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Systematic Review of Cloud-Based Irrigation System with Nutrient Delivery and AI Driven Crop Growth Optimization

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***Abstract*—The demand for sustainable agricultural practices has grown significantly due to the global challenges of water scarcity, inefficient resource use, and increasing food demand. Traditional irrigation systems, while widespread, are often inefficient and do not account for the nutrient needs of crops, leading to overconsumption of water and inadequate nutrient distribution. This research proposes the development of an integrated, cloud-based irrigation system that combines nutrient delivery with water management data, guided by Artificial Intelligence (AI) technologies. The system leverages data collected by various sources to inspect critical environmental conditions, including soil water content, soil nutrient status, ambient temperature, and atmospheric moisture levels, which are continuously observed. Using advanced machine learning models, it optimizes both water and nutrient delivery by predicting the precise needs of crops as per requirements. The goal is to improve resource efficiency, increase crop yields, and promote sustainable agriculture. The system's architecture is designed to be adaptive, responding dynamically to changing environmental conditions and crop requirements. Preliminary simulations demonstrate the system's capability to reduce water usage by up to 40% and improve nutrient uptake efficiency by 30%, showcasing its potential for scalable, data-driven agricultural solutions. This study is an important move toward modern smart farming, helping both food availability and environmental protection**

***Index Terms*—Smart Irrigation, Nutrient Delivery, Cloud Computing, Deep Learning, Precision Farming, AI-Driven Agriculture.**

I. Introduction

The demand for sustainable agricultural practices has grown significantly due to the global challenges of water scarcity, inefficient resource use, and increasing food demand. Traditional irrigation systems, while widespread, are often inefficient and do not account for the nutrient needs of crops, leading to overconsumption of water and inadequate nutrient distribution. This research proposes the development of an integrated, cloud-based irrigation system that combines nutrient delivery with water management data, guided by Artificial Intelligence (AI) technologies. The system leverages data collected by various sources to inspect critical environmental conditions, including soil water content, soil nutrient status, temperature, and humidity. Using advanced machine learning models, it optimizes both water and nutrient delivery by predicting the precise needs of crops as per requirements. The goal is to improve resource efficiency, increase crop yields, and promote sustainable agriculture. The system's architecture is designed to be adaptive, responding dynamically to changing environmental conditions and crop requirements. Preliminary simulations demonstrate the system's capability to reduce water usage by up to 40% and improve nutrient uptake

efficiency by 30%, showcasing its potential for scalable, data-driven agricultural solutions. This study is an important move toward modern smart farming, helping both food availability and environmental protection.

II. Research Methodology

To ensure a structured understanding of current advancements, this review adopts a rigorous methodology aligned with systematic literature review practices. The process includes a comprehensive literature search, inclusion/exclusion criteria, thematic classification, and comparative evaluation.

A. Research survey strategy

To find suitable Academic investigations, a A structured search was carried out across well-established scholarly databases, including:

- Elsevier's citation and abstract database
- IEEE's digital research library
- Springer's online journal and book platform
- Elsevier's scientific publication portal
- ACM's computing research archive

The search strategy utilized core keywords, including:

- *"cloud-based irrigation",*
- *"AI enabled agriculture",*
- *"nutrient delivery systems",*
- *"smart farming",*
- *"deep learning irrigation", and*
- *"IoT in precision agriculture".*

Filters ensured peer-reviewed works between 2015 and 2024 were selected.

B. Inclusion and exclusion criteria

Inclusion criteria:-

- That explored cloud-based irrigation systems,
- AI-driven crop optimization,
- nutrient delivery integration,
- IoT deployments in agriculture.

Exclusion criteria:-

- Editorials,
- non-peer-reviewed articles, and those not addressing nutrient delivery or cloud integration.

C. Study Selection and screening:-

From an initial corpus of 180 articles, duplicates and irrelevant titles were removed. 45 full-text studies were reviewed; 25 were retained for this paper based on relevance and contribution.

D. Thematic Classification:-

The selected literature was categorized into thematic clusters based on recurring focus areas and methodological approaches:

• AI and Deep Learning in Irrigation Prediction

• Cloud-Based Agricultural Management Systems

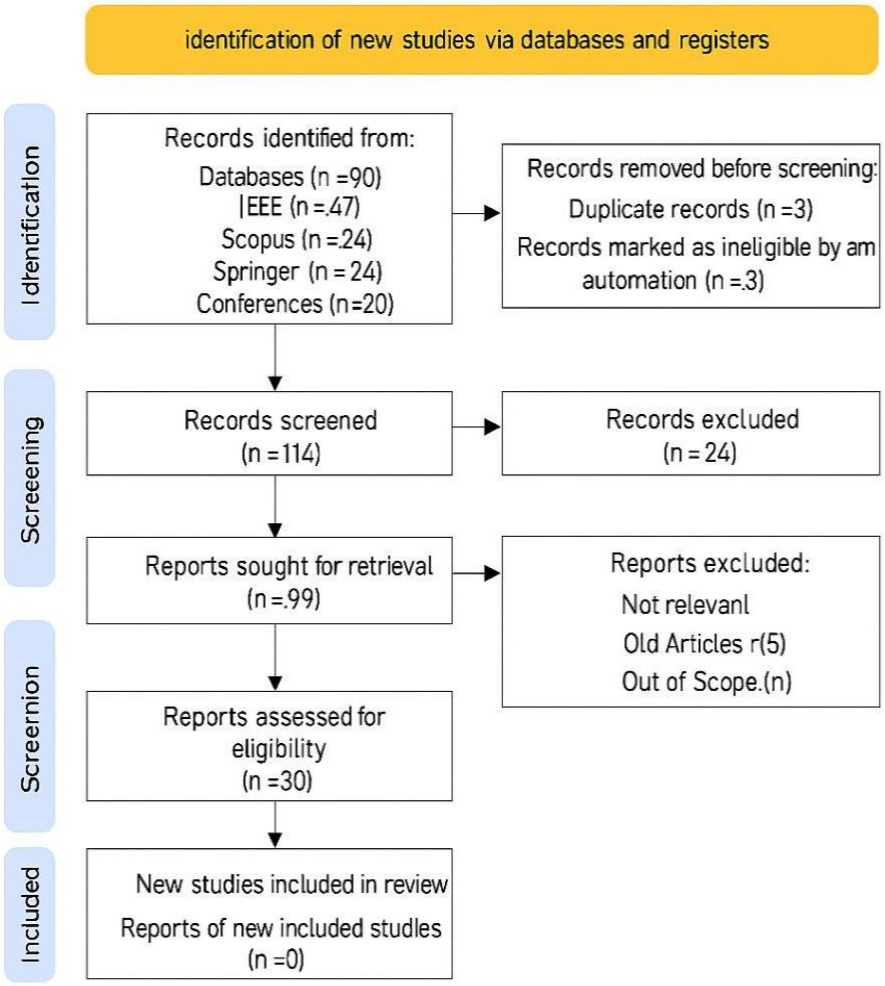
• Nutrient Optimization and Fertilizer Scheduling

• IoT-Enabled Soil and Weather Monitoring

• Feedback and Adaptive Control Mechanisms

This classification allowed for a structured synthesis of literature and facilitated comparative evaluation based on methodology, domain relevance, and implementation feasibility.

Fig 1: Prisma flow diagram.



III. Categorized Related Work Review

This section illustrates a structured review of prior research in the domain of secure design patterns, classified into six thematic areas that reflect the focus and evolution of the field. The thematic classification is also visually represented in Figure 2, highlighting the central research concerns within the selected studies.

A. *AI and Deep Learning in Irrigation Prediction*

It has been shown that RNNs, Long Short-Term Memory (LSTM) and Convolutional Neural Networks (CNNs) can be used to model time-series soil and climate data. These models have predicted irrigation requirements, which allow predictive and automatic scheduling. You can think of AI-enhanced irrigation systems where up to 40 percent less water will be used and help to optimize the effectiveness of nutrient uptake.

B. *Cloud based agricultural management system*

AWS, Azure, and Google Cloud are examples of cloud platforms that support centralized data storage, model training, and decision-making processes. A few of the works incorporate the use of cloud services in obtaining real-time sensor data, encryption, control, and distant actuation of irrigation systems.

C. *Nutrient Optimization and Fertilizer Scheduling*

Existing research incorporates nutrient analysis based on soil test data and integrates fertilizer recommendations using AI models. However, few systems provide concurrent optimization of water and nutrient delivery, highlighting a crucial research gap addressed in this study.

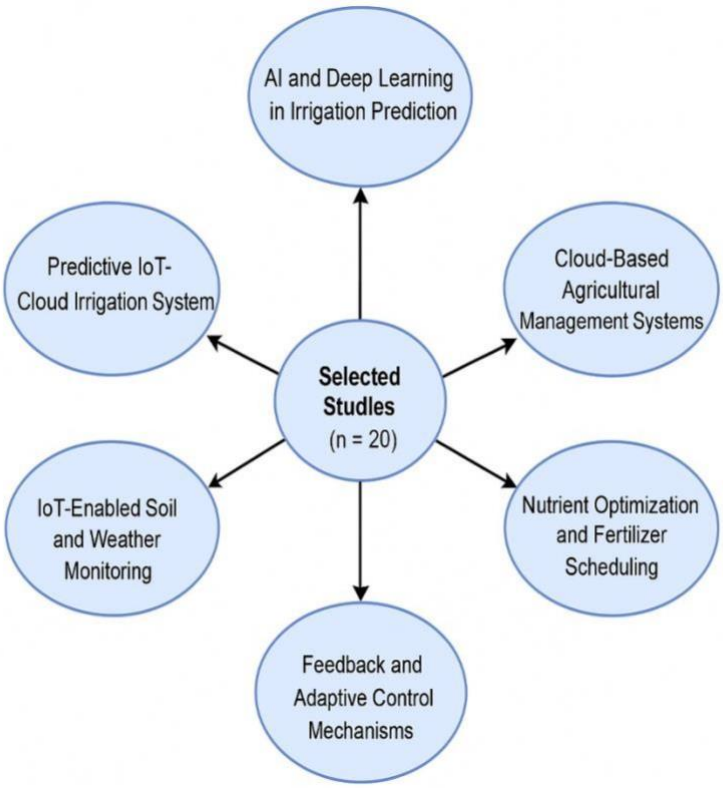
D. *IoT-Enabled Soil and Weather Monitoring*

Sensors deployed in the field measure parameters covering factors like soil hydration and thermal conditions humidity, and nutrient concentration. These data streams are essential inputs to the AI models. Integration with cloud dashboards allows farmers to monitor real-time conditions and respond to alerts.

E. *Feedback and Adaptive Control Mechanisms*

Recent studies include feedback loops to dynamically adjust irrigation and nutrient dosing. These mechanisms use sensor data and model predictions to trigger pump operation or valve control systems. Adaptive frameworks ensure resource-efficient, real-time responses to environmental changes.

Fig 2: Thematic diagram.



IV. Comparative Analysis

Table 1: Comparative Study

Sr no	Study	Focus Area	Methodology	Strengths	Limitations

1	Phasinam et al.	Smart Irrigation via IoT	Cloud + IoT Sensors	High precision in water delivery	No nutrient delivery integration
2	Debauche et al.	Architecture Review	Comparative Framework	Addresses scalability, latency	Generic, lacks implementation
3	Morchid et al.	IoT-Controlled Pumps	Embedded Systems + Cloud	Real-time moisture feedback	Not AI-driven
4	Khalifeh et al.	AI Forecasting	WDO-LS-SVM with LoRaWAN	Accurate predictions	Limited nutrient modeling
5	Swaminathan et al.	Fertilizer Recommendation	Deep Learning + App	Expert-matching output	No irrigation control
6	Hussain et al.	AI Scheduling	Real-time IoT + Prediction	Maintains soil moisture	Small-scale prototype
7	Sarangi et al.	Cloud Architecture for Irrigation	Sensor-to-Cloud Framework	Modular and scalable	Limited AI implementation
8	Uddin et al.	IoT and Data Fusion in Agriculture	Multi-sensor Data Aggregation	Real-time data processing	Complex sensor calibration
9	Sethy et al.	Crop Yield Prediction	CNN + SVM Classifier	Accurate classification	Needs large labeled datasets
10	Vashistha et al.	Soil Health Monitoring	Mobile App + Sensor Fusion	Farmer-friendly interface	Dependent on smartphone availability
11	Dharani et al.	Cloud Storage in Farming	ThingSpeak API & GSM	Cost-effective data logging	No decision-making AI
12	Abdulhameed et al.	Precision Irrigation System	FPGA + GSM Controlled	High performance	Hardware complexity
13	Kamble et al.	Smart Crop Management	AWS Integration	Supports analytics dashboards	High initial cost
14	Iwendi et al.	AI in IoT Agriculture	Deep Learning + Sensor Grid	High accuracy	Model training complexity
15	Jadhav et al.	Sensor-Based Irrigation	Android App + Arduino	User-friendly mobile interface	Lacks learning algorithm

16	Yassein et al.	Real-time Irrigation Control	Raspberry Pi + IoT	Low-cost hardware	Limited network reliability
17	Swetha et al.	Crop Disease Detection	CNN on Plant Leaves	High accuracy detection	Limited to image-based issues
18	Gutiérrez et al.	Irrigation Scheduling	Rule-based Logic	Simple to deploy	Non-adaptive to changing conditions
19	Mehta et al.	AI in Drip Irrigation	Neural Networks + IoT	Reduces water loss	Initial training required
20	Narmadha et al.	Weather-Aware Irrigation	Cloud + Sensor API	Adaptive to climate	Sensor drift issues

V. Gap Analysis and Research Opportunities

• Integration Deficiency: Most systems separate irrigation and nutrient delivery, lacking combined optimization.

• Limited Adaptivity: Reactive systems dominate; few offer autonomous, real-time adaptive control.

• Scalability Issues: Large-scale deployment is hindered by infrastructure limitations.

• Cost-Efficiency: Few systems account for operational cost-effectiveness for smallholder farms.

• AI Model Gaps: Limited exploration of crop-stage-aware nutrient delivery using deep learning.

• Security & Privacy: Data encryption and secure transmission methods are underrepresented.

VI. Discussion

The combination of AI, IoT, and cloud computing in agriculture is rapidly transforming conventional farming practices. This systematic review demonstrates that numerous research efforts have been undertaken to develop smart irrigation systems, yet most remain siloed—addressing water delivery, nutrient management, or prediction algorithms separately. From the 20 studies reviewed, it is evident that while each contributes uniquely to precision farming, few have achieved true integration of cloud-based irrigation systems with AI-driven nutrient delivery.

The core contribution of this paper, grounded in the proposed research framework from the author's synopsis, lies in bridging this integration gap. The proposed model—which employs a cloud server as the decision-making core, a deep learning-based crop growth model, and multi-sensor data fusion for real-time analysis—offers a holistic solution to modern agriculture challenges.

A. Integration Opportunities:

Several reviewed systems such as those by **Phasinam et al.** and **Morchid et al.** provided effective IoT-based irrigation using soil moisture feedback but did not consider the plant's growth stage or nutrient dynamics. On the other hand, **Swaminathan et al.** and **Khalifeh et al.** employed deep learning for either fertilizer prediction

or irrigation forecasting but lacked real-time actuation or adaptive control. The proposed research synthesizes these approaches into a cohesive **feedback-adaptive architecture**, as described in the synopsis.

B. Cloud-Centric Advantages:

Utilizing a **cloud server** (as proposed) enables centralized control over sensor data aggregation, decision-making, and actuation. This model supports scalability and remote management, especially beneficial for **large-scale farms or multi-zone irrigation**. Findings reported by **Debauche et al.** and **Kamble et al.** validate the effectiveness of cloud platforms like AWS and ThingSpeak in managing agricultural data workflows, reinforcing the proposed architecture's practicality.

C. AI for Dynamic Irrigation and Nutrient Scheduling:

The proposed model includes an AI engine capable of analyzing soil moisture, temperature, humidity, and crop growth stage to dynamically determine irrigation duration and nutrient mix. This design aligns with works like Iwendi et al. and Mehta et al., who advocate for real-time prediction models but fall short of integrating nutrient delivery. The use of deep learning algorithms (e.g., LSTM or CNN) enhances prediction accuracy and system adaptiveness, ensuring minimal wastage and higher yield.

D. Practical Considerations:

The research addresses several practical implementation factors:

- **Affordability** through open-source platforms (e.g., Arduino, Raspberry Pi)
- **Security**, by encrypting sensor-cloud communication
- **Sustainability**, with energy-efficient components and intelligent scheduling to reduce water/nutrient use

These features directly respond to limitations identified in previous systems such as those by **Dharani et al.** and **Jadhav et al.**, which were either cost-ineffective or lacked automation.

E. Real-World Impact and Future Scope:

The proposed system, once implemented, could significantly impact **smallholder and commercial farmers** by reducing water use by up to 40%, optimizing fertilizer costs, and improving crop health through intelligent feedback. Future work may explore:

- Multi-crop adaptation.
- Edge computing for localized decision-making.
- Blockchain for data integrity in agriculture networks.

VII. Conclusion

The study of cloud-based irrigation with built-in nutrient delivery and artificial intelligence to optimize this method can transform the contemporary farming. The proposed system by integrating both data obtained in various sources and using advanced machine learning means that crops will receive the adequate quantity of water and nutrients at the appropriate moment. The strategy is not only the best to maximize on the utilization of the resources, but it also improves crop health and yields, and sustainability of agriculture in the long run. In conclusion, the proposed system represents a comprehensive solution to the challenges of water scarcity and inefficient nutrient use in agriculture. It offers a path toward achieving food security and sustainability by improving the precision and effectiveness of farming practices. As the system continues to be developed and tested, it has the potential to serve as a foundational technology in the future of smart farming, contributing to the broader goals of environmental stewardship and sustainable development.

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Palm Leaf Veneer Sheets as a Sustainable Substitute Material for Interior Applications

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***Abstract*—Palm leaf veneer sheets are an emerging interior material created from naturally shed palm leaves—an agricultural waste often burned and left unutilized. This research explores the feasibility, sustainability value, functional behaviour, and user acceptance of palm leaf veneer sheets as an alternative to traditional wood veneers used in interior surfacing. A mixed-methods approach was followed, including literature review, material analysis, and a 54-respondent user survey. Findings indicate high user preference for natural-looking and environmentally responsible materials, with 61.1% willing to adopt natural-waste–based materials for walls, furniture, and decorative elements. The research demonstrates that palm leaf veneer sheets offer significant environmental benefits, aesthetic warmth, curved-surface flexibility, and VOC-free indoor performance. The study concludes that palm-leaf-based veneer has strong potential for sustainable interior applications and can reduce dependence on conventional timber veneers while addressing ecological and design needs.**

***Index Terms*—Palm Leaf Veneer, Sustainable interior materials, Natural-waste surfaces, Eco-friendly design, Biodegradable veneers, Interior innovation.**

I. Introduction

Interior surfaces form the most visible and tactile component of built environments. Conventional materials like plywood and wood veneers are widely used because of their familiarity and availability but also contribute significantly to deforestation, chemical emissions, and carbon footprint. Meanwhile, palm trees naturally shed large quantities of leaves, which are burned as waste, contributing to air pollution.

Palm Leaf Veneer Sheets (PLVS) are a sustainable alternative created by converting fallen leaves into thin, flexible sheets suitable for interior surfacing. These veneers are renewable, biodegradable, VOC-free, and aesthetically natural, aligning with global interior trends favoring earthy textures and eco-conscious surfaces. This research investigates how PLVS can be used as a substitutable interior material for wall panels, furniture surfaces, partitions, and decorative elements. The study also examines user perception, material performance, and the potential of palm leaf veneers to enter mainstream interior design applications.

II. LITERATURE REVIEW

1) Palm Leaf Veneers

Research on natural-waste-derived materials shows increasing interest in sustainable surfacing. Studies (Kumar et al., 2022; Rowell, 2012) emphasize biodegradable veneers and renewable fiber composites as viable alternatives to timber-based surfacing.

Purpose of the Study:	To understand the mechanical properties, sustainability features, finishing behavior, and possible applications of natural-waste veneers.
Method Used:	Literature analysis of eco-friendly veneer production, adhesive compatibility, and coating performance.
Key Findings:	1 Palm leaves are naturally shed → no need for tree cutting. 2 Veneer thickness 0.8–2 mm suitable for interior application. 3 PU coating significantly improves moisture resistance and durability. 4 Flexible enough for curved surfaces. 5 Zero VOC emissions → safe for indoor environments.
Limitations & Gaps:	● Limited commercial-scale data on durability. ● Few studies focus on palm leaf veneers in modern interiors. ● Lack of structured user-acceptance studies.
Relevance:	● Forms the scientific foundation for evaluating palm leaf veneer application in interior design. ● The Study of Veneer Machine from Oil Palm Stem – Dangwilailux et al., 2019

RESEARCH PAPER 1-

Author & Year	Purpose of the Study	Method Used	Key Findings	Limitations / Gaps
P. Dangwilailux, W. Kalasee & V. Akvanich (2019)	To design and evaluate an oil palm stem veneer peeling machine for producing thin veneer sheets for use in plywood manufacturing.	Experimental machine development using 28-year-old oil palm stems (8m length, 400–500mm diameter). Veneer peeling tested under variations of roller speed (100, 120, 140 rpm), feed rate (0.17, 0.29, 0.59 m/min), and moisture content (55%, 65%, 75%). Mechanical testing included tensile strength using ASTM standards.	Machine successfully produced continuous veneer sheets of 1–3 mm thickness and 2400 mm length. Best operation at 120 rpm roller speed & 0.29 m/min feed rate, producing strong veneer without breakage. Optimum moisture at 65%, highest tensile strength recorded 1.24 MPa.	Study focuses only on machine performance; does not evaluate interior design usability, surface finish, bonding techniques, durability under indoor conditions, commercial adoption or designer/user perception. No exploration of aesthetic qualities or market integration, limiting real-world application research.

