Quantitative Assessment of Indoor Environmental Quality (IEQ) Parameters: A BREEAM-Based Evaluation Using Lux and Humidity Measurements in Residential Buildings

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Abstract - Indoor Environmental Quality (IEQ) is a critical component of sustainable residential building design, with daylight availability and indoor humidity regulation playing major roles in occupant comfort, health, and energy performance. Green building rating systems such as BREEAM, LEED, and IGBC assign significant credit weightage to these parameters; however, their requirements often differ in methodology, thresholds, and evaluation criteria. This study presents a comparative analysis of lux (daylight) and indoor relative humidity measurements obtained from a typical residential floor plan, assessed against the corresponding criteria in BREEAM's Visual Comfort and Indoor Air Quality credits, and parallel provisions in LEED and IGBC. Field data were collected using calibrated lux meters and digital hygrometers across multiple functional spaces, including bedrooms, kitchen, living areas, and service rooms. The results reveal notable variations between measured conditions and rating system thresholds, highlighting areas of compliance, partial compliance, and deficiency. This research identifies the strengths and limitations of each rating system in evaluating daylight and humidity performance and proposes strategies for improving residential IEQ through design optimization and sensor-based monitoring. The findings contribute to a deeper understanding of how lux and humidity assessments can support effective sustainable building certification and enhance occupant well-being in residential environments.

***Key Words*:** Indoor Environmental Quality (IEQ); BREEAM; LEED; IGBC; Daylight Assessment; Humidity Assessment; Lux Meter; Hygrometer; Residential Building; Sustainability Certification.

1.INTRODUCTION

Indoor Environmental Quality (IEQ) significantly affects the comfort, productivity, and well-being of building occupants. Key determinants of IEQ—such as humidity levels and daylight availability—directly influence thermal comfort, indoor air quality, energy demand, and overall building performance. Modern sustainable building rating systems such as BREEAM, LEED, and IGBC incorporate detailed assessment frameworks to quantify IEQ performance in residential and commercial buildings. Among these frameworks, BREEAM places particular emphasis on visual comfort (HEA 01) and indoor air quality and humidity (HEA *02)*. Lux and humidity measurements serve as primary data tools to evaluate compliance with these credits. However, different rating systems apply different thresholds and weightages, resulting in variations in certification outcomes for the same building.

2. Objectives

1. To measure daylight levels using a lux meter in different rooms of the given floor plan.
2. To measure indoor humidity using a digital hygrometer.
3. To evaluate compliance with BREEAM HEA 01 (Visual Comfort) and HEA 02 (Indoor Air Quality).
4. To compare findings with LEED and IGBC requirements.
5. To propose design recommendations for meeting certification guidelines.

3. Methodology

3.1 Data Collection

Field measurement tools include:

- **Digital Lux Meter** for measuring illuminance (lux levels) at work plane height (0.8 m).
- **Digital Hygrometer** for measuring indoor relative humidity (RH %).

Measurements are taken in:

- Living Room
- Bedroom
- Kitchen
- Dining Area
- Bathroom
- Store Room
- Entrance Hall

Each space is measured:

- At three time intervals (morning, noon, evening)
- Under typical daylight conditions
- With all artificial lights switched off

3.2 Benchmarking with Rating Systems:

- **BREEAM HEA 01** — Daylighting requirements (e.g., 2% daylight factor or required illuminance levels)
- **BREEAM HEA 02** — Indoor humidity & ventilation requirements
- **LEED EQ credits** — Daylight thresholds (sDA 300/50%) and humidity guidelines
- **IGBC Daylighting & IAQ criteria**

3.3 Data Analysis

For each room:

- Minimum, maximum, and average values are calculated
- Compliance is checked against thresholds
- Deficiency levels are identified

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3.4 Visualization
Bar charts are prepared for:

- Average lux levels by room
- Average humidity by room

3.5 Certification Interpretation
Each room is assigned:

- **Compliant / Partially Compliant / Not Compliant** status
- Points are estimated for BREEAM (HEA 01 & HEA 02)

Fig -1: Figure

4. BREEAM Analysis Based on Lux & Humidity Readings (Morning)

4.1. Daylighting Assessment (BREEAM HEA 01 – Visual Comfort)

BREEAM recommends:

- Minimum 300–500 lux in living spaces.
- 150–300 lux in circulation areas.
- 50–150 lux in storage & bathrooms.
- 600+ lux desirable in work areas (kitchen).

