermal comfort and moisture regulation in classrooms built with burnt clay bricks.

METHODOLOGY

3.1 Research Design and Area Study

This study adopted a descriptive survey research design to assess the thermal comfort and moisture regulation properties of burnt clay bricks in classroom environments at Lagos State University of Science and Technology. The design was chosen because it allows the researcher to gather real opinions and experiences from users of the classrooms through questionnaires and simple observations, especially on issues like heat, ventilation, humidity, and general comfort levels inside the buildings. The study was carried out at Lagos State University of Science and Technology in Ikorodu, Lagos State, Nigeria. The area has a typical tropical climate, with high temperatures and humidity for most of the year. Because of these conditions, it provides a good setting for studying how burnt clay bricks perform in real classroom environments, especially in terms of keeping indoor spaces comfortable and reducing moisture-related issues like dampness.

3.2 Population and Sampling Framework

The population of this study comprises students, lecturers, and maintenance staff within Lagos State University of Science and Technology. These groups were selected because they are the main users of classroom buildings and are best positioned to evaluate indoor environmental conditions such as thermal comfort, ventilation, and moisture performance (Yin, 2018). The sample size for the study was determined using **Yamane's (1967) formula**, a widely accepted method in survey research for estimating sample size from a known population at a selected margin of error. The formula is given as:

$$n = \frac{N}{1 + N(e^2)}$$

This gives an approximate sample size of **133 respondents**, which was increased to **150 respondents** to improve reliability and to account for possible non-response. The final sample included 110 students, 25 lecturers, and 15 maintenance staff.

3.3 Instrument and Data Collection

The main instrument used for data collection in this study was a **structured questionnaire**, which is widely accepted in survey research for obtaining reliable information from many respondents (Creswell & Creswell, 2017). The questionnaire was designed to gather responses from students, lecturers, and maintenance staff within Lagos State University of Science and Technology regarding thermal comfort and moisture regulation in classroom environments. The questionnaire was divided into four sections: Section A captured demographic information, Section B focused on thermal comfort conditions such as heat perception and ventilation, Section C assessed moisture-related issues like dampness and humidity, while Section D covered overall satisfaction with classroom environmental performance. A **5-point Likert scale** was used to structure the responses, ranging from Strongly Agree (5) to Strongly Disagree (1). This type of scale is commonly used in quantitative research because it allows easy classification and analysis of respondents' perceptions (Creswell& Creswell, 2017). Data collection was carried out through **personal administration of questionnaires**, where the researcher distributed and retrieved the instruments directly from respondents. This approach helps improve response rate and allows clarification of any misunderstood questions during completion (Creswell & Creswell, 2017). A total of **150 questionnaires** were administered to ensure adequate coverage of the selected sample. In addition, **direct observation** was used to complement the questionnaire responses. This involved physically assessing classroom conditions such as temperature comfort, ventilation effectiveness, and visible signs of moisture problems. The combination of questionnaires and observation improves the reliability of findings through methodological triangulation (Creswell & Creswell, 2017).

3.4 Data Analysis and Ethical Consideration

Data collected were analyzed using descriptive statistics such as frequency, percentage, and mean scores to interpret respondents' views on thermal comfort and moisture regulation in classrooms at Lagos State University of Science and Technology. Likert scale responses were converted into numerical values and presented in tables for easy interpretation (Obafemi Ibitoye, 2019). Ethical approval was obtained from the institution before data collection. Respondents were informed about the purpose of the study, and participation was voluntary. Confidentiality and anonymity were ensured, and no personal identifiers were collected. Participants were also allowed to withdraw at any stage of the research without penalty (Hay, 2017)

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter presents, analyzes, and interprets data collected from respondents on the assessment of thermal comfort and moisture regulation properties of burnt clay bricks in classroom environments at Lagos State University of Science and Technology. The data were obtained through questionnaires and analyzed using descriptive statistics such as frequency, percentage, and mean scores.

4.1 Questionnaire Response Rate

Description	number	Percentage (%)
Questionnaire Distributed	150	100
Questionnaire Retrieved	142	94.7
Not Retrieved	8	5.3

The response rate of 94.7% indicates a high level of participation, which is adequate for reliable analysis.

4.2 Demographic Information of Respondents

Table 4.2: Gender Distribution

Gender	Frequency	Percentage (%)
Male	78	54.9
Female	64	45.1
Total	142	100

The table shows that male respondents were slightly more than female respondents.