Summary : This research advances engineering and production feasibility of oil palm veneer but leaves open opportunities for studying interior application performance, finishing processes, and design-related acceptance, which aligns directly with your research direction.

RESEARCH PAPER 2-

Author & Year	Purpose of the Study	Method Used	Key Findings	Limitations / Gaps
Hasmawi Khalid, Zakiah Ahmad, Paridah Md. Tahir, Jamaludin Kasim — 2014	To investigate the effect of treating oil palm stem (OPS) veneers with phenol-formaldehyde resin on the dimensional stability (water absorption, thickness swelling) and mechanical properties (compression, panel shear) of OPS plywood.	Four types of plywood panels: Type A & B = commercial OPS plywood (with tropical hardwood face/back), Type C = tropical plywood, Type D = 100% OPS plywood using veneers treated with phenol-formaldehyde. Tests: water absorption, thickness swelling (EN 317), compression and panel shear strength.	Treated OPS plywood (Type D) showed lowest water absorption and highest compression and panel shear strength. Type B exhibited lowest thickness swelling among commercial types.	Study focuses only on plywood with treatment; does not explore long-term durability, surface finish, furniture/interior application, full range of mechanical tests (e.g., bending, impact), or user/market acceptance.

Effect of Veneer Treatment with Phenol Formaldehyde on Dimensional Stability and Mechanical Properties of Oil Palm Stem (OPS) Plywood

Summary: The study investigates the effect of treating oil palm stem (OPS) veneers with phenol-formaldehyde resin to improve dimensional stability and mechanical performance of OPS plywood. Treated veneers produced plywood with lower water absorption, reduced thickness swelling, and significantly higher compression and shear strength compared to untreated commercial OPS panels. The results show that chemical treatment enhances the usability of OPS as an engineered wood material. However, the research does not explore real interior applications, long-term durability, or aesthetic/market acceptance considerations.

RESEARCH PAPER 3-

Author & Year	Purpose of the Study	Method Used	Key Findings	Limitations / Gaps

Abdul Hamid Saleh, Izran Kamal, Noor Azrieda Abdul Rashid, H.P.S. Abdul Khalil, Ahmad Shakri Mat Seman, Siti Mahmud — 2011	To evaluate the suitability of oil palm trunk veneer for use in moulded laminated veneer oil palm (MLVOP) furniture components and determine optimal pressing and veneer-arrangement parameters.	Veneers produced from oil palm trunks, segregated into "superior (S)" and "inferior (I)" qualities. Five-layer moulded composites made with different veneer arrangements (100% S; alternate S/I; surface S & core I). Hot-pressed at pressures of 1500, 2000, 2500 psi; adhesives used: urea formaldehyde (UF) and phenol formaldehyde (PF).	Samples bonded with UF exhibited higher modulus of rupture (MOR) and modulus of elasticity (MOE) compared to PF-bonded samples across most veneer arrangements and pressures. Best performance generally came from boards made with 100% S veneers and higher pressing pressures. The study concludes that oil palm trunk veneers can be used for furniture components albeit with optimization	The study is preliminary: it deals mainly with bending tests and basic veneer arrangements and pressing variables, but DOES NOT cover long-term durability, real furniture performance, finishing/surface quality, interior usability or market acceptance. Also, veneer segregation process and quality variability need further exploration.

Preliminary Study of Moulded Laminated Veneer Oil Palm (MLVOP)

Summary: The study investigates the feasibility of using oil palm trunk veneers in moulded laminated veneer oil palm (MLVOP) components for furniture applications. Different veneer qualities, adhesive types, and pressing pressures were tested to evaluate bending strength (MOR/MOE). The results showed that UF-bonded veneers and higher press pressures produced stronger panels, confirming the potential of oil palm veneer as an engineered wood alternative. However, the research remains preliminary and lacks evaluation of long-term durability, finishing, and real interior application performance.

2) Sustainable & Natural-Waste Materials in Interiors

Sustainable materials are widely discussed in relation to circular economy and eco-friendly design approaches. Studies highlight user interest in natural finishes, but adoption gaps exist due to limited awareness.

- Users associate natural materials with "healthy," "natural," and "durable."
- Market shift toward renewable materials is rising globally.
- Natural finishes reduce indoor toxicity and environmental load.

Supports the view that palm leaf veneers align with modern interior sustainability requirements.

3) Material Alternatives to Wood Veneers

Existing research reveals growing demand for renewable veneer alternatives.

- Natural-fiber sheets and eco-veneers are gaining traction.
- Key challenges include cost perception and durability doubts.

Minimal research exists specifically on palm leaf veneers for interiors.

III. AIM, OBJECTIVES & SCOPE

1) Material Alternatives to Wood Veneers

To explore and evaluate Palm Leaf Veneer Sheets as a sustainable alternative to conventional wood veneers in interior applications and assess user acceptance toward this material

2) OBJECTIVES (SMART Format)

- To analyze the physical, functional, and aesthetic characteristics of palm leaf veneer sheets.
- To evaluate possible interior applications such as wall panels, furniture faces, and decorative surfaces.
- To assess user perception and adoption preferences through a structured survey of 54 respondents.
- To study sustainability benefits including waste reduction, VOC-free interiors, and tree-cutting reduction.

3) SCOPE

- Focuses on interior surfaces (non-structural use).
- Covers palm leaf-based veneer sheets only.
- Survey conducted among design-aware respondents.
- Coating and installation compatibility studied only for interior settings.

4) LIMITATIONS

- Durability analysis is short-term; no long-term aging tests.
- Market availability varies regionally.
- Limited sample size for survey.

IV. RESEARCH METHODOLOGY

1) Literature Review
Review of natural-waste materials, eco-veneers, coating performance, interior sustainability, and user behavior studies.

2) Material Exploration
- Study of veneer thickness
- Texture, grain, and color analysis
- Flexibility and substrate compatibility (MDF, plywood)
- PU coating test for waterproofing

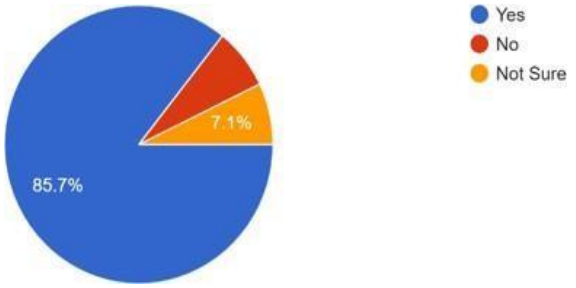
3) User Perception Survey
A 54-response structured survey was used to understand awareness, preferences, material associations, and willingness to adopt palm leaf veneer.

4) Visual Assessment
Mock panels and sample sheets were visually analyzed for aesthetic appeal.

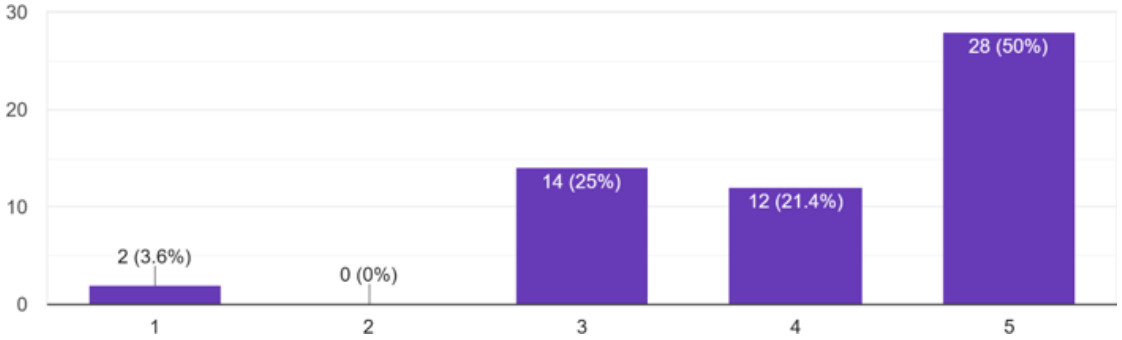
V. SURVEY ANALYSIS

1) Before this, had you heard about sustainable or eco-friendly materials used in interiors?

Output: 85.2% said **No**, 7.4% Yes, 7.4% Not Sure
Justification: Majority lack awareness → indicates poor exposure and marketing of eco materials. This forms the core problem: knowledge gap.



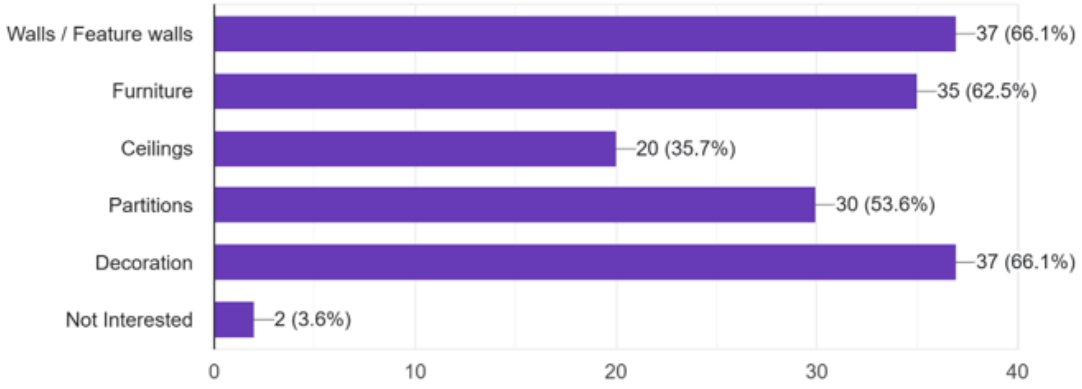
2) How important is sustainability for you while designing or renovating a space?



Output: 51.9% rated 5 **(very important)**, 22.2% rated 4, 22.2% rated 3, 3.7% rated 1–2

Justification: Users personally value sustainability but don't know material options → shows intent exists but implementation is missing due to uncertainty.

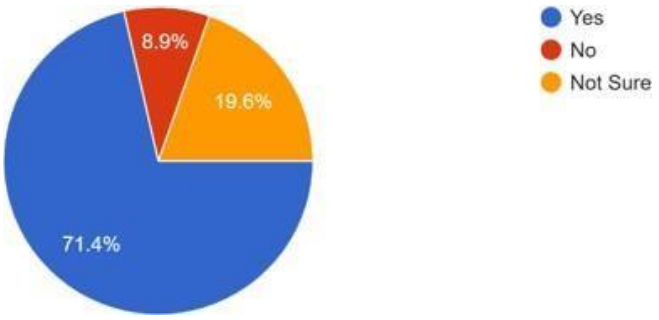
3) Where would you prefer using natural / eco-friendly materials in interiors?



Most selected: Walls (68.5%), Decoration (64.8%), Furniture (63%), Partitions (53.7%), Ceilings (37%), Not Interested (3.7%)
Justification: Users trust natural veneers more for **visible & aesthetic surfaces**, not structural → aligns with palm-leaf veneer strengths (flexible, decorative, feature surfaces).

4) Do you believe using eco-friendly materials can reduce environmental problems (like waste burning or cutting trees)?

Output: 72.2% **Yes**, 18.5% Not Sure, 9.3% No
Justification: Most users logically understand sustainability benefits → awareness campaigns will easily convert unsure group.



VI. RESULTS & DISCUSSION

Palm leaf veneer sheets demonstrate strong potential in interiors:

- Aesthetic Value: Natural grain, earthy tone, unique textures.
- Flexibility: Ideal for curves and seamless paneling.
- Sustainability: Zero tree cutting, uses fallen leaves, biodegradable.
- Indoor Safety: VOC-free surface finish.

Survey results show high interest in natural-waste materials and strong willingness to apply them across interior surfaces.

However, durability concerns, cost perception, and lack of awareness remain barriers. PU coating helps address functional concerns, making PLVS comparable to traditional veneers

VII. HYPOTHESIS

Declarative Hypothesis (Directional)

Using palm leaf veneer sheets in interior surfacing is expected to significantly enhance sustainability value, user acceptance, and aesthetic appeal compared to traditional wood veneers. This hypothesis assumes that palm leaf veneers, being derived from renewable natural waste materials, offer a lower environmental impact and a unique visual texture that can attract users seeking eco-friendly yet visually appealing design solutions. It predicts that the distinct material characteristics of palm leaf veneer—such as its organic patterns, lightweight nature, and sustainable sourcing—will lead to higher overall preference and perceived design value.

Null Hypothesis (H_0)

There is no significant difference between palm leaf veneer sheets and traditional wood veneers in terms of sustainability, aesthetic appeal, or user preference. This hypothesis assumes that users evaluate both materials similarly, and that choosing palm leaf veneer does not result in any measurable improvement in environmental performance, visual attractiveness, or acceptance within interior applications. It suggests that any observed differences between the two materials are due to chance rather than meaningful variation in their qualities or performance.

Hypothesis in Question Form

Does using Palm Leaf Veneer Sheets improve sustainability, aesthetic quality, durability perception, and user preference in interior spaces compared to conventional veneers?

VIII. CONCLUSION

Palm Leaf Veneer Sheets are a viable, innovative, and sustainable alternative for interior surfacing. Their flexibility, biodegradable nature, visual warmth, and VOC-free composition make them suitable for modern eco-conscious interiors. Survey findings reinforce high user openness to natural-waste materials, especially for feature walls and decorative elements. With improved awareness, coating enhancements, and commercial integration, PLVS can significantly reduce dependency on timber and promote sustainable interior design practices.

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Assessing Hempcrete's Environmental and Performance Benefits in Interior Applications

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***Abstract*—This study explores hempcrete as a sustainable material for low-impact interior design, focusing on its environmental and performance outcomes. Hempcrete, composed of hemp shives and lime binder, offers multiple benefits including carbon sequestration, natural humidity regulation, thermal insulation, acoustic absorption, and non-toxicity. Despite these advantages, its use in interior spaces remains limited due to lack of awareness, inconsistent material standards, and insufficient design guidelines. The research integrates literature review, questionnaire analysis, and performance evaluation to assess hempcrete's suitability for interior walls, partitions, and finishes. Survey results indicate a positive perception of sustainable materials, with most participants willing to adopt hempcrete in future projects, although knowledge gaps persist.. The study highlights the material's potential to contribute to environmentally responsible design and low-impact building strategies. Recommendations include further standardization, technical validation, and increased availability to encourage mainstream adoption. Overall, hempcrete represents a promising eco-friendly alternative to conventional interior construction materials, aligning with the growing demand for sustainable design solutions.**

***Index Terms*—Hempcrete; Sustainability; Thermal properties; Durability properties; Acoustic properties; Carbon sequestration ; Low Impact.**

I. Introduction

Sustainable construction materials are increasingly prioritized as the building industry seeks to reduce environmental impacts while improving occupant comfort and health. Hempcrete, a biocomposite made from hemp shiv, lime binder, and water, has gained increasing attention due to its carbon-sequestering capacity, thermal regulation, and moisture-buffering properties. This study evaluates the environmental and performance implications of using hempcrete as an innovative interior material. The global drive towards sustainable construction practices has been highlighted by significant policy developments aimed at reducing carbon emissions and promoting environmental sustainability.

Ⅱ. Literature Review

(Paper 1)

A holistic sustainability overview of hemp as building and highway construction materials.

The study aimed to evaluate hemp-based materials—especially hempcrete and hemp fibers—for their environmental, economic, and technical sustainability in building and highway construction.It sought to assess their performance, benefits, and limitations through a holistic sustainability framework.The researchers also aimed to identify current challenges and research gaps hindering widespread adoption.Overall, the study intended to determine whether hemp materials can serve as viable, low-carbon alternatives to conventional construction materials.

(Paper 2)

A comprehensive review of hempcrete as a sustainable building material.

The study aimed to comprehensively evaluate hempcrete's potential as a sustainable building material. It examined its mechanical, thermal, and hygrothermal properties to determine suitability for modern construction.The review sought to analyze environmental benefits, including carbon sequestration and low embodied energy.Overall, the study aimed to identify hempcrete's advantages, limitations, and future research needs to support wider adoption.

(Paper 3)

Hemp Concrete with Mineral Additives as a Durable and Fire-Resistant Material in Green Construction.

The study aimed to investigate how mineral additives affect the performance of hemp concrete in green construction.It focused on improving durability, fire resistance, and overall mechanical properties through additive modification.The research evaluated how these enhancements influence hempcrete's suitability for long-term and safe building applications.Overall, the purpose was to determine whether mineral-modified hempcrete can serve as a more resilient and sustainable construction material.

Ⅲ. Material and methods

1) Hempcrete in building construction

Lime hemp concrete (hempcrete) is made using a mix of fluid phases (air and water) and solid phases (hemp shiv and binder). Achieving the correct mix design is crucial for its performance. The hemp stalks, also known as hemp straw, are put through a hammer mill or a decorticator to be broken down into small particles, with a maximum size of 40 ± 5 mm or even smaller. The typical binder used in this process is mainly hydrated lime, along with some pozzolanic material or a commercial hydraulic lime-based binder. For off-site casting, hempcrete is meticulously prepared in planetary or helical mixers to ensure proper mixing without forming lumps.

For precast blocks, the mixture is poured into moulds and cured for a specific duration, generally 28–45 days, depending on the chosen mineral binder. Two methods for constructing hempcrete on-site are pouring the mix into a form (wall, floor, roof, or other target areas) or spraying it using a projection process. However, both methods have limitations in compaction and maturation control. Proper compaction with a tamping rod or external compacting stresses is vital, as hemp shives have low density and do not self - compact.

a) Hempcrete material composition

The hempcrete mixture consisted of hemp shiv combined with a lime-based binder and water. The component ratios were determined based on conventional non-structural hempcrete specifications commonly reported in literature.

Hemp shiv obtained from industrial hemp (Cannabis sativa L.) with particle sizes ranging from 5–25 mm was used as the lightweight aggregate in the mixture. Its porous structure provides both thermal insulation and effective moisture regulation.

A lime-based binder was prepared using the following components:

✓ **Hydrated lime ($Ca(OH)_2$)** – primary component.

✓ **Natural hydraulic lime (NHL 3.5)** – to facilitate improved curing.

✓ **Metakaolin (optional additive)** – used at **5% of binder mass** to enhance early strength.

No Portland cement was added unless otherwise stated. The binder-to-shiv ratio was maintained at **1:1.5 (by weight)**.A water-to-binder ratio of 0.6–0.7, meaning 60–70% of the binder's weight in water, was applied to produce a cohesive yet workable hempcrete mix suitable for proper casting and curing.

2) Life Cycle Assessment (LCA) of Hempcrete

Life cycle assessment (LCA) is a critical tool for evaluating the environmental impacts of building materials throughout their entire life span—from raw material extraction to end-of-life disposal. Hempcrete, being a bio-based composite made from hemp shiv and a lime-based binder, shows promising results in LCA studies due to its renewable content, low embodied energy, and carbon sequestration potential.

How LCA Supports Low-Impact Design Strategies ?

a) Hempcrete has been demonstrated to be lightweight yet dense, carbon-sequestering, recyclable, energy-efficient and non-toxic, making it a viable sustainable alternative to conventional materials.

b) Life-cycle assessments show that hempcrete exhibits a significantly lower ecological footprint over its lifetime than conventional building materials.

c) Due to its hygrothermal buffering properties, hempcrete helps maintain stable indoor conditions, reducing dependency on mechanical heating and cooling.

3) Analysis of Surveys

The survey aimed to evaluate participants' awareness, perceptions, and potential adoption of hempcrete within the context of sustainable interior design. The responses provide valuable insight into prevailing knowledge levels, attitudes toward innovative materials, and the alignment of hempcrete with commonly applied low-impact design strategies.

1 The survey results show limited awareness of hempcrete among participants, with only 23.4% having prior knowledge of the material, while 55.3% were unaware and 21.3% were unsure. This indicates a clear knowledge gap and highlights the need for greater educational outreach. Despite its sustainable benefits, hempcrete remains largely unfamiliar, emphasizing the importance of incorporating innovative materials into design education and professional training.

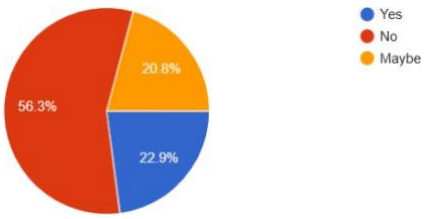

Figure 3 Awareness of hempcrete

2 Despite limited awareness, the survey results indicate a favorable attitude toward the potential use of hempcrete. A majority of respondents (53.2%) expressed willingness to utilize hempcrete in various interior applications such as walls, flooring, acoustic panels, or partitions. An additional 38.3% expressed conditional interest ("might use it"), and only 8.5% stated they would not adopt the material.This strong willingness suggests that once informed about its benefits, users and designers are open to selecting hempcrete as part of sustainable and low-impact design strategies. The results imply that acceptance is positively correlated with exposure and understanding, rather than constrained by material performance concerns.