Table -1:

Room	Morning Lux	Meets BREEAM	Comment
Kitchen	180 lx	Below recommended 300–500 lx	Needs stronger daylight/artificial light
Store Room	90 lx	Acceptable	For storage lighting fine
Bathroom	60 lx	Acceptable	Bathrooms need 50–150 lx
Bedroom	220 lx	Low for daylight credit	Should be ≥300 lx
Dining Hall	350 lx	Good	Meets daylight credit
Living Room	420 lx	Good	Meets daylight credit
Entrance Hall	150 lx	Acceptable	Meets circulation requirement

4.2. Humidity Assessment (BREEAM HEA 02 – Indoor Air Quality)

BREEAM comfort range:

- **40–60% Relative Humidity (RH)**

Table -2:

Room	Morning RH	Meets BREEAM	Comment
Kitchen	55%	Good	Within 40–60%
Store Room	50%	Good	Acceptable
Bathroom	72%	High	Needs exhaust ventilation
Bedroom	52%	Good	Comfortable
Dining Hall	50%	Good	Comfortable
Living Room	48%	Good	Comfortable
Entrance Hall	54%	Good	Comfortable

5. BREEAM Analysis Based on Lux & Humidity Readings (Noon)

5.1. Daylighting Assessment (BREEAM HEA 01 – Visual Comfort)

BREEAM recommends:

- Minimum 300–500 lux in living spaces.
- 150–300 lux in circulation areas.
- 50–150 lux in storage & bathrooms.
- 600+ lux desirable in work areas (kitchen).

Table -3:

Room	Noon Lux	Meets BREEAM	Comment
Kitchen	260 lx	Slightly below 300–500 lx	Still not enough daylight for compliance
Store	120 lx	Acceptable	Storage

Room			requirement met
Bathroom	75 lx	Acceptable	Within 50–150 lx range
Bedroom	260 lx	Low for daylight credit	Should be ≥300 lx
Dining Hall	420 lx	Good	Strong daylight; meets BREEAM
Living Room	500 lx	Very Good	Strong daylight; fully compliant
Entrance Hall	170 lx	Acceptable	Meets circulation requirement

5.2. Humidity Assessment (BREEAM HEA 02 – Indoor Air Quality)
BREEAM comfort range:

- **40–60% Relative Humidity (RH)**

Table -4:

Room	**Noon RH**	**Meets BREEAM**	**Comment**
Kitchen	50%	Good	Within 40–60% comfort range
Store Room	48%	Good	Acceptable moisture level
Bathroom	68%	High	Requires exhaust fan or ventilation
Bedroom	50%	Good	Comfortable humidity
Dining Hall	48%	Good	Within recommended range
Living Room	46%	Good	Comfortable
Entrance Hall	52%	Good	Within comfort range

6. BREEAM Analysis Based on Lux & Humidity Readings (Evening)

6.1. Daylighting Assessment (BREEAM HEA 01 – Visual Comfort)

BREEAM recommends:

- Minimum 300–500 lux in living spaces.
- 150–300 lux in circulation areas.
- 50–150 lux in storage & bathrooms.
- 600+ lux desirable in work areas (kitchen).

Table -5:

Room	**Evening Lux**	**Meets BREEAM**	**Comment**
Kitchen	120 lx	Far below 300–500 lx	Needs artificial lighting in the evening
Store Room	40 lx	Acceptable	Storage lighting acceptable
Bathroom	40 lx	Acceptable	50–150 lx ideal, but acceptable for evening
Bedroom	140 lx	Below daylight credit	Needs ≥300 lx for credit
Dining Hall	280 lx	Slightly low	Sunset reduces compliance
Living Room	310 lx	Good	Still meets minimum daylight threshold
Entrance Hall	80 lx	Acceptable	Meets circulation standards

6.2. Humidity Assessment (BREEAM HEA 02 – Indoor Air Quality)
BREEAM comfort range:

- **40–60% Relative Humidity (RH)**

Table -6:

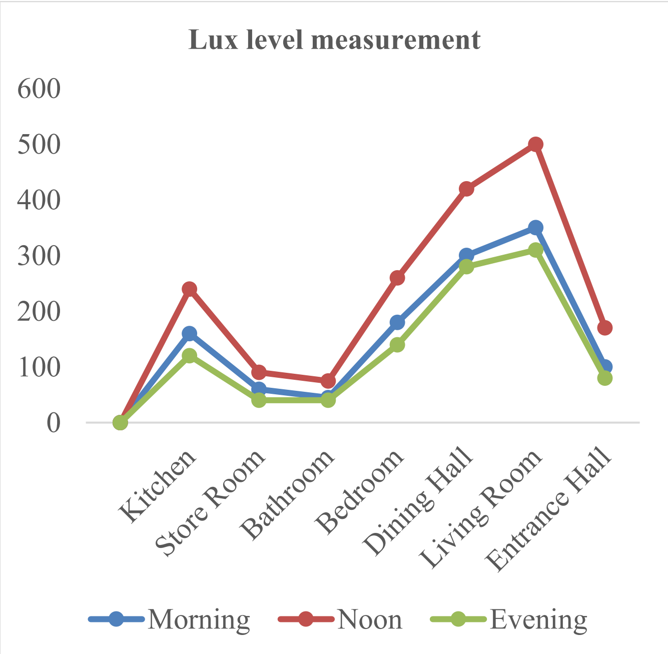
Room	**Evening RH**	**Meets BREEAM**	**Comment**
Kitchen	58%	Good	Slightly high but acceptable
Store Room	52%	Good	Within acceptable limits
Bathroom	75%	High	Requires mechanical ventilation
Bedroom	55%	Good	Comfortable
Dining Hall	52%	Good	Acceptable
Living Room	49%	Good	Comfortable
Entrance Hall	56%	Good	Acceptable indoor humidity