4.4 Analysis of Thermal Comfort

Statement	SA	A	N	D	SD
Classrooms are generally cool during hot weather	45	60	15	14	8
Ventilation is adequate in classrooms	50	55	18	12	7
Burnt clay bricks help reduce indoor heat	58	49	16	11	8

Interpretation:

The responses show that most occupants agreed that burnt clay bricks contribute positively to thermal comfort by reducing heat and improving indoor cooling conditions.

4.5 Analysis of Moisture Regulation

Statement	SA	A	N	D	SD
Classroom experience dampness frequently	18	25	20	45	34
Walls regulate moisture effectively	52	48	17	15	10
Mold growth is minimal in classrooms	47	51	16	18	10

Interpretation:

The results indicate that burnt clay bricks have moderate to good moisture regulation properties, helping to reduce dampness and mold growth in classroom environments.

CONCLUSION

5.1 Summary of The Study

This study assessed the thermal comfort and moisture regulation properties of burnt clay bricks in naturally ventilated classroom environments at Lagos State University of Science and Technology (LASUSTECH), Ikorodu. The research was motivated by the need to improve indoor environmental conditions in tropical climates, where high temperatures and humidity often affect learning comfort and productivity.

A descriptive research design survey was adopted, involving students, lecturers, and maintenance staff within the university. Data was collected through structured questionnaires and direct observations of classroom environments. The questionnaire focused on occupants' perceptions of temperature, ventilation, moisture conditions, and overall comfort.

The collected data were analyzed using descriptive statistical tools such as frequencies, percentages, and mean scores. The study aimed to determine the effectiveness of burnt clay bricks in enhancing indoor thermal comfort and regulating moisture levels, thereby contributing to improved learning environments and sustainable building practices within educational institutions.

5.2 Summary of Key Findings

The findings of this study indicate that burnt clay bricks contribute positively to thermal comfort and moisture regulation within classroom environments at LASUSTECH, Ikorodu. The key findings are summarized below:

5.2.1 Demographic Profile

- A total of 142 valid responses were obtained from the survey. The respondents consisted of 78 males (54.9%) and 64 females (45.1%), indicating a relatively balanced representation of classroom users.

5.2.2 Thermal Comfort and Heat Mitigation

- A majority of respondents (73.9%) agreed that classrooms constructed with burnt clay bricks remain relatively cool during hot weather conditions.
- About 75.4% of the respondents indicated that the brick walls help reduce indoor heat build-up, thereby enhancing thermal comfort.
- Similarly, 73.9% of participants reported that the classrooms provide adequate natural ventilation, contributing to a more comfortable indoor environment.

5.2.3 Moisture Regulation and Hygrothermal Performance

- Approximately 70.4% of respondents agreed that burnt clay brick walls effectively regulate indoor moisture levels.
- More than half of the respondents (55.6%) disagreed that the classrooms experience frequent dampness, suggesting satisfactory moisture control within the buildings.
- In addition, 69.0% of respondents agreed that mold growth is minimal within the classrooms, indicating that the buildings maintain relatively healthy indoor environmental conditions.

5.3 Conclusion

The findings of this study indicate that burnt clay bricks contribute positively to thermal comfort and moisture regulation within classroom environments at Lagos State University of Science and Technology (LASUSTECH), Ikorodu. The thermal properties of burnt clay bricks help moderate indoor temperature fluctuations by reducing the rate of heat transfer from the external environment into occupied spaces. As a result, classrooms constructed with burnt clay bricks provide relatively more stable and comfortable indoor conditions, particularly during periods of high ambient temperatures.

The study further reveals that the porous nature of burnt clay bricks enhances their moisture-regulating capacity. By absorbing and releasing moisture in response to changes in environmental conditions, the material helps maintain balanced indoor humidity levels and reduces the likelihood of excessive dampness. This characteristic contributes to improved indoor environmental quality and occupant comfort.

The results suggest that burnt clay bricks remain a viable and sustainable building material for educational facilities located in hot-humid climates. Their ability to support passive thermal regulation and moisture control can reduce dependence on mechanical cooling systems while promoting a healthier and more comfortable learning environment.

Therefore, the study concludes that the continued use of burnt clay bricks in educational buildings can contribute to sustainable campus development and climate-responsive architectural design in Nigeria. The findings provide useful insights for architects, builders, educational institutions, and policymakers seeking environmentally responsible building solutions that enhance occupant comfort and building performance.

5.4 Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Adoption of Burnt Clay Bricks in Educational Buildings

Educational institutions and facility managers should consider the use of burnt clay bricks in future building projects due to their ability to improve thermal comfort and regulate indoor moisture conditions.

2. Promotion of Passive Design Strategies

Architects and building designers should combine burnt clay bricks with passive design measures such as proper building orientation, adequate shading devices, and effective natural ventilation to enhance indoor environmental performance.