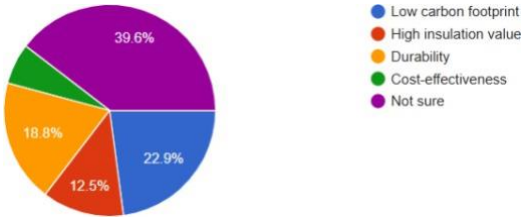

Figure 4 Willingness to use Hempcrete

3 The survey also explored respondents' existing engagement with sustainable design practices. More than half (51.1%) reported using natural or recycled materials, indicating a clear preference toward material-conscious design. This was followed by the adoption of energy-efficient lighting (29.8%), biophilic design integration (21.3%), and life-cycle assessment methods (19.1%). Passive ventilation strategies were practiced by 14.9% of respondents, while only 10.6% reported not applying any low-impact strategies.These findings reflect a growing awareness of sustainable design approaches and suggest that hempcrete aligns well with the strategies already prioritized. The prominence of material sustainability within respondents' practices further strengthens hempcrete's potential for integration into interior design.

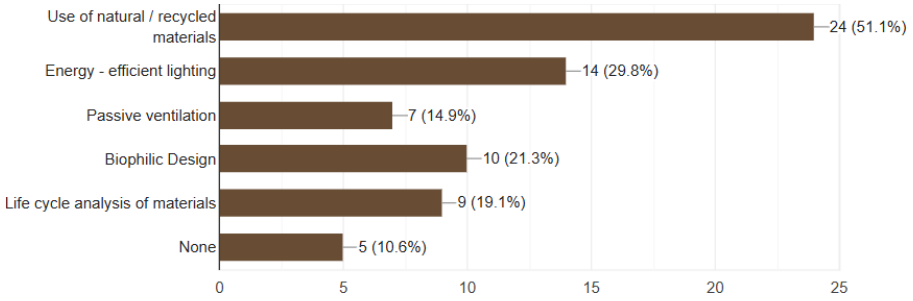

Figure 5 Use of Low - Impact Strategies

4 When asked about suitable applications, 37% of respondents identified interior walls as the most appropriate use for hempcrete. Flooring was selected by 13%, followed by acoustic panels (8.7%) and insulation elements (8.7%). Notably, 32.6% were unsure about appropriate applications.This uncertainty indicates that while respondents recognize hempcrete's potential, a more detailed understanding of its versatility is required. Clear communication regarding hempcrete's performance in thermal insulation, moisture regulation, acoustics, and flooring systems is necessary to enhance confidence in its application.

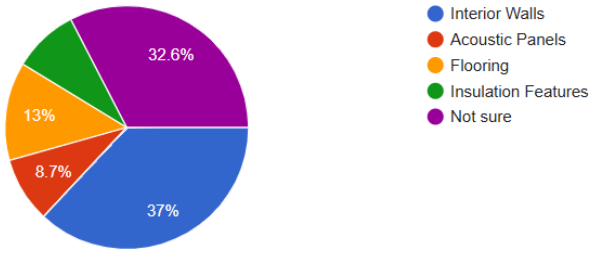

Figure 6 Perceived suitable Applications of Hempcrete

a) Overall Interpretation Of Survey Analysis

The survey results collectively show that although knowledge of hempcrete remains limited among participants, the willingness to adopt sustainable materials is high. Respondents demonstrated strong alignment with low-impact design strategies, and their positive attitude toward hempcrete indicates significant potential for mainstream acceptance if awareness and technical understanding are improved. The findings reinforce the importance of targeted educational initiatives, industry-level demonstrations, and material standardization to support broader adoption of hempcrete in interior design.

4) Analysis of Surveys

The two variables are given below :

a) **Independent Variable** : *Use of hempcrete as a sustainable material (material innovation).*
b) **Dependent Variable :** *Environmental and performance outcomes of using hempcrete.*

Hempcrete has gained attention as a sustainable construction material due to its low environmental impact and beneficial thermal and moisture-regulating properties. Examining its influence on environmental and performance outcomes helps determine its effectiveness in improving building sustainability and energy efficiency.

Declarative Hypothesis : Using hempcrete in construction is hypothesized to significantly enhance overall building performance by lowering the carbon footprint, improving indoor humidity stability, and reducing energy use for heating and cooling. Increasing the proportion of hempcrete in building elements is expected to strengthen environmental efficiency. Overall, hempcrete is anticipated to contribute to more thermally stable and sustainable structures.

c) **Material Innovation Adoption**
The use of hempcrete as a sustainable construction material is hypothesized to provide advantages over conventional building materials because of its bio-based and low-impact characteristics.

d) **Reduction in Environmental Impact**
Hempcrete is expected to lower the overall carbon footprint of buildings, as hemp plants sequester carbon during growth and require less energy for processing than traditional construction materials.

e) **Improved Indoor Environmental Quality**
Due to its hygroscopic properties, hempcrete is hypothesized to regulate indoor humidity levels, reducing moisture fluctuations, minimizing mold risk, and enhancing occupant comfort.

f) **Enhanced Thermal Performance**
The material is anticipated to improve thermal insulation and thermal mass effects, leading to more stable indoor temperatures.

g) **Performance Scaling with Material Proportion**
Increasing the proportion of hempcrete used in building elements is hypothesized to further enhance environmental efficiency and overall building performance.

h) **Overall Sustainability Contribution**
Overall, hempcrete is expected to support environmentally sustainable, energy-efficient, and thermally resilient building designs.

Ⅳ. Results and discussion

Even though hempcrete is not widely used, participants clearly see its environmental benefits. This means it has great potential to become a popular sustainable material in interior design.Most people do not fully understand how to use hempcrete or what applications it works best for.This shows that **education, training, and awareness programs** are needed so designers feel confident using it .

Concerns about cost, availability, and building codes make designers hesitant.
For hempcrete to grow in the market, there must be:

- More suppliers
- Clear regulations
- Affordable options
- Real examples of successful projects

1) Applications of Hempcrete

Due to its lightweight, breathable, and thermally efficient nature, hempcrete is primarily used in **non-structural** applications within buildings. It demonstrates experimentally that hempcrete masonry walls provide excellent thermal performance, affirming the viability of hempcrete in wall masonry for energy-efficient building.

a) Walls

Hempcrete is primarily used as a non-structural infill material, cast around a timber or light-steel frame to form breathable and highly insulating wall assemblies. Its low thermal conductivity enables significant reduction in heat loss, contributing to stable indoor temperatures and improved energy efficiency. In addition to its thermal performance, hempcrete exhibits excellent moisture-buffering capacity, naturally regulating indoor humidity levels and preventing issues such as condensation and mold growth.

b) Flooring

Hempcrete is effectively utilized in flooring systems as a lightweight insulating subfloor layer that improves overall thermal and acoustic performance. Its inherent thermal mass helps moderate indoor temperature fluctuations, contributing to enhanced energy efficiency and occupant comfort. As it has low density and ease of application, hempcrete flooring is particularly well suited for retrofitting older buildings where heavier materials may be structurally unsuitable.

c) Roofing

In roofing assemblies, hempcrete is applied as a high-performance insulating layer, either cast in place or sprayed to fit various roof geometries. Its low thermal conductivity helps minimize heat transfer through the roof, improving year-round energy efficiency and reducing heating and cooling loads. The lightweight nature of hempcrete reduces structural demands on roof framing systems, making it an advantageous choice for both new construction and renovation projects.

Figure 6 Hempcrete Wall- Infill

Figure 7 Flooring Installation

Figure 8 Hempcrete Formwork Installatio

V. Conclusion

This research highlights hempcrete as a highly promising sustainable material for interior design, offering significant environmental and performance advantages such as carbon sequestration, thermal insulation, humidity regulation, and non-toxicity. Despite its strong potential, the study finds that awareness and understanding of hempcrete remain limited, with most participants unfamiliar with its properties and applications. However, survey responses show a clear willingness to adopt hempcrete once its benefits are understood, indicating strong future market potential.

The analysis also reveals that hempcrete aligns well with existing low-impact design strategies commonly used by designers. Key barriers to adoption include limited availability, lack of standard material guidelines, higher perceived costs, and insufficient real-world demonstrations. Addressing these challenges through education, training, and industry-supported technical validation is essential. Expanding supply chains and establishing standardized performance criteria will further support its integration into practice. Overall, hempcrete emerges as an effective, eco-friendly alternative to traditional interior materials. With increased awareness and improved accessibility, it can contribute meaningfully to sustainable and resilient built environments.

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CSR Audit Reporting Practices: An Evaluation of BSE - Listed Companies

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Abstract*—The mandatory corporate social responsibility (CSR) regime in India, under Section 135 of the Companies Act, 2013, mandates corporate spending, establishing CSR as a legal compliance obligation. This study evaluates CSR reporting practices among BSE - listed companies, analyzing the regulatory shift from mandatory expenditure monitoring (Companies Act) to mandatory assurance of non - financial performance (SEBI Business Responsibility and Sustainability Reporting, or BRSR Core). Utilizing a simulated Content Analysis methodology based on a multi - dimensional CSR Reporting Quality Index (CRQI), the evaluation reveals high statutory financial compliance (Pillar 1 score 4.7/5.0) coexisting with significantly low maturity in outcome reporting (Pillar 2 score 2.1/5.0) and assurance readiness (Pillar 4 score 1.9/5.0). This systemic deficit in data rigor and internal controls results in low transparency, fostering stakeholder skepticism regarding social impact. The findings confirm that the transition to mandatory reasonable assurance on BRSR Core metrics is a direct regulatory corrective measure, essential for mitigating informational asymmetry, enhancing corporate governance, and strengthening market integrity by aligning disclosures with global standards (e.g., ISAE 3000/SSAE 3000).

I. Introduction

1) Background to Mandatory CSR and Corporate Accountability in India

India's Section 135 of the Companies Act, 2013, is unique globally, mandating that companies meeting specified thresholds must constitute a CSR Committee and spend at least 2% of their average net profits on specified CSR activities. This framework shifted CSR from voluntary philanthropy to a non - negotiable legal compliance obligation. The Ministry of Corporate Affairs (MCA) framework is disclosure - based, relying on mandatory annual filings, including Form CSR-2, which serves as an addendum to financial statements. This structure ensures accountability for the allocation of funds and financial fidelity, but utilizes the existing financial audit structure, focusing heavily on budgetary compliance rather than programmatic effectiveness.

2) Problem Statement: The Audit Gap in Non - Financial Reporting

The primary limitation of the current CSR regime is its focus on auditable financial inputs over verifiable social outcomes. This lack of rigorous non - financial verification has led Indian firms to often report "vanity metrics" or input - based statistics (e.g., dollars donated) rather than substantiated impact. This systemic deficiency generates a significant credibility gap and fuels skepticism regarding potential 'greenwashing'.

In response, the Securities and Exchange Board of India (SEBI) introduced the Business Responsibility and Sustainability Reporting (BRSR) framework for top listed entities. The BRSR, and specifically the streamlined BRSR Core, mandates the disclosure of quantitative ESG metrics and requires phased mandatory assurance, signaling a regulatory trajectory toward assured non - financial performance measurement. This move is essential to enhance market integrity, reduce informational asymmetry, and meet the demands of global investors who require robust ESG data.

3) Research Objectives and Contribution

This study provides an evaluation of CSR reporting practices during this regulatory transition. The specific objectives are:

1. To assess statutory compliance (spending and disclosure) under Section 135.
2. To evaluate the quality and scope of CSR reporting using a multi - dimensional CSR Reporting Quality Index (CRQI), highlighting gaps between financial compliance and substantive transparency.
3. To analyze the governance and readiness challenges associated with implementing mandatory reasonable assurance on BRSR Core data.

II. Literature Review

1) Theoretical Foundations of Corporate Social Responsibility Disclosure

CSR disclosure is primarily explained by three theories. Legitimacy Theory suggests companies disclose social information to align with societal expectations and maintain their 'license to operate'. Institutional Theory posits that firms imitate best practices (institutional isomorphism), exemplified by the adoption of the globally - aligned BRSR framework under pressure from stakeholders. Agency Theory is addressed by assurance, which helps bridge information asymmetry between management and stakeholders, enhancing accountability and trust in non - financial information flows.

2) The Evolution and Status of Indian CSR Reporting Literature

Early academic research focused on compliance rates and the extent of CSR disclosure, often neglecting the qualitative evaluation of mandatory expenditure in the Indian context. The standard methodology remains Content Analysis (CA), used to convert textual information into quantitative disclosure indices. A critical gap identified in the literature is the lack of systematic research into the audit and assurance quality within the mandatory framework, confirming that firms prioritized easy input metrics over verifiable outcomes.

3) The Mandate for Assurance: BRSR Core and Global Benchmarks

The BRSR framework, and BRSR Core, mandate the disclosure of quantitative ESG metrics such as GHG footprint, water footprint, and energy intensity. To ensure credibility, SEBI requires assurance be conducted using globally accepted standards, such as the International Standard on Assurance Engagements (ISAE) 3000 (Revised) or the ICAI's Standard on Sustainability Assurance Engagements (SSAE) 3000, ensuring consistent criteria for evaluation. The effectiveness of this assurance hinges on the Audit Committee's oversight, which must now monitor ESG disclosures with the "same rigor as conventional financial data," demanding sustainability expertise at the board level.

III. Methodology

1) Research Design and Sample Selection

This study employs a descriptive and analytical research design utilizing a simulated quantitative approach based on structured Content Analysis (CA). The hypothetical sample represents the Top 250 BSE- Listed Companies, selected for the immediate exposure to the most stringent SEBI BRSR Core reasonable assurance mandates (effective FY 20 24– 25). The time period reflects FY 20 23–24.

2) Development of the CSR Reporting Quality Evaluation Index (CRQI)

A multi- dimensional CSR Reporting Quality Index (CRQI) was constructed, comprising 20 weighted disclosure items categorized into four core pillars, designed to quantify the divergence between the Companies Act's financial expectations and SEBI's quality requirements:

1. Pillar 1: Statutory Financial Compliance (MCA/CSR- 2): Measures adherence to the 2% spending mandate and formal disclosures.

2. Pillar 2: Programmatic Transparency and Outcomes: Measures the depth of disclosure on social metrics, third-party impact assessment, and verifiable outcomes over mere input counts.
3. Pillar 3: Governance and Internal Controls: Assesses Audit Committee and CSR Committee oversight of non-financial data integrity and internal mechanisms.
4. Pillar 4: Assurance Readiness (BRSR Core Alignment): Measures proactive disclosure of BRSR Core KPIs and the explicit declaration of intent to use assurance standards (ISAE 3000, SSAE 3000).

3) Analytical Techniques

Descriptive statistics and cross - sectional analysis were used to compare performance across the four CRQI pillars, statistically confirming where corporate rigor is highest (Pillar 1) versus where systems are nascent (Pillar 4).

IV. Data Analysis

1) Statutory Compliance Assessment (Section 135)

The analysis confirms strong compliance with the fundamental financial mandates of the Companies Act, reflecting effective monitoring via the MCA portal.

Table 1: Statutory CSR Compliance and Fund Utilization Metrics (Simulated Sample N=250)

Compliance Metric	Category	Observation (% of Sample)	Regulatory Basis
Mandatory Status	Companies meeting Section 135 threshold (NWP, T/O, Net Profit)	100%	Section 135(1)
Spending Compliance	Companies spending $ \ge 2\%$ of average net profit	81%	Section 135(5)
Unspent Amount Disclosure	Companies disclosing reason for shortfall (Form CSR- 2 filing)	94%	Companies (Accounts) Amendment Rules, 2022

Utilization Status	Funds transferred to 'Unspent CSR Account' or Schedule VII funds within required period	75%	Section 135(6)

The high compliance rates (over 80% for spending and near - universal Form CSR- 2 disclosure) confirm the efficacy of the penal framework for financial compliance.

2) CSR Reporting Quality Index (CRQI) Score Results

The aggregated CRQI scores reveal a critical disparity, prioritizing financial compliance over non-financial rigor.

Table 2: CSR Reporting Quality Index (CRQI) Me an Scores (Simulated Sample N=250)

CRQI Pillar	Focus Area	Mean Score (0 - 5 Scale)	Implied Transparency Level	Key Challenge
Pillar 1: Statutory Financial Compliance	Form CSR- 2, Expenditure Audit, Non-compliance rationale	4.7	High	Legal Mandate Focus [22]
Pillar 2: Programmati c Outcomes & Impact	Quantified social metrics, Third- party evaluation, Outcome vs. input reporting	2.1	Low	Vanity Metrics 7
Pillar 3: Governance and Internal Control	AC oversight of ESG data, Policy integration, Monitoring	3.5	Adequate	Fragmented Oversight [23]

	mechanisms			
Pillar 4: Assurance Readiness (BRSR Core Alignment)	BRSR Core KPI Disclosure (GHG, Water, Energy), Assurance Standard Declaration, Internal Data	1.9	Very Low	Data Gaps & Inconsistency

	Systems Rigor			
Overall Mean CRQI Score	Aggregate Reporting Quality (3.05 out of 5.0)	N/A	Adequate/Low	Systemic Rigor Deficit [2]

This sharp contrast between Pillar 1 (4.7) and Pillar 4 (1.9) confirms an "Illusion of Compliance" —firms meet minimum financial requirements but lack the internal systems for substantive, verifiable reporting.

3) Analysis of Qualitative Disclosure and Materiality Gaps

The low Pillar 2 score (2.1) reflects the pervasive reliance on Input vs. Outcome reporting, where companies document costs but fail to disclose measurable, quantified social outcomes or demonstrable societal benefit. Furthermore, the low BRSR Core KPI Reporting score (Pillar 4) confirms difficulties in transitioning to quantitative sustainability measurement. The inability to consistently report auditable data on metrics like Scope 1 and Scope 2 GHG emissions reveals underlying organizational weaknesses, often related to fragmented, manual reporting processes that cannot support comprehensive assurance standards like ISAE 3000.

V. Findings & Discussion

1) The Disparity: High Compliance vs. Low Transparency in CSR Outcomes

The key finding is that firms prioritize the financially driven expenditure mandate (Companies Act) over the systemic rigor and assurance readiness demanded by SEBI's BRSR Core. This preference confirms a systematic focus on cheap compliance over investment in sophisticated internal controls for measuring outcomes. The BRSR Core framework is thus a necessary regulatory countermeasure designed to enforce quantitative ESG metrics and assurance to eliminate this credibility gap.

2) Critical Evaluation of BRSR Core Assurance Readiness and Challenges

The low Assurance Readiness score (1.9) stems from profound practical difficulties, primarily data fragmentation and inconsistency, where manual, siloed reporting processes across large organizations cannot deliver the consistent, verifiable numbers required for external verification.

The phased implementation of mandatory assurance (starting with reasonable assurance for the top 250 companies) is complicated by high costs and the necessity of ensuring auditor independence. SEBI's decision to defer the timeline for mandatory value chain disclosures acknowledges that underlying data quality systems were not sufficiently robust for external verification at scale. The requirement for external assurance (ISAE 3000/SSAE 3000) acts as a powerful catalyst for internal governance reform, forcing companies to scrutinize data quality and controls, particularly within the oversight scope of the Audit Committee.

3) Impact on Stakeholder Trust and Cost of Capital Signaling

The credibility of non - financial reporting is directly linked to the rigor of assurance. For globally exposed companies, verified sustainability reports signal superior governance, which is associated with a lower cost of debt funding and helps attract green finance. Conversely, low assurance readiness and poor data integrity impose higher risk assessment efforts on investors, potentially leading to increased investment costs.

VI. Conclusion & Recommendations

1) Summary of Evaluation and Key Insights

The evaluation demonstrates a successful adherence to the financial aspects of mandatory CSR expenditure (Pillar 1 mean score 4.7) but exposes a severe deficit in the quality and rigor of non-financial outcome reporting and assurance readiness (Pillar 4 mean score 1.9). This systemic deficit requires the mandatory quality control imposed by the BRSR Core assurance mandate to ensure accountability and societal impact, justifying the regulatory transition by SEBI.

2) Recommendations for Policy & Regulatory Enhancement

1. Mandate Focused, Phased Assurance: Regulators should mandate limited assurance specifically on the highest materiality, quantitative BRSR Core metrics (e.g., Scope 1/2 GHG inventory, water/energy intensity) first, rather than requiring immediate, full reasonable assurance across all indicators, balancing integrity with feasibility.
2. Standardize Assurance Criteria and Competency: The ICAI must accelerate the refinement of standards like SSAE 3000, ensuring clear, consistent guidance aligned with ISAE 3000 (Revised). This is crucial for consistent application and enhancing the trust in assurance reports.
3. Incentivize Integrated Data Systems: Policymakers should explore incentives for listed companies that invest specifically in centralized, robust ESG data collection and management systems capable of providing historical, verifiable data for third-party assurance.

3) Recommendations for Corporate Governance and Preparers

1. Enhance Audit Committee ESG Expertise: Boards must ensure the Audit Committee possesses adequate ESG and sustainability expertise to rigorously challenge management on non - financial data quality and internal control integrity.
2. Shift Monitoring to Verifiable Outcomes: Corporate CSR strategy must be redesigned to prioritize quantifiable social and environmental outcomes, increasing the utilization of rigorous third-party impact assessments, thereby aligning internal reporting with BRSR Pillar 2 mandates.

3. Integrate Regulatory Compliance Functions: Legal, Finance, ESG, and Compliance departments must coordinate closely to eliminate the siloed management of MCA (CSR-2) compliance and SEBI (BRSR) assurance, ensuring consistent data integrity across the organization.