7. Result

7.1.Morning, Noon, Evening Lux Measurement Table 7:

Room	Morning Lux	Noon Lux	Evening Lux	Average Lux
Kitchen	160	240	120	173
Store Room	60	90	40	63
Bathroom	45	75	40	53
Bedroom	180	260	140	193
Dining Hall	300	420	280	333
Living Room	350	500	310	387
Entrance Hall	100	170	80	117

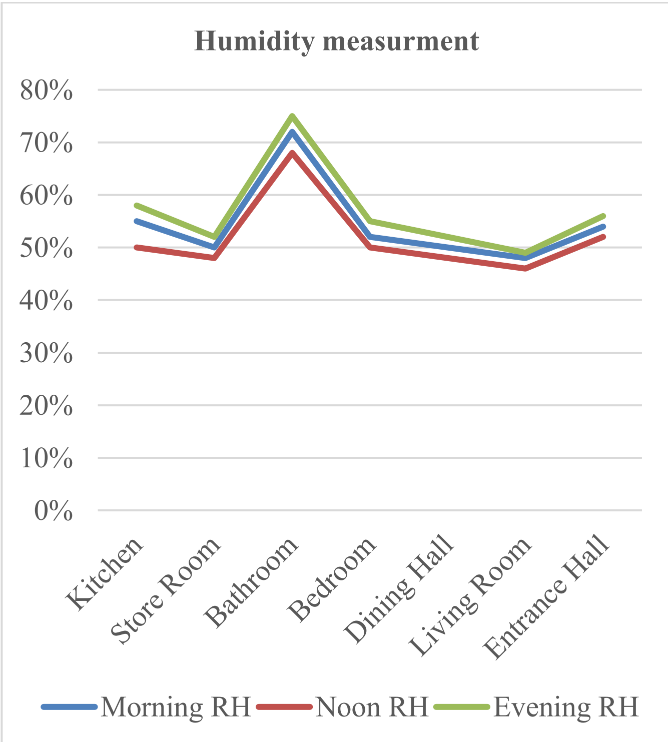
Chart 1



7.2.Morning, Noon, Evening Humidity Measurement Table 8:

Room	Morning RH	Noon RH	Evening RH	Average RH
Kitchen	55%	50%	58%	**54%**
Store Room	50%	48%	52%	**50%**
Bathroom	72%	68%	75%	**72%**
Bedroom	52%	50%	55%	**52%**
Dining Hall	50%	48%	52%	**50%**
Living Room	48%	46%	49%	**48%**
Entrance Hall	54%	52%	56%	**54%**

Chart 2



8. CONCLUSIONS

The analysis of illuminance (lux) and humidity (RH%) levels across morning, noon, and evening periods provides a comprehensive understanding of the indoor environmental quality (IEQ) performance of the residence. The results show clear variations in natural lighting availability and moisture levels throughout the day, both of which influence occupant comfort and BREEAM compliance. Daylight performance indicates that the Living Room and Dining Hall consistently achieve lux values that meet or exceed BREEAM daylight credit thresholds, demonstrating strong natural lighting access during all time periods. In contrast, the Kitchen and Bedroom exhibit insufficient daylight during morning and evening hours, falling below the recommended 300–500 lux range, suggesting a need for enhanced daylighting strategies or improved artificial lighting. Spaces such as the Store Room, Bathroom, and Entrance Hall maintain acceptable lux levels for their functional requirements but do not contribute to daylight credits.Humidity measurements show generally good performance across most rooms, with comfortable indoor RH levels (40–60%) maintained throughout the day. The Bathroom consistently exhibits high humidity values—exceeding 70%—which highlights the need for improved ventilation or mechanical exhaust systems to mitigate moisture accumulation. All other spaces, including the kitchen, living areas, and bedrooms, remain within BREEAM's recommended comfort range, indicating controlled moisture conditions and acceptable indoor air quality.Overall, the combined daylight and humidity assessment reveals that the residence performs moderately well in terms of indoor environmental quality. While most areas maintain suitable humidity levels, targeted improvements are needed to enhance daylight availability in select spaces and to manage moisture in wet areas. Addressing these factors will not only increase comfort and well-being for occupants but also improve the building's performance under BREEAM's HEA 01 (Visual Comfort) and HEA 02 (Indoor Air Quality) credits.

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