3. Proper Maintenance of Brick Structures

Building managers should adopt maintenance practices that preserve the moisture-regulating properties of burnt clay bricks. The use of non-breathable finishes and coatings that may restrict moisture movement through the walls should be minimized.

4. Encouragement of Sustainable Building Materials

Government agencies, professional bodies, and educational institutions should promote the use of locally sourced and environmentally sustainable materials such as burnt clay bricks in building construction.

5. Further Research

Future studies should incorporate quantitative environmental measurements, including temperature and humidity monitoring, to provide additional evidence on the thermal and moisture performance of burnt clay bricks in different climatic conditions and building types.

References (APA 7th Edition)

[1] Asamoah, R. O., Offei-Nyako, K., Duker, D. A., & Osei-Tutu, S. (2023). Promoting burnt clay brick as an affordable housing material in developing economy: Building professionals' perspective. International Journal of the Built Environment and Asset Management, 2(3), 230–245. https://doi.org/10.1504/IJBEAM.2023.130532

[2] Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). Sage Publications. https://us.sagepub.com/en-us/nam/research-design/book255675

[3] Diviš, J., Buxmann, S., & Vacek, J. (2022). The influence of clay structures on the hygrothermal behavior of interior building elements. Materials, 15(7), 2415. https://doi.org/10.3390/ma15072415

[4] Hay, I. (2017). Qualitative research methods in human geography (4th ed.). Oxford University Press. https://global.oup.com/academic/product/qualitative-research-methods-in-human-geography-9780199019381

[5] Ibitoye, O. (2019). Fundamentals of research methods and statistical analysis. National Open University of Nigeria. https://nou.edu.ng

[6] Kothari, C. R. (2004). Research methodology: Methods and techniques (2nd ed.). New Age International Publishers. https://www.newagepublishers.com

[7] Maduabum, A., Khattak, S., & Wright, A. (2025). Thermal comfort performance of interlocking compressed earth blocks in off-grid classrooms: A case study from Anambra State, Nigeria [Preprint]. SSRN. https://doi.org/10.2139/ssrn.5829365

[8] Makrygiannis, I., &Grafakos, S. (2023). Optimizing building thermal insulation: The impact of brick materials on heat transfer. Materials, 16(3), 89–102. https://doi.org/10.3390/ma16030089

[9] McGregor, F., Heath, A., Shea, A., & Lawrence, M. (2014). The moisture buffering capacity of unfired clay masonry. Building and Environment, 82, 599–607. https://doi.org/10.1016/j.buildenv.2014.09.027

[10] McGregor, F., Heath, A., Shea, A., & Lawrence, M. (2014). The moisture buffering capacity of unfired clay masonry as a passive solution to indoor humidity control. Building and Environment, 81, 177–186. https://doi.org/10.1016/j.buildenv.2014.05.019

[11] Munonye, C. C., &Maduabum, A. (2024). Classrooms and comfort temperature in South East Nigeria. World Journal of Advanced Research and Reviews, 24(2), 1564–1573. https://doi.org/10.30574/wjarr.2024.24.2.3509

[12] Okafor, M. U. (2022). Evaluation of indoor thermal comfort conditions of traditional and modern buildings in Southeastern Nigeria. Sustainability, 14(19), 12138. https://doi.org/10.3390/su141912138

[13] Oti, J. E., Kinuthia, J. M., & Bai, J. (2010). Design thermal values for unfired clay bricks. Materials & Design, 31(1), 104–112. https://doi.org/10.1016/j.matdes.2009.07.011

[14] Oumeziane, Y. A., Leroy, N., & Hinchliff, J. (2021). Hygrothermal properties of an early 20th century clay brick: Experimental characterization. Energy and Buildings, 260, 111920. https://doi.org/10.1016/j.enbuild.2021.111920

[15] Owolabi, T. O. S., Bello, B. I., Ogunnaike, A. O., & Ibitoye, O. A. (2025). Indoor air quality and thermal environment assessment of South-West Nigerian homes with different building fabrics. International Journal of Built Environment and Earth Sciences, 8(4). https://doi.org/10.70382/tijbees.v08i4.049

[16] Saunders, M., Lewis, P., & Thornhill, A. (2019). Research methods for business students (8th ed.). Pearson Education. https://www.pearson.com/en-gb/subject-catalog/p/research-methods-for-business-students/P200000003208

[17] Yamane, T. (1967). Statistics: An introductory analysis (2nd ed.). Harper & Row. https://archive.org/details/statisticsintrod00yama

[18] Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). Sage Publications. https://us.sagepub.com/en-us/nam/case-study-research-and-applications/book250150