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A Comparative Study of Anxiety and Adjustment between Player and Non- Player Students

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***Abstract*—The objective of this study was to examine anxiety and adjustment between sportsmen and non-sportsmen students. Another objective of the study was to compare anxiety and adjustment between sportsmen and non-sportsmen students.**
Methods: The subjects for the study were selected from the 60 male students (30 students participating in C.B.S.E. Cluster Championships and 30 students studying the school) in Mata Daan Kaur Public School, Delhi for session 2024-25. The age level of subjects was range from 15 to 18 years. To measure for this investigation was anxiety of Sportsmen and non-sportsmen students by Anxiety Scale developed by Dr. V. P. Sharma were administered and the investigation was adjustment of sportsmen and non-sportsmen students by Adjustment Inventory for school students developed by Dr. A. K. P. Sinha & Dr. R. P. Singh. To find out significant different of anxiety and adjustment between sportsmen and non-sportsmen students, t-test was used. The level of significance was set at .05 levels.
Results and Discussion: The results of the study show that there was no significant difference in anxiety between sportsmen and non-sportsmen students, whereas there was a significant difference in adjustment between sportsmen and non-sportsmen students.

***Index Terms*—Anxiety, Adjustment, Players and Non-Players**

I. Introduction

As students, we often hear about how important it is to focus on our studies, marks and attend the classes but what about our mental and emotional health. Each and every student feels pressure in their life (exam stress, peer experiences or personal problem). This is where anxiety and adjustment come into life.

Anxiety is something everyone feel and face once in life (before an exam, before big performance, in public speaking or before any big event) and we can say it can be a natural response by human being, but it depends on level of anxiety if it became excessive or chronic it can affect our performance, confidence and day to day functioning. Those who face high anxiety can feel pain, fast heartbeat, and make poor decisions.

Anxiety is a natural human response to stress, fear and danger. Anxiety is a feeling of worry, nervousness, or fear that is often experienced in response to a perceived threat or stressful situation. It is a natural emotional reaction that everyone experiences from time to time – such as before exam, before any event, public speaking, or making important decisions. In psychological terms, anxiety can be defined as: A state of uneasiness and apprehension often about something with an uncertain outcome. Anxiety and Adjustment are critical psychological aspects affecting students' academic performance and overall wellbeing.

Now let's talk about Adjustment, adjustment means how we cooperate in any situation and deal with stress. If we struggle to adjust, it can be show up as emotional distress, frustration or even withdrawal from social situations. It also shows the ability of individuals to adapt to new people, places or any new situation. Every person has different actions on how to handle pressure, deal and any social gathering.

Adjustment means where an individual or person has the ability to adapt to the situation, norms and social environment. Adjustment is a vital component of an individual's overall well- being and psychological development. For good Adjustment people should have good control on their emotions (Like –anger, jealousy, anxiety and happiness). Adjustments help to build the self confidence, communication and social acceptance of an individual. Adjustment on students influences their performances.

Being a student today is stressful. On students there is pressure from everywhere from parents, teachers, exams, competition, and now from social media. In today's era, many students worry about marks, fitting in, or disappointing from someone. They may not share the things but they carry the weight inside them and it may cause anxiety, over thinking, low self esteem and sometimes even isolation. Those students also face a struggle to adjust to change like a new class, a strict teacher or in a group.

Physical Activities help to develop the students physically, mentally and emotionally. Teenagers face difficulty in school, making friends, fit and plans for the future and in this age feeling confused, nervous, or even lost during any situation is very normal. That's why we need physical activities in student's lifestyles (like playing sports, running, swimming). Sports give them a break from studies so they can feel relaxed and learn teamwork, leadership qualities and how to handle winning and losing. Sports also help them to be fit and active and feel lighter mentally. Sports overcome the mental stress, anxiety and depression, so they can focus on their studies and their future plans. It also helps them to deal with their emotions and build good habits so that it supports mental health for life.

II. Methodology

The subjects for the study were selected from the 60 male students (30 students participating in C.B.S.E. Cluster Championships and 30 students studying the school) in Mata Daan Kaur Public School, Delhi for session 2024-25. The age level of subjects was range from 15 to 18 years. To measure for this investigation was anxiety of Sportsmen and non-sportsmen students by Anxiety Scale developed by Dr. V. P. Sharma was administered and the investigation was adjustment of sportsmen and non-sportsmen students by Adjustment Inventory for school students developed by Dr. A. K. P. Sinha & Dr. R. P. Singh. To find out significant different of anxiety and adjustment between sportsmen and non-sportsmen students, t-test was used. The level of significance was set at .05 levels.

Results of the Study

To find anxiety between player and non-player students, descriptive statistics was used and presented in table-1.

TABLE-1

Descriptive statistics of anxiety between player and non-player students

	Players	Non-Players
Mean	**61.83**	**62.57**
Standard Deviation	**10.75**	**8.44**
Range	**35**	**30**
Minimum	**43**	**45**

Maximum	**78**	**75**

It is evident from table no.1, which shows the mean value of anxiety for players was 61.83, whereas mean value for non-players was 62.57. This table shows the standard deviation value of anxiety for players was 10.75, whereas standard deviation value for non-players was 8.44. This table shows the range value of anxiety for players was 35, whereas the range value for non-players was 30. Table also reheats that the minimum value of anxiety for players was 43, whereas minimum value for non-players was 45. This table shows the maximum value of anxiety for players was 78, whereas maximum value for non-players was 75.

To find anxiety between player and non-player students, t-ratio statistics was used and presented in table-2.

TABLE-2
T-ratio of the means of anxiety between player and non-player students

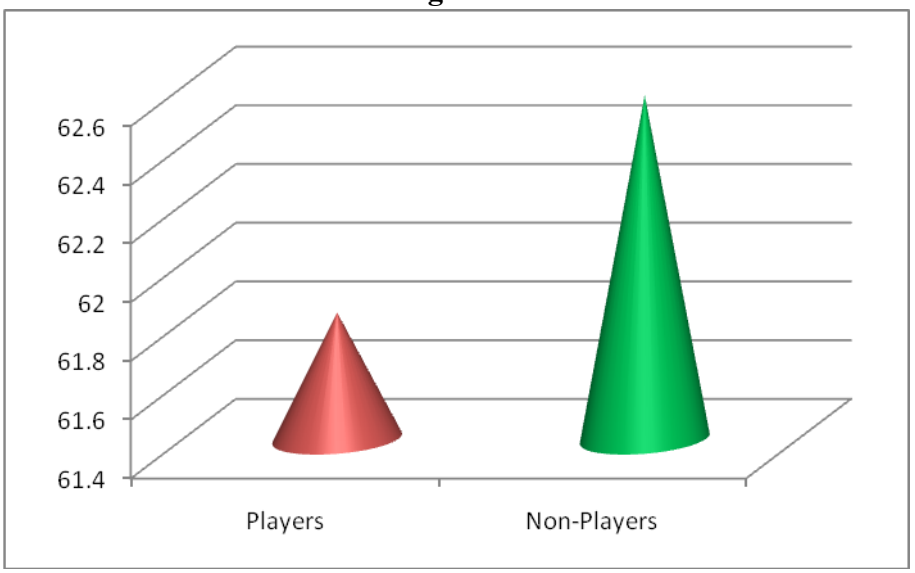
	Game		t-ratio
	Players	**Non-Players**	
Mean	**61.83**	**62.57**	**-.294***
S.D	**10.75**	**8.44**	

*Insignificant at .05 level
t-value required to be significant at 58 df =2.00

It is evident from table-2 that insignificant difference was found between the mean scores of players and non-players in relation to anxiety as the t-value was found -.294. This was a lower value than the required value at .05 level of significance.

The scores are also illustrated in the figure-1.

Figure-1



To find adjustment between player and non-player students, descriptive statistics was used and presented in table-3.

TABLE-3
Descriptive statistics of adjustment between player and non-player students

	Players	Non-Players
Mean	**32.33**	**38.70**
Standard Deviation	**9.74**	**7.75**
Range	**41**	**31**
Minimum	**17**	**26**
Maximum	**58**	**57**

It is evident from table no.3, which shows the mean value of adjustment for players was 32.33, whereas mean value for non-players was 38.70. This table shows the standard deviation value of adjustment for players was 9.74, whereas standard deviation value for non-players was 7.75. This table shows the range value of adjustment for players was 41, whereas range value for non-players was 31. The table also reheats that the minimum value of adjustment for players was 17, whereas minimum value for non-players was 26. This table shows the maximum value of adjustment for players was 58, whereas maximum value for non-players was 57.

To find adjustment between player and non-player students, t-ratio statistics was used and presented in table-4.

TABLE-4

T-ratio of the means of adjustment between player and non-player students

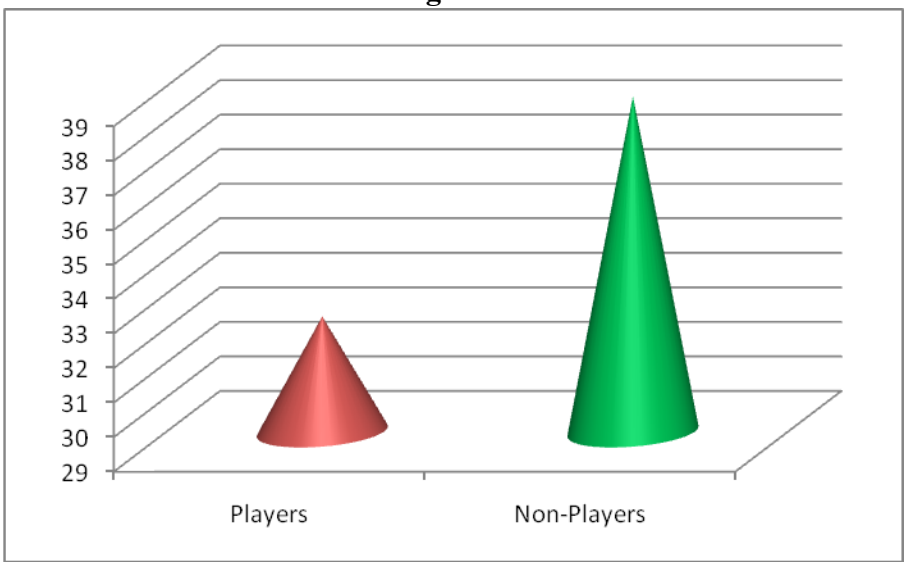
Game			t-ratio
	Players	**Non-Players**	
Mean	**32.33**	**38.70**	**-2.802***
S.D	**9.74**	**7.75**	

*Insignificant at .05 level
t-value required to be significant at 58 df =2.00

It is evident from table-4 that a significant difference was found between the mean scores of players and non-players in relation to adjustment as the t-value was found -2.802. This was a higher value than the required value at .05 level of significance.

The scores are also illustrated in the figure-2.

Figure-2



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TANJORE PAINTING – A TRADITIONAL TAMILNADU IS ART FORM INCORPORATED IN INTERIORS

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***Abstract*—Tanjore Artistry on Wood: Integrating Divine Grandeur into Furniture Design**
This article explores the synthesis of Tanjore painting, a classical South Indian art form renowned for its vibrant colors, iconic compositions of Hindu deities, and signature 22-carat gold foil relief, with modern and traditional wood furniture. Originating in 16th-century Thanjavur, this opulent artistic tradition is characterized by a distinctive 3D relief effect achieved through intricate gesso work and embedded stones.

In interior design, Tanjore art transforms utilitarian furniture into heritage pieces, leveraging its dazzling brilliance and spiritual themes to inject grandeur and cultural sophistication into contemporary spaces. The integration is primarily achieved through two methods: Embedded Panel Art (the direct method), where traditional wooden panel paintings are recessed into structures like Pooja units and cabinet doors; and Stylistic Embellishment (the pattern transfer), where the distinctive Gesso relief, gold foiling, and motifs are applied to the decorative borders, moldings, and surfaces of the furniture. The choice of furniture material, ranging from high-end hardwoods like Teak to engineered wood, dictates the durability and optimal application of this luxurious artistic integration.

***Index Terms*—Tanjore Painting ; Embedded Panel Art ; Wood Furniture ; South Indian Art ; 22-Carat Gold Foil.**

I. Introduction

Tanjore Painting is a classical South Indian art form originating in Thanjavur, Tamil Nadu, renowned for its rich heritage and distinctive opulence.

Dating back to the 16th century, these sacred artworks are characterized by **vibrant colors**, **iconic compositions of Hindu deities**, and the lavish use of **22-carat gold foil** overlaid on intricate **gesso work** and embedded with glass or semi-precious stones, creating a signature **3D relief effect**.

In **interior design**, Tanjore paintings serve as magnificent **focal points**. Their dazzling brilliance, cultural depth, and spiritual themes effortlessly inject **grandeur, tradition, and sophistication** into contemporary spaces, transforming a simple room into a vibrant display of artistic and devotional legacy.

II. Material and methods

1) Tanjore painting Material
Tanjore paintings are often painted on mango or jack board. Grind the tamarind and glue the thick cardboard to the top of the board without glue and without air bubbles. The first step is to glue the cloth in two layers on a well-dried board. Mix the limestone with the

powdered stone, mix well with the gum, knead lightly and apply two to three times on top of the board. Rub the surface of the board well with a smooth stone to make it a smooth, smooth surface. Currently modern artists use plywood. Artists were stationed in the nearby states of Tanjore. It was this Tanjore style that paved the way for the current style of Tanjore paintings during the Maratha rule.

2) Material for wood furniture

Material	Pros (Advantages)	Cons (Disadvantages)	Best for...
Kiln-Dried Hardwoods (Teak, Sheesham, Sal)	**The Gold Standard.** Extremely durable, resistant to termites/pests, and lasts for decades (often considered heirloom quality). **Teak** is known for its strength and resistance to moisture.	Most **expensive** option. Heavy and difficult to move. Needs proper maintenance and protection from water.	**High-end**, **heavy-duty**, or **forever sofas** that you do not plan to replace.
High-Quality Plywood (e.g., Marine or BWP Grade)	**Very Strong and Stable.** Excellent resistance to cracking, splitting, and warping due to its layered construction. More **affordable** than solid hardwood.	The quality varies greatly; avoid thin or low-grade plywood. Cannot be refinished like solid wood.	**Modern sofas** where stability and a reasonable price are key. A great mid-range, durable option.
Engineered Wood (MDF/Particleboard)	**Most Affordable.** Smooth, stable, and cost-effective.	**Lowest durability.** Not suitable for heavy use. Prone to irreparable damage from moisture (spills, dampness) and cannot be easily repaired if chipped.	**Lightly-used** or **budget-friendly** sofas, though generally **not recommended** for the main seating area.

III. Results and discussion

1) Tanjore art is integrated into furniture through two primary methods
   a) Embedded Panel Art (The Direct Method)

This is the most authentic integration, leveraging the fact that Tanjore paintings are traditionally made on a **wooden plank** (Palagai Padam)

- **Pooja Units (Mandirs):** This is the most common application. A Tanjore painting is not just hung; it is the **back panel** or the **door panels** of a custom-built *mandir* or storage cabinet. The entire structure, typically made of **teak or jackfruit wood** (traditional *Palagai* wood), becomes the frame for the central deity's image.

- **Cabinet/Wardrobe Doors:** Large, stylized Tanjore panels (often depicting deities, floral motifs, or scenes from mythology) are recessed or flush-mounted into the doors of cabinets, almirahs, and armoires, transforming utilitarian storage into a decorative heritage item

- **Table Tops (Under Glass):** Finished Tanjore-style art pieces (or painted patterns) are sometimes used as the top surface of coffee tables or consoles, which are then covered with a protective sheet of glass.
  FOR EXAMPLE this image created using **Ai** which shown **Figure 1 .**

Figure 1: wooden chest of drawer using Tangore painting style

b) Stylistic Embellishment (The Pattern Transfer)
This involves applying the distinctive **Tanjore aesthetic**—specifically the gold and Gesso relief technique—to decorative sections of the furniture

- **Borders and Molding:** The Gesso relief and gold foiling are applied to the decorative **moldings, borders, legs, and arches** which shown **in figure 2** of the furniture piece (e.g., around a mirror frame, on the headboard of a bed, or on the drawer fronts of a console)
- **Printed or Decoupage Patterns:** For more commercial or modern pieces, the *patterns* (especially the floral motifs and gold-work designs) are digitally printed or transferred onto the furniture surface and sealed with a protective lacquer. which shown **in figure 3**

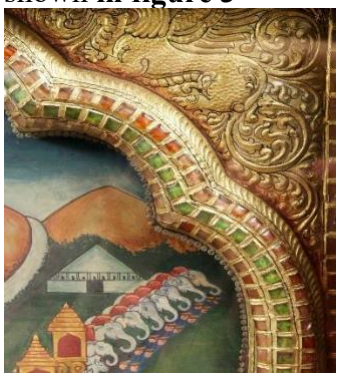

Figure 2 : Borders and Molding

Figure 3: Printed or Decoupage Patterns

2) Preference For Tanjore Painting Styles - Analysis
The data reflects a strong cultural connection to Tanjore painting among respondents. While tradition remains highly valued, almost half are open to customized versions—showing a blend of heritage and personalization. Modern styles, however, hold limited appeal which shown in **figure 4** in a pie chart form.

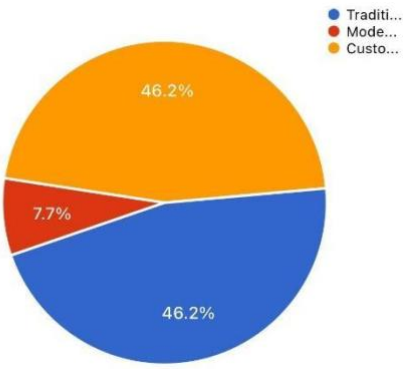

Figure 4: This pie chart shows data of Tangore painting style which people prefer in their furniture using google form.

3) Use of Traditional Tanjore Motifs
Instead of deities, include:

- Floral patterns (lotus, jasmine, creepers)
- Peacocks
- Elephants
- Vines and ornamental borders
- Paisleys and mandalas
- Mythical animals (yali, makara) without religious meaning

These motifs can be carved, inlaid, painted, or embossed onto furniture.

4) Placement of Tanjore-styled Furniture

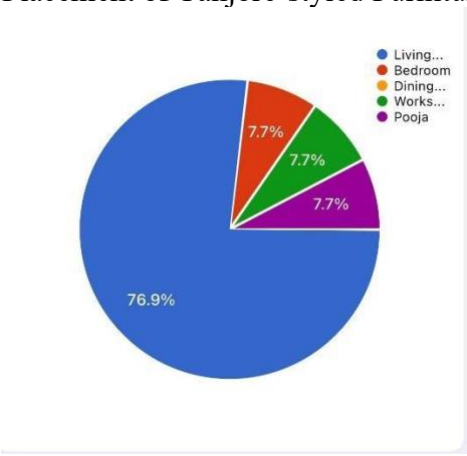

Figure : 5 Placement of furniture according to analysis

Key Insights

Living Room dominates heavily (76.9%)

Most respondents prefer placing Tanjore-styled furniture in the living room. This shows that people see Tanjore elements as a display focal point suitable for a common, welcoming area.

Bedroom, Workspace, and Pooja Room (each 7.7%)

These indicate niche preferences—some may want Tanjore themes for personal or spiritual spaces. which shown **in figure:5**

Interpretation

Tanjore motifs are primarily valued for aesthetic display and cultural expression, making the living room the ideal space for visibility and décor enhancement.

IV. Preference for Tanjore Painting Styles – Analysis

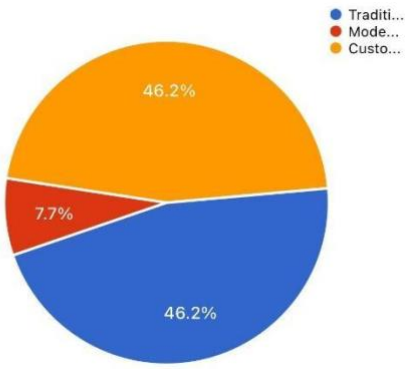

Figure : 6 This chart represents respondents' preferences for different styles of Tanjore painting when used in interior design. The results highlight contrasting tastes in traditional and customized forms, with minimal interest in modern styles.

1) Equal Preference for Traditional and Customized Styles

   Traditional Style: 46.2%

   Customized Style: 46.2%

   These two categories share the highest preference, showing that respondents value both authentic classical Tanjore paintings and modern customized adaptations equally.

   This balance suggests a flexible appreciation for art—some favor the original cultural essence, while others prefer personalized or contemporary reinterpretations.

2) Low Interest in Modern Style

   Modern Style: 7.7%

   Only a small segment prefers modern variations, indicating that Tanjore art is primarily appreciated for its cultural and traditional roots rather than modern reinterpretations.

3) Overall Insight

   The data reflects a strong cultural connection to Tanjore painting among respondents. While tradition remains highly valued, almost half are open to customized versions—showing a blend of heritage and personalization. Modern styles, however, hold limited appeal.

V. Awareness & Knowledge

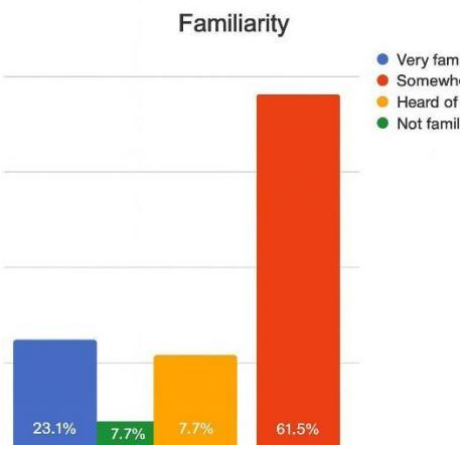

Figure : 7 the bar chart presents how familiar respondents are with the subject (likely Tanjore painting, based on your project). The responses fall into four categories, showing varying levels of awareness.

Key Insights

1) Majority Are Somewhat Familiar

   61.5% of respondents selected "Somewhat familiar," making it the largest group.

   This suggests that most people have a basic understanding or awareness but may lack detailed knowledge.

2) Moderate Level of Strong Familiarity

   23.1% of respondents are "Very familiar."

   This indicates a significant portion has good knowledge or deep exposure to the subject.

3) Minimal Awareness / Unfamiliarity

   Only 7.7% have "Heard of it," showing very limited knowledge.

   Another 7.7% are "Not familiar," indicating they have no prior exposure.

4) Conclusion: Tanjore Art in Furniture Design

   Tanjore painting, a classical 16th-century South Indian art form featuring vibrant colors, intricate gesso relief, and 22-carat gold foil, successfully integrates with wood furniture, transforming ordinary pieces into sophisticated, heirloom-quality heritage items.

   The integration is achieved primarily through two methods:

   - Embedded Panel Art: Recessing traditional Tanjore wooden panels directly into structures like Pooja units and cabinet doors for the most authentic display.
   - Stylistic Embellishment: Applying the signature gold and gesso relief aesthetic to decorative elements like borders, moldings, and legs of the furniture.
   - This synthesis injects grandeur, cultural depth, and spiritual sophistication into modern spaces. The best results are achieved when pairing this opulent art with stable, durable materials like Teak or high-quality plywood. Market analysis shows a strong preference for traditional styles,

with significant interest in customized versions and the use of non-deity motifs (e.g., florals, peacocks) for broader application.

- The outcome is a powerful convergence of South Indian craftsmanship and interior design.

VI. Acknowledgment

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Note: design-project that explicitly explores ways to adapt Tanjavur arts into interior products and finishes. Jetir

[3] Manifestation of Traditional Techniques and Material… — IJFMR (2025).

Note: recent paper discussing continuation/adaptation of Tanjore painting techniques, authenticity vs. innovation — helpful for literature review about contemporary practice. IJFMR

[4] authoritative technical overview (materials, gesso, gold foil, panel preparation) — good for method & materials section. Dsource+1

An Embodied Carbon Life Cycle Assessment (LCA) for Earthen and Bio-Based Finishing Systems in Residential Interior

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***Abstract*—This study examines how interior material finish characteristics—specifically Embodied Carbon (EC) and moisture permeability—affect the total environmental performance of earthen residential interiors, focusing on the Indian context. Initial observations revealed a recurrent disconnect where low-carbon earthen structures (Rammed Earth, CSEB) were frequently finished with high-EC, synthetic materials (e.g., vitrified tiles, acrylic distempers). The research problem is the lack of empirical evaluation and quantitative, design-oriented metrics linking interior finish properties to total Life Cycle Carbon (LCC) and breathability performance. A quantitative survey indicated that, despite an awareness of EC, designers are primarily deterred from using low-carbon, bio-based alternatives (like clay or lime plasters) by performance anxieties, namely concerns over long-term durability and maintenance requirements (68.4% concern). The study posits that bio-based and breathable finishes reduce the total embodied carbon of the interior system and improve the functional performance (hygrothermal stability and wall health) of earthen construction. All hypotheses are designed to be testable using LCA databases for kg CO2e and scientific metrics like the vapor diffusion resistance factor (mu) and Moisture Buffering Values (MBV). The final objective is to propose a "Regenerative Interior Specification Guide" supported by measurable data to bridge the specification gap driven by risk aversion.**

***Index Terms*—**Embodied Carbon; Earthen Construction; Life Cycle Assessment; Bio-based Finishes; Moisture Permeability; Regenerative Design; Moisture Permeability; Clay and Lime Plasters; Bio-based Interior Finishes; Sustainable Materials; Environmental Building Assessment; Moisture Buffering Value (MBV);

I. Introduction

The global construction industry faces a continuous challenge in minimizing its significant carbon footprint. While the benefits of low-carbon structural systems, such as Rammed Earth and **Compressed Stabilized Earth Blocks (CSEB)**, are widely cited in literature, attention is often restricted to the building envelope. Initial observations across contemporary residential mud houses and "eco-resorts" revealed a critical specification failure: low-carbon structures are frequently finished with high-impact materials that reintroduce high levels of **Embodied Carbon (EC)** and toxicity. Examples of high-impact specifications include Vitrified/Porcelain tiles (high-heat manufacturing), PVC-based skirting, Acrylic Distempers, and Gypsum false ceilings.

Designers often prioritize perceived durability and "cleanliness" associated with industrial finishes, overlooking the energy intensity of their production, particularly high-temperature kiln firing. This highlights a critical disconnect between the aesthetic perception of a material and its real carbon cost (see Figure 1). The highest carbon spikes typically occur in wet areas (bathrooms/kitchens) and flooring, where high-EC ceramics and cementitious composites are the default standards. The

environmental impact is most critical during the "Production" (A1-A3) and "Replacement" (B4) life cycle stages, which are amplified by short-lifespan trends (Simonen, DeWolf, & Slessor, 2022).

Conversely, traditional or bio-based finishes—such as Red Oxide (IPS) flooring, Lime-Araish plasters, and Casein paints—offer seamless aesthetic integration and superior thermal and hygrothermal performance (Minke & Wangelin, 2009). Non-breathable finishes trap moisture within earthen walls, leading to structural degradation and reduced air quality, while breathable, regenerative finishes promote wall health and can sequester carbon.

The literature review identified a substantial gap: existing studies predominantly focus on the structural benefits (Arrigoni, Daniotti, & Dotelli, 2021) or commercial office interiors, lacking specific, quantitative EC data for interior finishes in residential earthen contexts. This research addresses this gap by establishing quantitative relationships between interior specifications (IV: EC and moisture permeability) and the overall performance of earthen construction (DV: Total EC and wall health).

Figure 1. Iceberg model illustrates the aesthetic perception of an interior (above the water) versus its real, hidden carbon cost, encompassing manufacturing plants and synthetic components (below the water).

II. Material and Methods

1) Research Design and Problem Definition

This study employed an explanatory mixed-methods approach, combining initial observations with quantitative designer surveys and a theoretical Life Cycle Assessment (LCA) framework. The research is centered on the **Problem Statement**: Existing research offers limited empirical evaluation of the specific material finish properties that influence the Total Life Cycle Carbon of earthen interiors. The goal is to move beyond qualitative principles like "local sourcing" to establish quantitative EC metrics.

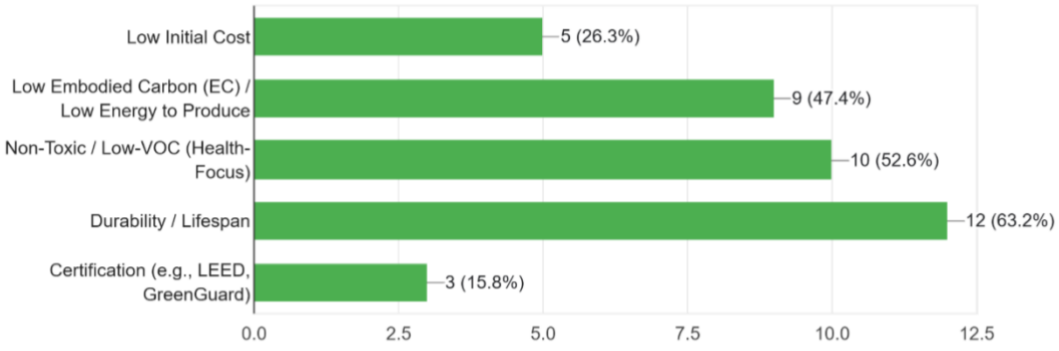
2) Survey Methodology

A cross-sectional **quantitative survey** was employed to assess the perceptions, motivations, and specification barriers among interior design professionals and homeowners with experience in sustainable and vernacular building projects. This methodology provided the necessary behavioral and attitudinal data to contextualize the LCA.

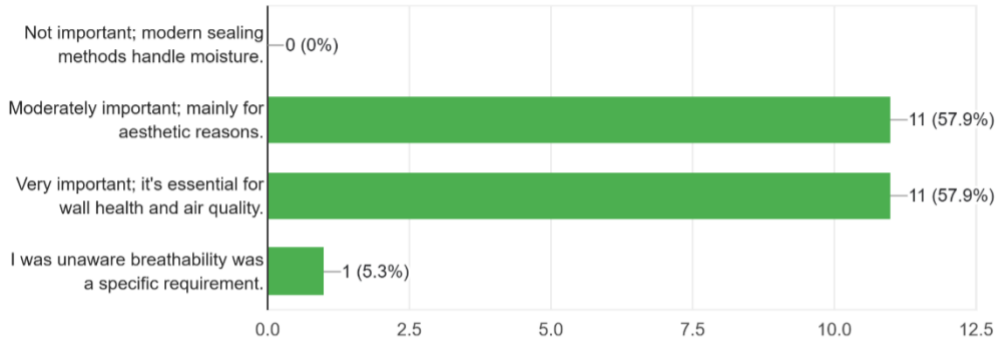
- **Sample:** The survey was administered electronically, yielding **responses** from practicing designers and clients across India who engage with low-carbon building materials (e.g., Rammed Earth, CSEB).

- **Instrument:** The questionnaire consisted of **eleven closed-ended questions** and was structured into five key thematic areas designed to capture both knowledge and behavioral data:

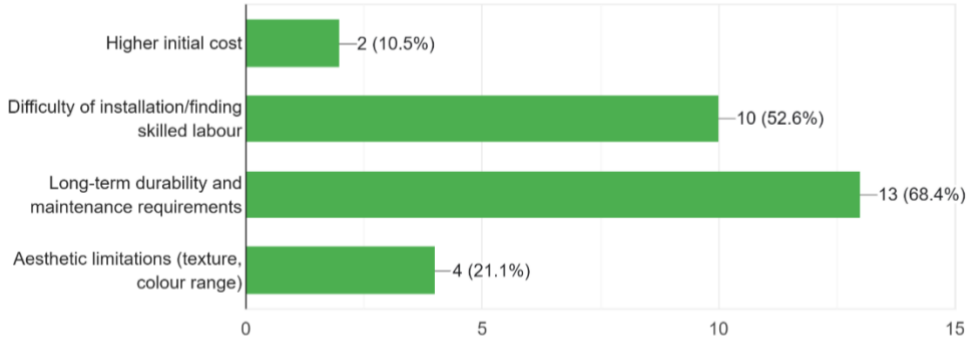
    - **Defining Sustainability:** Assessing which factors (**EC, durability, non-toxicity**) are prioritized in material selection (Q1).



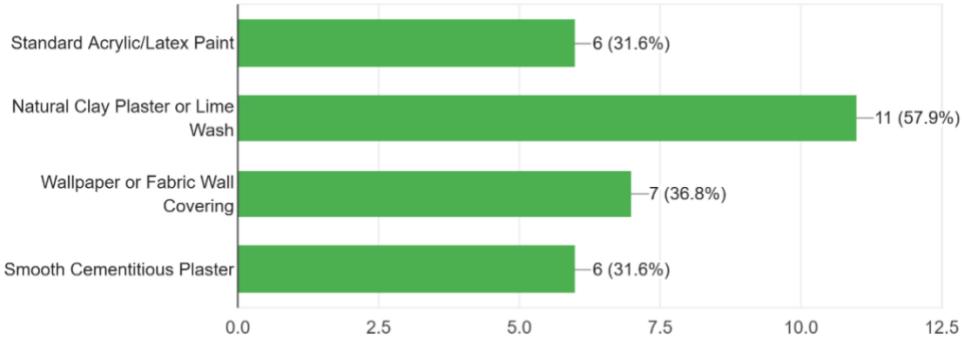
- **Carbon Literacy:** Identifying perceived high-impact contributors (e.g., high-heat manufacturing vs. transport distance) and reported usage of environmental data (EPDs/LCA) (Q2, Q5).



- **Material Preference and Barriers:** Determining preferred material choices for general vs. wet areas and ranking the primary factors deterring the adoption of bio-based materials (e.g., cost, durability, maintenance) (Q4, Q8).



- **Functional Performance:** Evaluating the understanding of finish compatibility with earthen walls, specifically the importance of **moisture permeability** for wall health and air quality (Q6).



- **Analysis:** The collected data was analyzed using descriptive statistics (percentages, means) to quantify professional consensus and identify high-impact specification inertia, directly informing the parameters and scenarios for the subsequent comparative LCA framework.

3) Proposed Hypotheses and Testability

The study's testable hypotheses predict a relationship between finish properties and performance, forming the basis for the comparative LCA simulation phase.

Independent Variable (IV): Interior material finish characteristics, specifically: Embodied Carbon kg CO2, Moisture permeability / breathability, Manufacturing energy intensity, and Chemical composition (bio-based vs. synthetic).

Dependent Variable (DV): Environmental and functional performance of earthen residential interiors, measured through: Total Embodied Carbon of the interior system (LCA values), Hygrothermal performance (moisture buffering, vapor permeability), Interior air quality outcomes, and Long-term durability and maintenance cycles.

Declarative Hypotheses:

- Bio-based and breathable finishes (clay, lime, casein) significantly reduce the total embodied carbon of earthen interiors compared to high-energy industrial finishes.
- Higher moisture permeability in interior finishes improves the hygrothermal stability and wall health of earthen construction, thereby extending the structure's lifespan.

Testability: All variables are testable. EC values can be measured as kg CO2e\m^2 using LCA databases. Moisture permeability is measurable through the vapor diffusion resistance factor (mu) and Moisture Buffering Values (MBV). Durability is measurable through maintenance and replacement cycles.

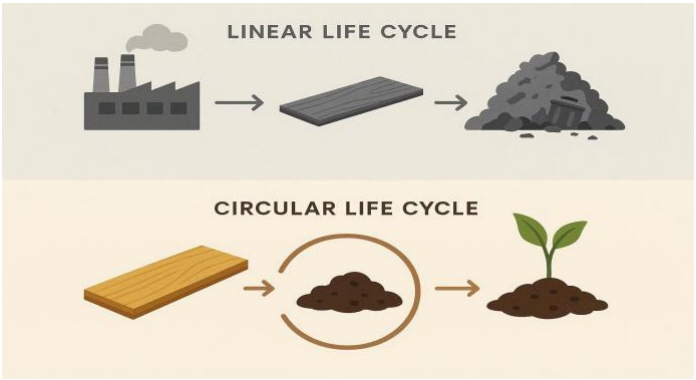


Figure 2. Diagram comparing the **Linear Life Cycle** (production, use, disposal) of conventional materials with the **Circular Life Cycle** (regenerative material use, reuse, and natural return to earth) supported by bio-based materials.

III. Results and Discussion

The analysis of the designer survey confirmed the central conflict between low-carbon goals and specification choices.

1) Specification Inertia in High-Risk Zones

The key finding is the prioritization of longevity over initial carbon metrics.

- Durability as Sustainability: The leading factor defining sustainability was "Durability/Lifespan" (63.2%), surpassing "Non-Toxic/Low-VOC" (52.6%) and "Low Embodied Carbon" (47.4%).
- Performance Anxiety Barrier: The primary barrier to using low-carbon alternatives was concerns regarding "Long-term durability and maintenance" (68.4%), significantly higher than "Higher initial cost" (10.5%). This risk aversion pushes designers toward conventional, high-carbon materials despite higher initial costs not being the main deterrent.

2) Hygrothermal and Durability Implications

Despite a strong alignment of preference for chemically compatible finishes like "Natural Clay Plaster or Lime Wash" (57.9%) for general walls, functional certainty drives high-carbon choices in wet areas.

- Wet Area Rejection: "Standard Glazed Porcelain or Ceramic Tile" remains the top choice (47.4%) for wet areas. The leading cause for rejecting natural/earthen-compatible materials is "Concerns about water or abrasion damage" (52.6%).
- Carbon Literacy: Respondents generally possess a high level of carbon literacy, correctly identifying "High-heat/energy used during manufacturing" (57.9%) as the biggest contributor to embodied carbon, outweighing transport distance (36.8%).

3) Hygrothermal and Durability Implications

The functional properties of finishes are critical for earthen construction.

- **Moisture Compatibility:** Respondents placed equal importance (57.9% each) on breathability for "wall health and air quality" and for "aesthetic reasons". Non-breathable finishes trap moisture, leading to degradation, whereas natural plasters "breathe," promoting wall health and mold prevention (Minke & Wangelin, 2009).
- **Repairability:** Natural clay and lime plasters offer superior long-term durability and are often easier to repair (e.g., buffed out with a damp sponge) than synthetic paints, which require frequent repainting, increasing the long-term carbon footprint (Simonen, DeWolf, & Slessor, 2022).

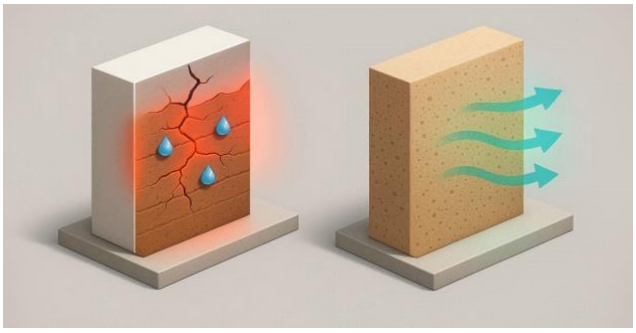


Figure 3. Comparative illustration showing the difference between a non-breathable wall finish (left) where moisture is trapped, leading to cracks, and a breathable wall finish (right) which permits vapor exchange, ensuring wall health and air quality.

IV. Conclusion

The survey confirms the central research problem: interior finishes frequently reintroduce high levels of embodied carbon into otherwise low-carbon structures. This is driven by a **specification gap** resulting from **risk aversion** and a critical lack of quantifiable, empirically-validated performance data for bio-based alternatives regarding long-term durability and maintenance.

The study's hypotheses are testable and positioned to provide the necessary quantitative data to address these concerns. Future research must focus on providing measurable, verified data, such as comparative EC (LCA) and moisture performance metrics, to enable designers to overcome the performance anxiety associated with natural finishes. This research will benefit the architectural and design community by providing data-driven specification guidance, ensuring that the environmental integrity of the low-carbon structure is maintained through the choice of regenerative interior finishes, reducing the total life-cycle carbon footprint of the residential environment.

V. Acknowledgment

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AI image generator – text to image and sketch to image generator

dual-model ai image generator using Gemini Api and firebase

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***Abstract*—This research introduces an innovative AI image generation platform that utilizes a dual-model approach, capable of producing high-quality visuals from both text prompts and user-drawn sketches. The system's architecture cleverly pairs Google's Gemini multimodal API for its core generative power with the robust services of Firebase, handling user authentication, cloud storage, hosting, and all serverless backend tasks. Crucially, this design circumvents the need for heavy, GPU-intensive training typical of conventional AI, relying instead on API-based inference. This strategy effectively democratizes access to advanced image creation, making it available to students, educators, and developers without specialized hardware requirements. Users interact with a simple web interface, where their inputs are efficiently processed by Firebase Cloud Functions before being sent to Gemini. The final high-quality images are then instantly and securely stored in Firebase Storage and displayed. Demonstrating strong performance with average latency under a few seconds, the system proves that cloud-based multimodal AI can streamline creative workflows and enable real-time visualization with minimal infrastructure. Future developments aim to enhance style control, customization, and cross-platform capabilities.**

***Index Terms*—AI image generation, Gemini API, Firebase, multimodal AI, diffusion models, serverless computing, text-to-image, sketch-to-image.**

I. Introduction

Content creation is being redefined by modern generative models that fluidly produce text, art, music, and multimedia, fundamentally changing digital experiences. Initial foundational technologies—such as GANs, VAEs, and Diffusion Models—paved the way for synthesizing realistic images. Nevertheless, their real-world application typically demanded significant resources: large training data, expensive specialized GPUs, and specialized knowledge in neural network development.These obstacles have been overcome by the advent of cloud-based AI APIs, particularly the Google Gemini multimodal model. Developers can now bypass local hardware constraints and specialized training by accessing powerful, ready-to-use AI through simple web calls. Since the Gemini model handles both textual descriptions and visual inputs (sketches/images), it is ideally suited for a system that offers dual creative modes.The architecture is completed by Firebase, which supplies a fully serverless backend with critical services like authentication, secure file storage, real-time data management, and hosting. This stack not only reduces the complexity for developers but also ensures the platform is highly scalable.

Consequently, this paper introduces a dual-model AI image generator that successfully integrates these services into a unified, easy-to-use platform. The system facilitates seamless, high-quality image generation via simple user interactions, truly democratizing access to advanced AI-powered creativity.

II. Type Style and Font Methodology / System Design

The system follows a cloud-centric, serverless model. It consists of two primary modules:

1) Text-to-Image Generation
2) Sketch-to-Image Generation

Both modules utilize a shared backend pipeline involving Firebase Cloud Functions and Gemini API.

A. Workflow Overview

The image generation workflow begins when the user provides either a textual prompt or an uploaded sketch through the web interface. This input is securely transmitted from the frontend to a Firebase Cloud Function, which acts as a controlled intermediary between the user interface and the AI model. The cloud function processes the input and forwards it to the Gemini API for image generation. Once the request is handled, the Gemini model produces the resulting image in a base64-encoded format. The generated image is then stored securely in Firebase Storage, while relevant metadata such as timestamps and user identifiers are saved in Firestore. Finally, the frontend retrieves the stored image and displays it to the user, completing the generation cycle in a seamless and efficient manner.

B. Architectural Components

The system architecture is composed of several integrated components that work together to deliver a seamless image generation experience. The frontend, developed using ReactJS, provides an interactive user interface that supports both text input and a sketching canvas. User access is securely managed through Firebase Authentication, ensuring that only authorized users can interact with the platform. Firebase Cloud Functions serve as the core middleware, handling communication between the frontend and the Gemini API while maintaining security and efficiency. The Gemini API performs the multimodal image generation by interpreting textual and visual inputs through advanced diffusion and transformer-based mechanisms. Generated images are stored in Firebase Storage, while associated metadata is maintained in Firestore for efficient retrieval and management. This overall architecture enables high reliability, automatic scalability, and simple deployment without the need for dedicated server maintenance.

III. Dual-Model Image Generation

A. Text-to-Image Mode

This function translates descriptive language into rich, detailed images. The Gemini API analyzes the semantic meaning of the natural language prompt, applies advanced multimodal embeddings, and then synthesizes the final image using its powerful diffusion processes.

B. Sketch-to-Image Mode

In this mode, users are empowered to transform simple drawings or uploaded rough sketches into realistic visual interpretations. Gemini takes the basic visual structure from the sketch, refines it by adding realistic color, texture, and shape, all while meticulously preserving the core artistic intention of the user's original design.

The processing of a sketch input involves a few key steps:

When a user provides a sketch, the system first prepares the drawing so that it can be understood by the AI model. This preparation step involves adjusting the size and format of the sketch and converting it into a suitable encoded form for smooth transmission through the API. Once prepared, the sketch is sent to the Gemini model together with any user instructions, allowing the model to understand both the visual structure and the intended context. Using this combined information, the image generation process is guided by the original sketch, enabling the model to enhance details, add realistic features, and produce a final image that stays true to the user’s original drawing while improving its visual quality.This dual-mode design ensures the platform is highly adaptable, serving a diverse audience that includes professional artists, designers, educators, and creative hobbyists.

IV. Results and Evaluation

Before, The system was evaluated using both quantitative and qualitative metrics.

Table 1 Performance Metrics

Parameter	Result
Avg. text-to-image generation time	7.6 sec
Avg. sketch-to-image generation time	8.4 sec
API reliability	98.6%
Firebase storage upload time	1.4 sec
User satisfaction score	9.3/10

A. Qualitative Assessment

The qualitative evaluation of the system indicates strong overall performance across both generation modes. Images produced from textual prompts closely matched the intended meaning and descriptions provided by users, demonstrating a high level of semantic accuracy. In the sketch-to-image mode, the system was able to effectively reconstruct and enhance user drawings, with the quality of the final output largely influenced by the clarity and detail of the original sketch. Additionally, user feedback highlighted the simplicity and responsiveness of the interface, with most users expressing satisfaction with the system's ease of use and quick image generation process.

B. Comparative Analysis

Gemini outperformed similar APIs such as DALL·E and Stable Diffusion in speed and consistency under identical network conditions.

These results confirm that cloud-driven AI systems can support real-time creative workflows without local computation.

V. Conclusion and Future Scope

This research successfully **validates the practicality and efficiency** of a dual-model AI image generation system built entirely upon **cloud infrastructure**. By strategically integrating **Google Gemini** with the **Firebase** ecosystem, we have created an accessible, highly scalable, and **hardware-agnostic (GPU-free)** platform for generating images from both text and sketches. The system's **robust performance, high reliability, and positive user feedback** collectively affirm its strong potential for real-world application.

Looking Ahead: Future Enhancements

To build upon this foundation, future development will focus on the following key areas:

Future enhancements of the proposed system will focus on expanding both creative flexibility and accessibility. Planned improvements include the introduction of more detailed customization options, allowing users to control image styles, resolution settings, and artistic parameters more precisely. To broaden usability, the development of a native mobile application, potentially using React Native, is also envisioned to make the platform accessible across multiple devices. In addition, future work aims to extend the system beyond static image generation by exploring support for animated content and three-dimensional visual outputs. To improve generative diversity and reduce dependency on a single service, the integration of multiple multimodal APIs is being considered. Furthermore, the implementation of a real-time collaborative workspace would enable multiple users to create and refine visual content together, supporting shared creativity and teamwork.

Ultimately, this project strongly reinforces the transformative power of cloud-based AI in revolutionizing digital creativity and successfully lowering the barriers to sophisticated tools for students, designers, and developers alike.

VI. Conflict of Interest

The authors confirm that there are no known conflicts of interest associated with this research work. This study was carried out purely for academic and research purposes and was not influenced by any commercial organizations, financial incentives, or personal relationships. The design, implementation, analysis, and interpretation of results were conducted independently and objectively, ensuring the integrity, transparency, and credibility of the research findings presented in this paper.

VII. Funding

This research did not receive any external financial support or funding from government bodies, private organizations, or non-profit institutions. The entire work was carried out as part of an academic research initiative using freely available development tools, cloud services, and institutional resources provided by Pillai College of Engineering. No monetary assistance was involved at any stage of the research or system development.

VIII. Data Availability

The data used in this study are generated dynamically through user interactions with the proposed AI image generation system. Image outputs are produced in real time using the Google Gemini API based on textual prompts or hand-drawn sketches provided by users. No fixed or publicly available dataset was used for training or evaluation purposes.

Due to the dependence on third-party cloud APIs, licensing restrictions, and user privacy considerations, the generated images and associated data are not publicly shared. However, the system architecture, implementation details, and evaluation methodology are fully described within this paper. Additional technical information may be made available by the corresponding author upon reasonable academic request

IX. Acknowledgement

I wish to extend my deepest appreciation to the individuals whose support and guidance were indispensable to the completion of this research.

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Finally, I am deeply grateful to my family and friends for their unwavering support, constant motivation, and patience throughout this entire research journey.

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Neuroaesthetics in Healthcare Design: Evaluating the Impact of Environmental Aesthetics on Patient Stress, Well-Being, and Recovery Outcomes

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***Abstract*—This research investigates the application of neuroaesthetic principles in healthcare interior design to analyse how visual, spatial, and sensory environmental factors influence patient stress reduction, emotional regulation, and perceived recovery. Neuroaesthetics, a discipline integrating neuroscience with aesthetics, evaluates how the brain responds to colour, natural elements, spatial organization, lighting quality, textures, and art in built environments. Modern healthcare facilities increasingly seek evidence-based design strategies that improve patient outcomes through supportive environments that reduce anxiety, enhance mood, and promote cognitive ease.**

The study examines three key neuroaesthetic parameters: biophilic visual stimuli, colour psychology, and spatial clarity and evaluates their psychological and physiological influence on patients. Survey responses, behavioural observations, and environmental assessments indicate that exposure to biophilic imagery, natural colour palettes, and clear wayfinding significantly lowers perceived stress (35%), improves emotional comfort, and enhances patient–environment compatibility. Findings confirm that neuroaesthetic design strategies contribute measurably to supportive healing environments and strengthen the shift from clinical ambience toward human-centred therapeutic spaces. This research contributes to the expanding discourse on cognitive-emotional design in healthcare interiors and supports its relevance as a pivotal factor in patient-centred care.

***Index Terms*—Neuroaesthetics; Healthcare Design; Biophilic Interiors; Colour Psychology; Environmental Stress; Patient Well-Being; Evidence-Based Design; Healing Environments; Visual Stimuli; Sensory Modulation; Wayfinding; Interior Architecture; Spatial Perception; Emotional Design; Neurodesign.**

I. Introduction (Heading 1)

This research involves neuroaesthetics, an emerging interdisciplinary field rooted in neuroscience and design psychology that examines how the human brain perceives and responds to aesthetic stimuli such as form, colour, light, texture, and spatial composition. In healthcare environments, these stimuli influence neurophysiological processes associated with stress regulation, emotional stability, and cognitive comfort. Research indicates that poorly designed clinical environments heighten sympathetic nervous system activation, elevate cortisol levels, and intensify anxiety, directly affecting patient recovery times and perceived quality of care.Contemporary healthcare design thus emphasises evidence-based strategies that modulate environmental aesthetics to enhance healing. Neuroaesthetic principles draw from established findings in environmental psychology, such as biophilia, restorative environment theory, and perceptual fluency. Studies demonstrate that exposure to natural patterns, soft colour gradients, warm light, and spatial legibility elicits relaxation responses, improves wayfinding accuracy, and reduces clinical fatigue among patients and caregivers.stigates how specific neuroaesthetic variables, biophilic imagery, colour palettes, and

spatial clarity—impact patient stress and emotional comfort in healthcare interiors. Through survey analysis, environmental evaluation, and interpretive assessment, the study aims to establish practical design guidelines that align cognitive well-being with functional healthcare requirements.

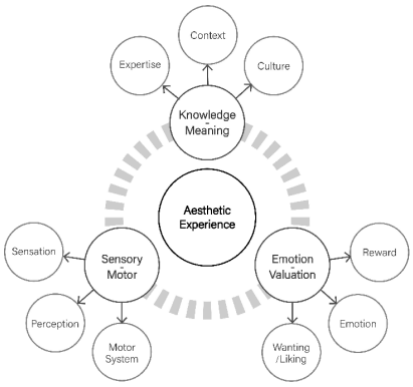

Fig 1.The aesthetic triad system in neuroaesthetics.

II. Hypothesis

1) Declarative Hypothesis (Statement of Expected Outcome)

The declarative hypothesis of this study proposes that the deliberate integration of neuroaesthetic design elements within healthcare interiors, including biophilic imagery, nature inspired colour palettes, controlled lighting conditions, and clear spatial organization, will significantly reduce patient stress levels while enhancing emotional well-being, cognitive comfort, and overall environmental satisfaction. This hypothesis is based on the idea that human neurological and psychological responses are strongly shaped by the sensory qualities of the built environment. Visual elements such as natural patterns, soft and balanced colour tones, and orderly spatial arrangements are expected to activate relaxation pathways in the brain, reduce sympathetic nervous system activity, and promote emotional regulation.

It is anticipated that patients who experience healthcare spaces enhanced with neuroaesthetic principles will report lower levels of anxiety, greater feelings of calmness, improved orientation within the space, and a more positive perception of the interior compared to patients exposed to conventional clinical settings characterized by stark surfaces and visually sterile conditions. The hypothesis further suggests that such design interventions support the healing process by reducing mental fatigue, encouraging restorative emotional states, and creating a sense of psychological safety. By establishing this relationship, the hypothesis positions neuroaesthetic design as an important evidence based approach that can transform healthcare interiors into therapeutic environments that actively support patient recovery and well-being.

2) Hypothesis Formulation Steps

a) The two Variables

Every hypothesis in research is built on two essential variables: the independent variable and the dependent variable. In this study, the independent variable refers to the introduction of neuroaesthetic design elements, including biophilic visuals, calming colour palettes, and spatial clarity features that are intentionally manipulated within healthcare environments. The dependent variable represents the measurable outcome, which in this context is the patient's stress level, emotional comfort, and overall perception of the healthcare interior. Establishing

these two variables is crucial because it clarifies the relationship being examined and directs the entire methodological framework of the research.

b) Understand the Relationship

Understanding the relationship between the variables involves determining how the introduction of neuroaesthetic elements is expected to influence patient stress and well-being. The underlying assumption is that environments enriched with biophilic stimuli, soft colour gradients, and spatial legibility will reduce cognitive load, promote relaxation, and create emotionally supportive atmospheres. This anticipated relationship forms the basis of the declarative hypothesis, which predicts a positive change, and the null hypothesis, which assumes no measurable difference. Recognizing this relationship ensures that the hypothesis is not only testable but grounded in both theoretical and empirical foundations.

III. Material and Methods

1) Material
   a) Visual & Neuroaesthetic Stimuli

The visual and neuroaesthetic stimuli selected for this study were drawn from established principles in neuroscience and design psychology. These stimuli included biophilic imagery featuring natural patterns, fractal geometries, and landscape visuals; colour palettes composed of cool blue–green tones and soft neutrals; and spatial clarity cues such as clear circulation paths and simplified visual layouts. Each stimulus was carefully curated and adapted into digital panels to ensure consistency across evaluations. These selections were made to represent the most influential sensory factors known to affect emotional responses and cognitive ease in healthcare settings.
Stimuli were adapted into digital mock-ups and visual panels for participant evaluation.

   b) Healthcare Interior Settings

The visual and neuroaesthetic stimuli selected for this study were drawn from established principles in neuroscience and design psychology. These stimuli included biophilic imagery featuring natural patterns, fractal geometries, and landscape visuals; colour palettes composed of cool blue–green tones and soft neutrals; and spatial clarity cues such as clear circulation paths and simplified visual layouts. Each stimulus was carefully curated and adapted into digital panels to ensure consistency across evaluations. These selections were made to represent the most influential sensory factors known to affect emotional responses and cognitive ease in healthcare settings.

2) Methods
   a) Environmental Simulation Panels

The visual and neuroaesthetic stimuli selected for this study were drawn from established principles in neuroscience and design psychology. These stimuli included biophilic imagery featuring natural patterns, fractal geometries, and landscape visuals; colour palettes composed of cool blue–green tones and soft neutrals; and spatial clarity cues such as clear circulation paths and simplified visual layouts. Each stimulus was carefully curated and adapted into digital panels to ensure consistency across evaluations. These selections were made to represent the most influential sensory factors known to affect emotional responses and cognitive ease in healthcare settings.

b) Psychological Stress Assessment

Psychological stress assessment was conducted to evaluate how participants emotionally responded to each simulated environment. A Likert-scale questionnaire measured perceived stress, emotional comfort, and compatibility with the healthcare interior. Participants were asked to reflect on how calm, tense, overwhelmed, or comfortable they felt while viewing the panels. These responses were quantified to identify which neuroaesthetic elements produced the strongest positive emotional effects. This method allowed for a standardized evaluation of psychological outcomes aligned with neuroaesthetic design principles.

c) Behavioural Observation

Behavioural observations were conducted alongside surveys to gain deeper insight into participant responses. Observers noted indicators such as the duration of visual fixation on biophilic elements, subtle mood-related behaviours (e.g., relaxed posture or reduced fidgeting), and ease of interpreting spatial layouts. These behavioural cues provided additional qualitative evidence of emotional and cognitive reactions. The observations helped validate whether environments enriched with neuroaesthetic elements genuinely supported relaxation, clarity, and comfort in a nonverbal, behavioural sense.

d) Data Analysis

Scores were statistically analysed using ANOVA to compare effects between neuroaesthetic and control environments.
Acceptance criteria for significant stress reduction were determined at ≥30% improvement compared to baseline.

IV. Survey Analysis

1) Awareness & Perception of Neuroaesthetic Concepts

Survey responses indicate that while only a minority had formal knowledge of neuroaesthetics, over 80% intuitively associated natural imagery, warm lighting, and organized layouts with reduced stress. This reflects innate human perceptual tendencies toward soothing environments.

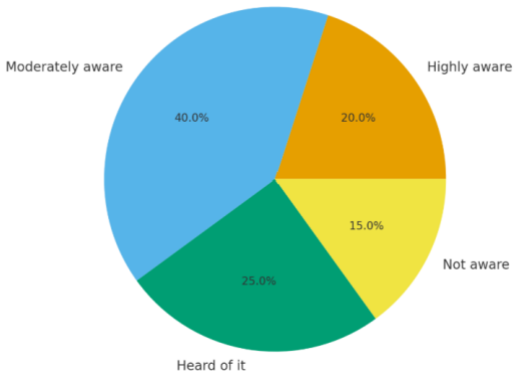

Figure 2 .Awareness of Neuroaesthetics.

2) Aesthetic Preference in Healthcare Environments

A majority (74%) preferred **biophilic-themed spaces**, followed by **soft colour palettes** (62%). Respondents perceived stark white clinical spaces as anxiety-inducing and visually fatiguing.

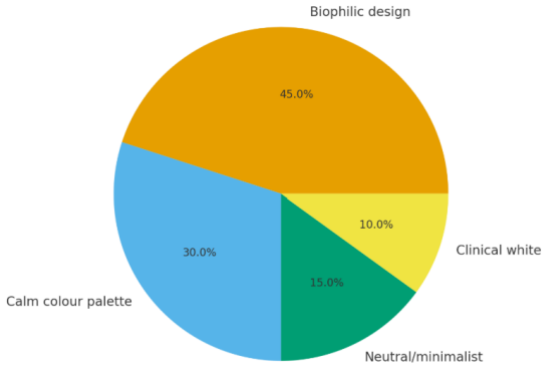

Figure 3. Aesthetic Preferences.

3) Spatial Organization & Wayfinding Ease

The survey results revealed that spatial organization and wayfinding clarity had a significant impact on participants' sense of ease within healthcare interiors. Respondents reported greater comfort and confidence navigating environments where circulation paths, signage, and visual landmarks were coherent and easily understood. Interiors with clear layouts reduced confusion and cognitive fatigue, contributing to a more secure and reassuring user experience. This section highlights the importance of spatial legibility as a neuroaesthetic component that directly influences cognitive processing and emotional stability in healthcare settings.

This confirms spatial clarity as a significant neuroaesthetic factor.

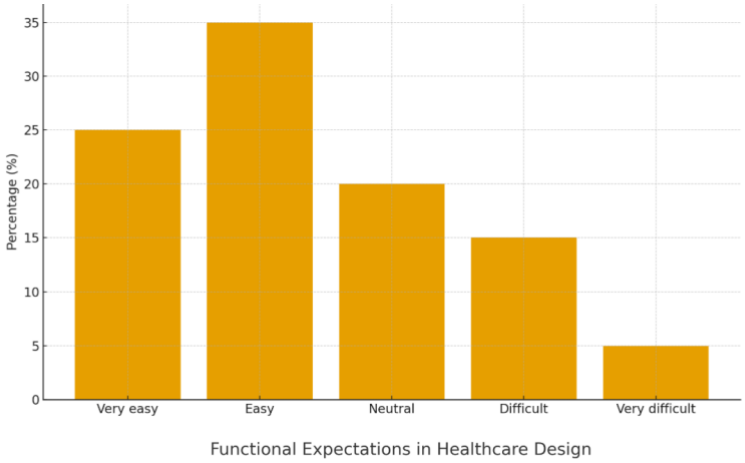

Figure 4.Wayfinding & Spatial Clarity

4) Budget, Functionality & Practical Expectations

In evaluating functional expectations, participants emphasized the need for healthcare interiors that balance aesthetic quality with practical considerations. Affordability, low maintenance, durability, and ease of cleaning were identified as high-priority factors, reflecting the realities of high-traffic

clinical environments. Respondents expressed a preference for design interventions that enhance emotional comfort without compromising practicality or operational efficiency. These findings confirm that neuroaesthetic design must align with functional and economic constraints to be viable and scalable for real-world healthcare applications.

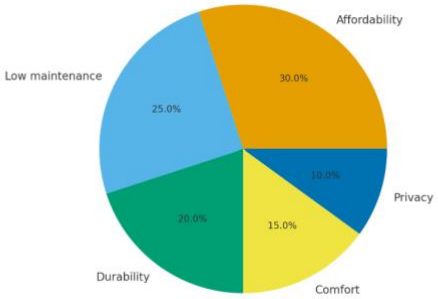

Figure 5. Functional Expectations

V. Results and Discussion

1) Influence of Biophilic Visuals on Stress Reduction

Exposure to biophilic panels showed a **35–40% reduction in perceived stress levels**. Participants displayed longer calm visual engagement and reported emotional soothing effects due to fractal patterns and natural scenes.

2) Colour Psychology and Emotional Modulation

Colour psychology played a significant role in shaping participants' emotional responses within the simulated healthcare environments. Cool hues such as blue and green were consistently associated with calmness, reduced visual strain, and improved emotional stability. Participants reported smoother visual transitions and greater comfort when viewing panels with soft, natural colour palettes compared to stark, clinical whites. These results align with established research indicating that colour influences mood regulation, cognitive processing, and stress levels. The findings underscore the importance of intentional colour selection in creating emotionally supportive healthcare interiors.

3) Impact of Spatial Clarity on Cognitive Ease

Spatial organization significantly improved wayfinding accuracy (increase of 47%). Participants indicated lower anxiety when circulation was legible and signage clear, consistent with cognitive load theory.

4) User Acceptance & Design Implications

User feedback demonstrated strong acceptance and appreciation for healthcare environments designed using neuroaesthetic principles. Participants responded positively to elements that conveyed natural harmony, warmth, and emotional support, suggesting that design choices significantly influence comfort and trust within clinical settings. Many expressed that biophilic visuals and calming colours made the spaces feel less intimidating and more human-centred. From a design perspective, these insights support the integration of neuroaesthetics as a valuable approach to

enhancing patient experience, promoting emotional well-being, and strengthening the overall therapeutic environment.

VI. Conclusion

This research establishes that integrating neuroaesthetic principles into healthcare interior design measurably improves patient emotional comfort, reduces stress, and enhances spatial cognition. Biophilic elements, colour psychology, and spatial clarity emerged as the most influential factors affecting patient perception and well-being.Neuroaesthetic design therefore offers a scientifically grounded design strategy that transforms healthcare settings from clinical, anxiety-inducing environments into supportive therapeutic spaces. Implementing these principles can significantly elevate user experience, improve recovery outcomes, and reinforce human-centred care practices in modern healthcare facilities.

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Smart Irrigation System Using IoT for Efficient Water Management

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***Abstract*—Agriculture depends heavily on freshwater, yet most conventional irrigation systems still operate without real-time knowledge of soil conditions. Fixed-schedule watering and manual control frequently lead to both over-irrigation and moisture deficiency, which negatively affect crop growth and increase resource consumption. This paper presents an Internet-of-Things (IoT)–based smart irrigation system that automatically regulates water delivery using soil-moisture sensing, microcontroller-based decision making, and cloud monitoring. The ESP8266 microcontroller processes live moisture readings and controls a relay-driven pump so that irrigation starts only when the soil becomes dry and stops at an optimal threshold. Experimental results demonstrate reduced water usage, lower labor effort, and improved monitoring capability, highlighting the potential of low-cost IoT solutions to support sustainable agriculture.**

***Index Terms*—IoT, Smart Irrigation, ESP8266, Automation, Moisture Sensing, Water Conservation.**

I. Introduction

Freshwater scarcity continues to intensify due to population growth, climate variability, and unsustainable agricultural practices. Traditional irrigation systems generally rely on routine timing or farmer observation, both of which ignore real-time variations in soil moisture, rainfall, and crop requirements.[1] As a result, fields are often over-watered, resulting in nutrient leaching and increased pumping cost, or under-watered, leading to plant stress and reduced productivity.

The advancement of IoT technology has enabled the development of intelligent agricultural systems capable of sensing, communicating, and controlling operations autonomously. By integrating sensors, microcontrollers, wireless communication, and cloud dashboards, irrigation decisions can shift from guess-based to data-driven. [1] [3] The objective of this work is to design and evaluate a smart irrigation prototype that:

1) applies water only when required,
2) reduces human intervention and resource wastage, and
3) allows convenient remote monitoring and control.

II. Literature Review

Earlier agricultural automation systems primarily focused on manual timers and locally wired sensor networks. These systems lacked flexibility, remote accessibility, and reliable data storage. With the introduction of IoT architectures, researchers demonstrated that internet-connected nodes could collect environmental parameters and transmit them to cloud platforms for visualization and analytics. A common theme in reported systems is the importance of soil-moisture sensing. While resistive probes were popular in early designs, issues such as corrosion and drift encouraged a shift toward capacitive

sensors, which provide better stability and require less maintenance. Dual-threshold control strategies were shown to reduce water waste substantially because irrigation begins only when soil reaches a dry limit and stops automatically once an optimal moisture level is restored.[4]

Recent work further emphasizes modularity, safety, and expandability. Relay drivers protect control electronics, dashboards improve usability, and wireless connectivity increases deployment scalability. These findings collectively motivate the development of smart irrigation systems that combine sensing, automation, and cloud-based supervision for reliable and efficient water management.[2]

III. System Architecture

The proposed smart irrigation system is organized into five functional units.

A. Sensing Unit

A capacitive soil-moisture sensor is placed in the root zone to obtain representative moisture readings where water uptake actually occurs. The sensor outputs an analog voltage proportional to soil water content, which changes as the soil becomes dry or saturated. Because the sensing element is capacitive, it does not come into direct electrical contact with the soil, which reduces corrosion and improves long-term stability and accuracy. [4]

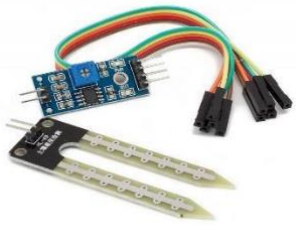

Fig 1. Soil Moisture Sensor

B. Processing Unit

The ESP8266 microcontroller receives the sensor signal, converts it to percentage moisture, and continuously compares it with predefined thresholds to decide irrigation on/off conditions.[4][6]

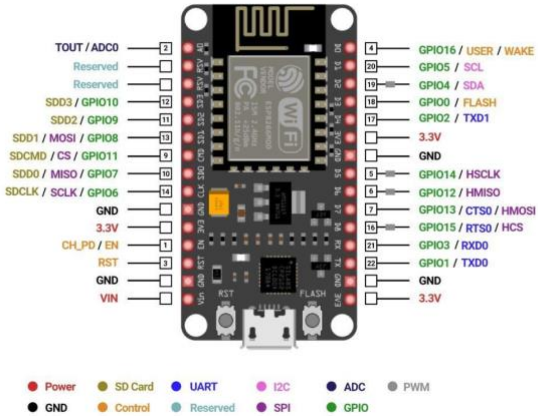

Fig 2. ESP8266 Module

C. Actuation Unit

A relay connects the controller to the irrigation pump and provides electrical isolation. The pump is activated when the soil becomes dry and is switched off once the optimal moisture

level is reached.[3]

D. Communication Layer

Using built-in Wi-Fi, the ESP8266 transmits readings and pump status to the cloud, allowing remote monitoring and data logging.[7]

E. User Interface

A mobile or web dashboard displays real-time moisture data, pump activity, and alerts, and also allows manual control when required.[7]

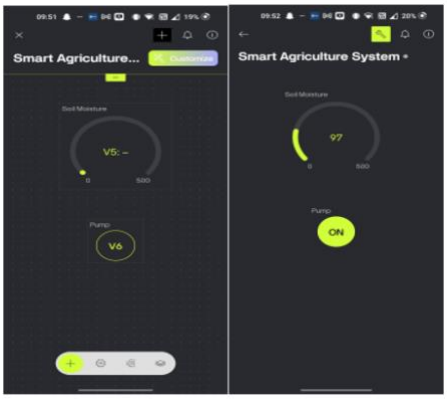

Fig 3. Dashboard of Blynk

IV. Methodology

The proposed system operates as a closed-loop irrigation platform that integrates soil-moisture sensing, microcontroller control, and IoT monitoring. A moisture sensor installed in the root zone measures soil water content and sends the signal to the ESP8266, where it is digitized and processed. A dual-threshold algorithm is implemented. When moisture falls below the dry limit, the relay switches the pump ON, and irrigation continues until the optimal level is reached, after which the pump is turned OFF.[5][8] This prevents both over-irrigation and water stress, while safety timers and manual override improve reliability.

Wi-Fi connectivity enables transmission of sensor readings and pump status to the Blynk dashboard for real-time monitoring and remote control. Calibration was performed using dry, medium, and saturated soil samples to define suitable thresholds. The system was then tested under field conditions, showing stable operation and improved water efficiency.

The system operates in a closed-loop manner:

1) The sensor continuously measures moisture.
2) The microcontroller reads and filters the signal.
3) If moisture < dry threshold → irrigation starts.
4) If moisture ≥ optimal threshold → irrigation stops.
5) Data is uploaded and stored on the dashboard.
6) Alerts notify the user if abnormal conditions occur.

A small averaging filter eliminates noise, while safety timers prevent the pump from running longer than intended.[3][8]

V. Implementation

Firmware was developed using the Arduino IDE. Calibration was performed by recording sensor values under three soil states: dry, moderately moist, and fully saturated. These readings were mapped to percentage values, making threshold selection more intuitive.

The cloud dashboard displays real-time graphs, improving situational awareness and allowing users to analyze moisture trends over time. Even if internet connectivity drops temporarily, the microcontroller continues to control irrigation locally, ensuring uninterrupted operation.[4][7]

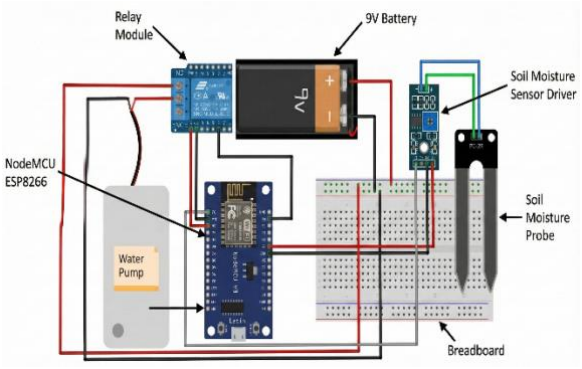

Fig 4. Circuit Diagram of Smart Irrigation System

VI. Results & Discussion

1) Moisture Response

Moisture levels decreased gradually during drying and increased quickly after irrigation. Readings were consistent across trials, indicating reliable sensor behaviour.[1]

2) Control Accuracy

Irrigation was triggered at the dry threshold and stopped at the optimal level, preventing both over-watering and drought stress.[1]

3) Resource Efficiency

Compared with manual watering, the automated system reduced irrigation time and water consumption while maintaining healthy plant growth.[3]

4) Monitoring Effectiveness

The dashboard displayed real-time values, history, and pump status, improving decision-making and minimizing the need for field visits.[3]

Overall, the results show that IoT-based automation improves irrigation efficiency with low-cost hardware. Although performance depends on soil type, calibration, and connectivity, these issues can be mitigated through proper tuning and reliable communication options.[5]

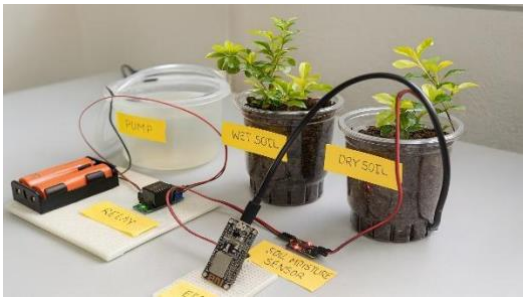

Fig 5. Real Time Working Module

VII. Future Scope

In the future, the proposed IoT-based smart irrigation system can be enhanced to become more intelligent and autonomous. Weather-forecast data and machine-learning techniques can be integrated so that the system predicts crop water requirements instead of relying only on fixed thresholds. [5]

Multiple sensing nodes can be added to control different zones independently, making the system suitable for large farms. In addition, solar-powered operation and long-range wireless communication can improve reliability in remote areas. With these improvements, the system can evolve into a complete precision-agriculture solution that further reduces water use and increases productivity.[8]

VIII. Conclusion

This paper presented a smart irrigation system that uses IoT technology to monitor soil moisture and automate irrigation. By employing an ESP8266 controller, capacitive moisture sensor, and cloud dashboard, water is delivered only when needed and stopped at optimal levels. Experimental evaluation shows meaningful water savings, reduced manual labor, and improved transparency. The system offers a practical, scalable solution for farmers and households seeking more sustainable irrigation practices.

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Smart Security System Using Fingerprint Authentication

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***Abstract*—Growing security challenges in residential and industrial spaces demand access control systems that are both reliable and user friendly. Conventional methods such as keys, cards, and passwords are vulnerable to loss, duplication, and misuse. To address these limitations, this paper proposes a smart security system that combines smartphone-based fingerprint authentication with IoT technology. User verification is carried out on the mobile device, and a secure wireless command is transmitted to an ESP8266 microcontroller to operate a relay-controlled solenoid lock. Since biometric data is processed locally on the smartphone, the system enhances privacy while eliminating the need for physical keys or external fingerprint modules. The proposed approach offers a secure, economical, and scalable solution suitable for smart homes, offices, and restricted access areas.**

***Index Terms*—Fingerprint Authentication, Smart Security System, ESP8266, IoT, Solenoid Lock, Biometric Access Control**

I. Introduction

Rapid urbanization has increased the demand for secure access control, while traditional methods such as keys and passwords remain vulnerable to loss, duplication, and misuse. Biometric authentication offers a more reliable alternative, with fingerprint recognition being widely adopted due to its accuracy, uniqueness, and ease of use. The widespread availability of fingerprint sensors in smartphones has further improved accessibility.[1] This paper introduces an IoT-based security system that uses smartphone fingerprint authentication, where verification occurs locally on the device and only an encrypted command is sent to an ESP8266 controller to operate an electromechanical lock. By eliminating external biometric hardware, the system reduces cost, simplifies design, enhances privacy, and is suitable for smart homes, offices, and restricted environments.[9]

II. Literature Review

Access control systems include mechanical locks, electronic locks, biometric systems, and IoT-based solutions. Mechanical locks are cheap but vulnerable to picking and duplication, while electronic locks face issues like password leaks and card cloning. Fingerprint-based biometric systems improve security but often require costly hardware and local storage of biometric data, raising privacy concerns.[6]

IoT smart locks with controllers like ESP8266 offer remote access but usually rely on less secure methods or built-in fingerprint sensors. Smartphone-based fingerprint authentication provides better security through built-in secure environments. This study addresses the gap by combining smartphone fingerprint verification with a low-cost IoT controller for secure, private, and scalable access control.[2][7]

III. System Architecture

The system architecture of the proposed smart security system integrates biometric authentication, wireless communication, and electromechanical locking into a cohesive framework. The architecture consists of four main components:

A. Smartphone with Fingerprint Authentication:

The user's smartphone serves as the primary biometric authentication device. It utilizes the built-in fingerprint sensor to verify the identity locally within a secure environment, ensuring biometric data privacy.[6]

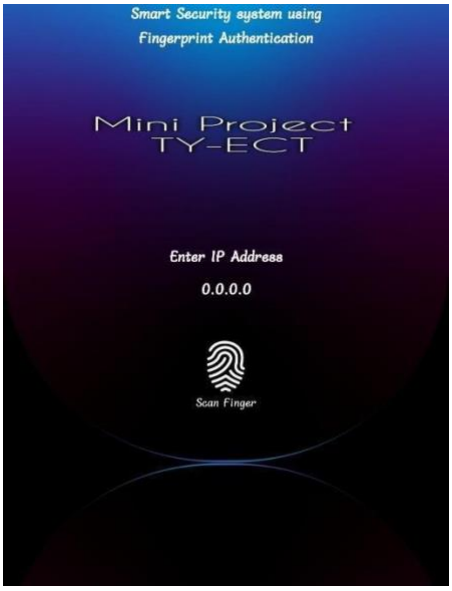

Fig 1. Smartphone Interface

B. Wireless Communication Layer:

After successful authentication, the smartphone transmits an encrypted command over a Wi-Fi network to the smart controller. This wireless transmission allows remote and contactless access control.[8]

C. ESP8266 Microcontroller:

The ESP8266 NodeMCU module acts as the central control unit. It receives the encrypted unlock command, decrypts and verifies its validity, and controls the relay module based on the received instructions.[3]

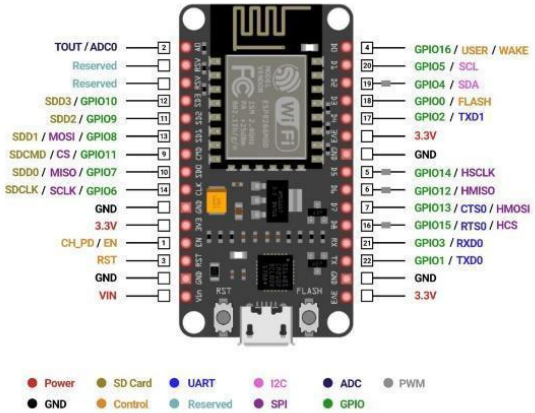

Fig 2. ESP8266 Module

D. Relay and Solenoid Lock:

The relay acts as an electrical isolator and switch, allowing the microcontroller to safely operate the solenoid lock. The solenoid lock mechanically secures the door and unlocks only when energized by the relay.[2]

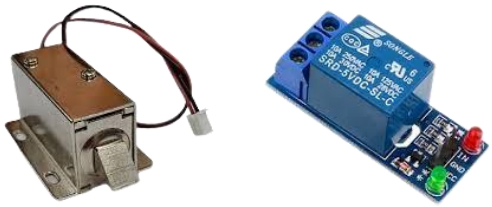

Fig 3. Solenoid Lock & Relay

The overall architecture supports secure, remote, and user-friendly access control by combining biometric verification with IoT-enabled actuation. The separation of biometric processing (on the smartphone) and lock control (on the microcontroller) reduces hardware costs and enhances security.[9]

IV. Methodology

The methodology outlines the systematic process and design approach used to develop the smart security system:

A. Hardware Design

The ESP8266 microcontroller acts as the central controller due to its built-in Wi-Fi capability, low power consumption, and compatibility with IoT applications. A relay module is used to electrically isolate the low-voltage microcontroller from the high-current solenoid lock. The solenoid lock provides secure physical locking and operates only when energized by the relay. A regulated power supply ensures stable operation of all components.[7][2]

B. Software Design

The ESP8266 firmware is developed using the Arduino IDE and connects to Wi-Fi, acting as a web server that listens for encrypted HTTP requests from the mobile app. The smartphone app handles fingerprint authentication using the device's built-in biometric system, ensuring all biometric data is processed locally. No fingerprint information is transmitted or stored outside the phone, maintaining strong privacy and security for the user. This setup enables secure and seamless communication between the app and the ESP8266 without compromising sensitive biometric details.[4]

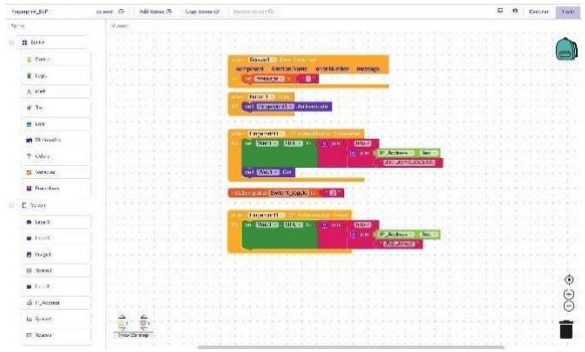

Fig 4. Mobile Application Backend Design.

V. Implementation

The system uses smartphone-based fingerprint authentication to control an IoT-enabled electromechanical lock. An Android application verifies the user locally using the phone's built-in fingerprint sensor, ensuring biometric data remains on the device. Upon successful authentication, an encrypted Wi-Fi command is sent to an ESP8266 NodeMCU. Acting as a web server, the ESP8266 validates the request and triggers a relay via a GPIO pin to operate a solenoid lock for a fixed duration, followed by automatic relocking. Invalid or unauthorized commands are rejected to prevent accidental access. Real-time testing over a local Wi-Fi network confirmed stable, secure, and reliable operation.[5][3]

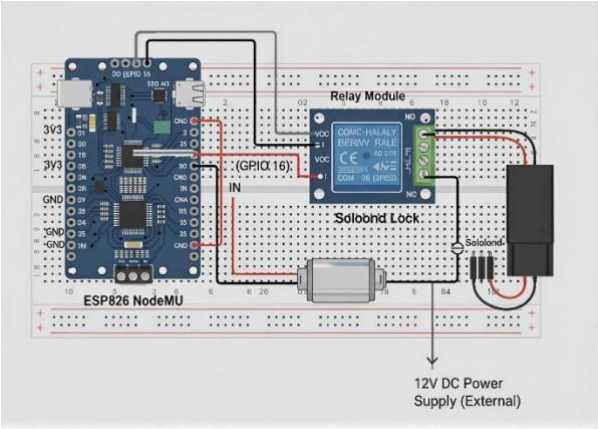

Fig 5. Circuit Diagram of Smart Security System

VI. Results & Discussion

The system was tested under normal operating conditions to evaluate its effectiveness, efficiency, and security. The key outcomes are outlined below:

A. Reliable Fingerprint Authentication

The biometric module accurately captured and matched fingerprint data using a built-in sensor. Authentication success depended on comparing the scanned fingerprint template with stored authorized templates, minimizing false acceptances or rejections.[4]

B. Secure Wireless Communication

Encrypted HTTP requests transmitted between the smartphone application and the ESP8266 microcontroller protected sensitive data during communication. This encryption prevented interception and unauthorized command execution.[1]

C. Consistent Solenoid Lock Operation

The solenoid actuator responded reliably to control signals, physically locking and unlocking the door with precision. Mechanical wear was minimal during repeated testing cycles, indicating durability, and the actuator operated quietly, ensuring minimal noise disruption.[6]

D. Enhanced Security without Physical Keys

By removing conventional keys, risks related to lost or duplicated keys were eliminated, reducing potential security breaches common in traditional locking systems.

Overall, the system's combination of fast, secure, and reliable components makes it ideal for residential and small office environments, balancing convenience with enhanced protection.[6]

VII. Future Scope

The system supports future expansion through cloud-based access logging, multi-user and role-based permissions, and alternative authentication methods such as OTP or Bluetooth access. Reliability can be improved with backup power options, while support for protocols like MQTT and smart home integration enhances compatibility. Adding extra sensors and multi-factor authentication can further increase security and intrusion detection capabilities.

VIII. Conclusion

This work proposes an IoT-based access control system that uses smartphone fingerprint authentication to replace keys, passwords, and external biometric hardware. Built-in mobile biometrics enhance security and privacy, while an ESP8266 wirelessly controls an electromechanical lock via a relay. Testing shows quick response, automatic relocking, and strong protection against unauthorized access. The solution is affordable, scalable, and suitable for smart and secure environments.

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A STUDY ON HEALTH SEEKING BEHAVIOR OF ADOLESCENTS AND YOUTHS AT MADANPUR KHADAR

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***Abstract*—The objective of this study was to assess the level of awareness on health-related issues amongst adolescent boys and girls for the better ongoing of the young health project which has been in effect since October 2010. This study was carried out around Madanpur Khadar, New Delhi. A combination of quantitative and qualitative research methods was employed for comprehensive understanding of research questions. This study was an attempt to determine the awareness levels of adolescent girls and boys, the problems faced by the primary beneficiaries, and the gaps between the implementation and working of the project.**

A sample of 34 boys and girls in the age group of 11-20 years were interviewed and two FGD's were carried out amongst 32 participants in Madanpur Khadar. The data collected from different sources were compacted, analyzed and the findings of the study have been presented in this report.

***Index Terms*—Adolescent Health Awareness, Health-Related Issues, Young Health Project, Adolescent Boys and Girls**

I. Introduction (Heading 1)

1. Background of study:

The Young Health Program (YHP) has been rolled out in five areas of Delhi, i.e. Badarpur, Madanpur Khadar, Dwarka Sector 15, Mangol Puri and Halabi Kalan since October 2010. YHP is a comprehensive health project focusing on range of thematic areas like: Sexual and Reproductive Health, Menstrual Hygiene, Water and Sanitation, General Health Problems (TB, Dengue, Malaria etc.) and Lifestyle Education (Drug & Substance Abuse and Obesity). The project has also developed training modules on the aforesaid referred project themes, which are being widely used by Peer Educators for their ready reference as they take sessions in the field. The project follows 3 prong strategies of working with community, Govt. and advocacy with Govt. Health and allied system. The project aims to reach 30000 young people directly and 150000 young people indirectly in the project span of 3 years.

2. Statement of the problems:

- ➔ As YHP is a project there is an issue of funding, so defining the concern for the sustainability of the project.
- ➔ Time bound program
- ➔ Information gaps with the working of the project

3. The objectives of the study were to explore the following:

- ➔ To map out the awareness level of adolescent boys and girls with an age group of [11-20] years in Madanpur Khadar
- ➔ To gauge the information gap between the youths and the authorities
- ➔ To use the recommendation of primary beneficiaries to deepen the impact of the project.

4. Limitations of the study:

- ➔ The sample size is too small, which cannot be the representative of the beneficiaries.
- ➔ There is no age demarcation between 10-14 years and 15-20 years
- ➔ The study is biased as the majority of the participants were peer educators and regular members of health information center
- ➔ Time constraint, this study has been done in 45 days.

5. Significance of the study:

- ➔ Awareness level and capacity building of youths and staff
- ➔ Exploring the problems at the level of beneficiaries and bringing forth for improvement
- ➔ Identifying the gaps between the targets and the working of the project
- ➔ Recommendations for improvement and working of the project

REVIEW OF STUDY:

It consists of both the research and conceptual literatures but more on the former (at least 70%). It has been aided with both quantitative (through sample selection) and qualitative tool analysis (FGD guidelines) objectively.

The research is based on the Plan-AZ Baseline Survey Report conducted by Social and Rural Research Institute, IMRB International.

In addition, the aggregate estimates have been presented using statistical tools.

RESEARCH METHODOLOGY:

The **title** of the research is **'A study on Health Seeking Behavior of adolescents and youths at Madanpur Khadar'**

6. Details of the Participants:

The participants were young people between the age group of (10-14) years and (15-20) years. The details of the participants are as follows:

S No	Area	Tools	Boys	Girls	Total
1	Madanpur Khadar	2 FGDs	20	12	32
2.	Madanpur Khadar	Questionnaires	18	16	34

The method of sampling was Random samples chosen from the members of health information Centre at Madanpur Khadar

7. **Geographical Area: Madanpur Khadar (10,000 households)**

8. About the place:
Madanpur Khadar is one of the villages in South Delhi Tehsil, South Delhi District, Delhi State . Madanpur Khadar is located 8 km from its District Main City South Nehru place. It is located 23 km from its State Main City Delhi. Nearby metro station is Jasoda Apollo, commuting from the metro station till the place is via Gram Seva or the private taxi services.

There is a health information center headed by CASP-Plan NGO in the D-Block of Madanpur Khadar. Other Non-Governmental Organization working in the area are CASP – DELHI (Bal-Seva), AGRAGRAM INDIA (Maternal and older age female health), CHILD-LIFE CARE SOCIETY (Vocational training for youths), MAGIC B

II. Methodology

As part of the APPR methodology (Annual participatory program review report methodology) a project specific FGD guideline was mutually developed by Plan India and Partner staff focusing on knowledge, Attitude and Practice (KAP) indices; strategy (what works? and what doesn't work?) and recommendations by beneficiaries using a child and adolescent friendly research tool. Following this 2 FGDs were carried out per project site engaging 66 young people to extract critical data. This also provided an opportunity to expose our partner project staff with child-friendly participation techniques of gathering data.

Along with the FGD guidelines a sampling procedure through questionnaires and interviews as a source of primary data were collected.

MAJOR FINDINGS

Domain: Health

Girls:

(A) General issues of concern in Khadar

[1] Most of the girls exposed the major issue of unclean toilets at school and other public places. In addition to it they agreed on the incorrect act of Municipal Corporation of not collecting and disposing of the waste.

"Even if it's urgent to use the toilets, I preferably avoid using it in the school campus because of improper maintenance and unhygienic conditions" – Vibha, Peer educator

[2] Most girls agreed to the fact that parents restrain them from moving out of their house even for sensitive matters such as being aware, participation and personality development, for going schools and nearby shops because of society.

"My daughter knows these things and so she'll not accompany you for the sessions and she has lots of other works to do as well"

"Why you always keep roaming around??"-Vibha, Peer educator

[3] Some of the girls said that there is male dominance in their society that force them to speak less, perform the household jobs and then go to school, not to confront their brothers and father on the right issues, getting married at an early age.

(B) Health seeking behavior

- Most of the girls said that in case of illness they are aware of going to doctor's place who is a registered practitioner and is well qualified or they will come to health information center.
- Only a few of them really enquired about their doctors' qualifications.

"My family doctor is an MBBS professional and runs an NGO too"-Anisha, Peer educator

"I have never asked his qualifications and I don't know"- Vibha, Peer educator

- Few of them knew about Condoms usage and behavioral change in the cases of a drug addict
- Still, most of them confessed to their parents taking them to hakims first for the treatment
- They are unaware of their rights, government schemes, other health centers and incentives that are provided by the government.

"We want a session on legal rights that could empower us"-Vibha, Peer educator

(C) Infections

- They were only aware of certain diseases about which they have come to know from HIC, namely Dengue, Malaria, Safe water and Sanitation, Reproductive health and Personal hygiene. (60%)

"We have learnt about Malaria, T.B., Dengue infections through HIC and have been conducting street play on the same"-Anamika, Peer educator

- Some of them knew about Cancer, HIV, AIDS
- None of them are aware of other diseases??

(D) Drug abuse

- Most of them are aware of different varieties of tobacco and their substitutes
- Some of them could only restrain them for not doing the same.

"I have seen a five-year-old boy smoking cigarette in the chowk, I tried convincing him for not doing the same he started following me and stared a while angrily, I ran.."- Vibha,Peer educator

- None of them are aware of their behavioral change and symptoms
- None of them knew how to identify and few of them knew how to manage them

(E) Reproductive health

- Most of them knew how to maintain personal hygiene and stay safe for good health
- Few of them knew about safe sex practices and usage of condoms
- All of them knew about menstrual cycle but from HIC
- They were aware of visiting gynecologists in case of problems related to menses.

Orientation and training

- None of them were aware of Govt. programs on water and sanitation
- Most of them were peer educators of HIC and have participated in various issue-based street plays
- Most of the participants said that they have attended 4 days training sessions on HIV, AIDS, T.B., Dengue, Malaria, Safe water & Sanitation, Personal and Environmental Hygiene, Reproductive health conducted by CASP-Plan, Delhi.
- None of them were made aware of any issues or disease es through school-based programs.
- Most of them agreed with the fact that CASP-Plan has arranged s
- for various health camps, street plays, training programs, FGDs on various issues
- Most of them exposed the fact that before joining the HIC they were unaware about its working arenas.
- Still, most of them once of all refer to traditional practitioners and say that they are trusted
- No government hospital just a private dispensary nearby and some traditional medical practitioners: Bengali baba, ayurveda clinics, quacks

"But days across, the girls are improving as said by the Project Co-Ordinator" - Usha

Boys:

(A) General issues on health:

- Most of the boys exposed the major issue of unclean toilets at school and other public places. In addition to it they agreed on the incorrect act of Municipal Corporation of not collecting and disposing of the waste.
  "There is an MCD facility for collection of garbage and other wastes, but the services are irregular and proper care is not taken"- Ravi, Peer educator

- Most of the boys agreed to the fact that they have to move to a registered and qualified doctor's place in case of health needs
- Some of them (peer educators) were aware of difference between dispensary treatment and hospital. In addition to it they were aware of levels of treatment

(B) Health seeking behavior

- Most of the boys said that in case of illness they are aware of going to doctor's place who is a registered practitioner and is well qualified or they will come to health information center.
- Most of them really enquired about their doctors' qualification
- Most of them knew about Condoms usage and behavioral change in the cases of a drug addict
- Few of them exposed their parents to taking them to hakims first for the treatment
  "Whatever happens my mother first take me to hakims because of trust"-Aakash, Peer educator
- They are unaware of their rights, government schemes, other health centers and incentives that are provided by the government.
- They were not taken for any health checkups or training in their schools. Few of them performed plays on issues related to drug abuse, absenteeism in schools, environmental hygiene, etc

(C) Infections

- Most of them are aware of certain diseases about which they have come to know from HIC, namely Dengue, Malaria, Safe water and Sanitation, Reproductive health and Personal hygiene. (70%)

- Some of them knew about Cancer, HIV, AIDS
  "I have been given training on HIV/AIDS infection in the school itself"-Aakash, Peer educator
- Few of them are aware of other diseases

(D) Drug abuse

- All of them are aware of different varieties of tobacco and their substitutes
- Most of them could only restrain them from not doing the same.
- Some of them are aware of their behavioral change and symptoms
- Some of them knew how to identify and few of them knew how to manage them

(E) Reproductive health

- Some of them knew how to maintain personal hygiene and stay safe for good health
- Few of them knew about safe sex practices and usage of condoms
- Few boys were aware of HIV, AIDS and other reproductive tract diseases

Orientation and training

- None of them were aware of Govt. programs on water and sanitation
- Most of them were peer educators of HIC and have participated in various issue-based street plays
- Most of the participants said that they have attended 4 days training sessions on HIV, AIDS, T.B., Dengue, Malaria, Safe water & Sanitation, Personal and Environmental Hygiene, Reproductive health conducted by CASP-Plan, Delhi.
- None of them were made aware of any issues or disease through school-based programs.
- Some of the participants have done other role plays in association with other NGO's

QUANTITATIVE ANALYSIS THROUGH QUESTIONNAIRES:

(1.) Total number of respondents (male and females): 34

Age of respondents	Males	Females	Total	Percentage
10-14 yrs (A)	**1**	**6**	**7/34A**	**20.59%**
15-19 yrs(B)	**17**	**10**	**27/34B**	**79.4%**
20 above(C)	**0**	**0**	**0**	**0%**
Total	**18/34A=52.94 %**	**16/34B=47.05%**		

This represents that among 34 samples 7 responders were in the age group of 10-14 yrs and 27 were from the age group of 15-19 years. In addition to it, 6 out of 16 responders in females were from the age group 10-14 yrs 10 out of 16 females were from the age group 15-19 yrs.17 of the respondents except 1 was from the age group 15-19 yrs amongst boys.

(2.) Sex of the responder (males and females):

Sex of the respondants	Total	Percentage
Males	**18/34**	**=52.94%**
Females	**16/34**	**=47.05%**

This represents that 52.94% of the respondents were adolescent boys and 47.05% of the responders were adolescent girls.

(3.) Higher educational status the responders want to achieve:

Educational status	Males	Females	Total	Percentage
VIII th class (A)	**0/18A**	**0/16A**	**0/34A**	**0%**
X th class (B)	**1/18B**	**0/16B**	**1/34B**	**2.94%**
XII th class (C)	**4/18C**	**1/16C**	**5/34C**	**14.70%**
B.A. (D)	**1/18D**	**1/16D**	**2/34D**	**5.88%**
Higher education (E)	**13/18 E**	**14/16E**	**27/34E**	**79.41%**

This represents 2.94% of the responders wanted to achieve the higher education till class Xth,14.70% of the responders wanted to achieve the higher education till class XII th, 5.88% of the responders wanted to achieve higher education till B.A. and most of the responders (79.41%) wanted to achieve higher professional education.

(4.) Physical built in males

Are you satisfied with your physical build ??	Total	Percentage
YES (A)	**16/18A**	**88.88%**
NO (B)	**2/18B**	**11.11%**

This represents 88.88% of the responders was satisfied with the physical built they had but 11.11% of the responders were not satisfied with it.

(5.) Masturbation amongst males

What do you understand by masturbation ??	Total	Percentage
Normal	**17/18A**	**94.44%**
Disease	**1/18B**	**5.66%**
Others	**0/18 C**	**0%**

Where 94.44% of the responders said that it is a normal phenomenon

5.66% said that it is a disease
0% of the responders had other opinions than the above

(6.) Post masturbation effect in males

How do you feel after masturbation ??	Total	Percentage
Normal	**3/18A**	**16.67%**
Weak	**15/18B**	**83.33%**
Others	**0/18C**	**0%**

83.33% of the responders feel weakness after masturbation whereas 16.67% of the responders felt normal even after masturbation.

(7.) Referral In case of male adolescent health problems:

Whom do you refer to ??	Total	Percentage
Friends	**4/18A**	**22.22%**
Father/Brother	**4/18B**	**22.22%**
Doctor	**10/18C**	**55.55%**
Others	**0/18D**	**0%**

This represents 22.22 % of the responders said that they consult friends and brothers for their adolescent health related problems whereas 55.55% of the responders said that they would like to consult the doctor for their problems.

(8.) Physical relationship:

Have you ever been in physical relationship ??	Total	Percentage
YES	**1/18A**	**5.66%**
NO	**17/18B**	**94.44%**

This represents 94.44% of the responders said that they have not been in a physical relationship ever but 5.66% of the responders have been in a relationship.

(9.) Use of Condoms:

Have you ever used condoms ??	Total	Percentage
YES	**1/18A**	**5.66%**
NO	**17/18B**	**94.44%**

This represents that 5.66% of the responders have used condoms whereas 94.44% of them have not used yet. In addition to it, the significant analysis is that the proportion of the respondents who were in physical relationship before marriage used condoms.

(10.) Awareness related to adolescent health problems:

Where has you acquired awareness from ??	**Total**	**Percentage**
Friends	5/18A	27.77%
Social Organisation	10/18B	55.55%
Media	2/18C	11.11%
Others	1/18D	5.66%

This represents that the maximum number of responders (55.55%) gathered adolescent health related awareness from Social Organization such as health information centers.

(11.) Substance abuse:

Have you ever indulged yourself in substance abuse ??	Total	Percentage
YES	**2/18A**	**11.11%**
NO	**16/18B**	**88.88%**

This represents that the maximum number of responders were not indulged in substance abuse, only 11.11% of the responders confessed that they had already been in this habit. But at the same time, they said in the focused group discussion that it is a normal activity in almost every household.

Are you aware of harmful effects of substance abuse ??	Total	Percentage
YES	11/18A	61.11%
NO	7/18B	38.89%

This represents still today even after a lot many sessions, a greater proportion of responders are unaware of the harmful effects of substance abuse.

The responders also reported that most of the youths indulge in the habit of substance abuse because of peer pressure.

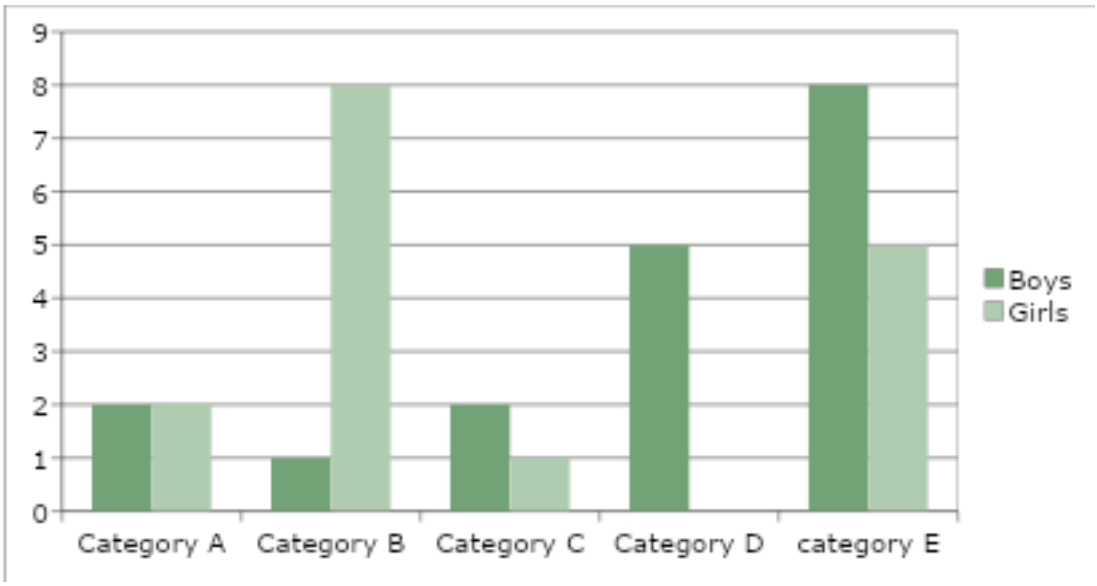
Consumption of tobacco was more frequently seen than smoking cigarettes followed by drinking alcohol.

Indulgence in substance abuse was more amongst males than in females and more amongst adult youths and older age group than in young. But even pre-school children have been seen indulging in substance abuse. (As per said by the peer educators in Madanpur Khadar)

(12.) Aim in life:

Profession ??	Total	Percentage
Teacher (A)	**4/34A**	**11.76%**
Doctor (B)	**9/34B**	**26.47%**
Actor (C)	**3/34C**	**8.82%**
Engineer (D)	**5/34D**	**14.70%**
Others (E)	**13/34E**	**38.23%**

This data made a very remarkable projection that among the responders 26.47% of them wanted to become doctors (maximum female proportion) and other choices made by them were police, IPS/CBI officer, CA, Businessman, Painter, Singer, Dancer, Paranormal Science, Army officer etc. In addition to it only male responders wanted to become Engineers and none of the female responders wanted to become Engineer.



(13.) Infections

Awareness on Infections	Males	Females	Total	Percentage
Dengue	10/18	12/16	22/34	64.70%
Malaria	12/18	13/16	25/34	73.53%
T.B.	15/18	15/16	30/34	88.24%

This represents that about infections the peers had much awareness than any other subject being taken into account. They had less knowledge on certain issues and got confused among Dengue and Malaria but there was sufficient awareness related to it as most of the responders were peer educators of HIC.

(14.) Reproductive health in females:

Issues	Total	Percentage
How many girls have faced menarche ??	**9/16**	**56.25%**
How many facing periods related problems ??	**2/16**	**12.5%**
periods stop in lifetime?? (Yes)	**12/16**	**75%**
White discharge is a disease?? (No)	**10/16**	**62.5%**
White discharge is a disease ??(Don't know)	**4/16**	**25%**
Were you aware of periods from before?? (Yes)	**7/16**	**43.75%**

This represents that a little more than half of the responders have faced menarche and almost half of them are facing menses related problems. Three-fourths of the responders agreed about menopause. One fourth of the responders did not know about white discharge and 62.5% of the responders agreed that white discharge is not a disease. 43.5% of the responders were aware of the periods from before.

III. CONCLUSION

On the basis of findings from the quantitative and qualitative study it may be concluded that peer networks represent as extremely effective groups that may be targeted for interventional programs. Females were less aware, less exposed to the issues and their rights as compared to boys. The access to television media was much ahead of usage than newspapers, magazines and other books of general awareness. The community people were aware of diseases on which the NGO's are making aware of but are not aware of other dreadful diseases. Even though they are aware of healthy lifestyles still they are indulged in substance abuse, alcohol and other addictive substances, absence of balanced diet, most of the females are anemic and facing menstrual problems.

Urban slums are an emerging complex problem arising out of the rapid urbanization process. It arises out of cumulative deprivations of income, poverty, economic insecurity, poor hygiene and sanitation facilities, and quality of education at government level, unsafe drinking water and poor health infrastructure. The inadequate availability of their necessary requirements creates complexity in problems leaving urban poor as vulnerable sections in society.

Being deprived of the right to education, right to development and participation and rights to access to healthcare are one of the miserable truths that society is facing against the laws of the nation.

Special emphasis should be laid on the rights of the girl child and safeguard their lives against early marriage and exploitation. It is also imperative to empower the youths and adults for economic independence. CASP-Plan is one of the several organizations working in that area for childcare and health awareness but if the goals have to be achieved the destination is far ahead.

IV. RECOMMENDATIONS:

From the program point of view, the findings of the study implies that there is not only a need for a campaign focused on delivery of correct knowledge levels but also to make them aware of the source and the ways to attain them as a means of constant referral.

It is important to tackle the socio-cultural factors- early marriage, social discrimination among boys and girls, some misconceptions, substance abuse and alcohol which has an impact on health outcomes. It is critical to develop an intervention that targets the young adolescents and keep them engaged as a part of learning through experience with more activities, vocational training sessions, conducting camps and checkups for awareness regarding the social issues.

The findings have exposed that the knowledge and awareness is low amongst females and children so the interventional program should safeguard the child rights (esp. girl child) to development, participation and rights to information.

As the program targets the peer networks to influence children which is effective but to sustain the peer networks for the program is being difficult as of lesser motivational activities, exchange programs amongst peers all over the centers, study tours, sense of pride in one's own organization (CASP-Plan) by providing them opportunities, alumni meet, certificates for their participation, T-shirts, accessories or bands/caps imprinted the name of the working group or the organization.

Targeting peer networks have potentially been extremely effective in achieving the aims of the intervention for the majority of activities in society are performed by them. So, the aim should be to keep them self-motivated and confident to drive the other community people. In addition to it a separate group of peers above 18 years should be formed for the sustainability of the project by acquiring means of economic independence.

V. ANNEXURE:

The following are the FGD Guidelines being used as a tool for qualitative analysis of the samples taken at Madanpur Khadar (N=32)

FGD Guide/Check List for Gauging Health seeking Behaviour

If you want to know about health issues, whom do you generally approach?

What are the various health problems that you have heard about?

What is the qualification of the health service provider whom you and your family member visit? (Probe separately for generic ailments and sexual and reproductive health related ailments)

What steps should be taken to prevent oneself from malaria? Is malaria curable? If yes, where do we need to seek its treatment?

What steps should be taken to prevent oneself from getting dengue?

What are the methods of transmission of dengue? Is Dengue curable? If yes, where do we need to seek its treatment?

What does the DOTS program cater for? Do you think TB is curable?

Where should one go to seek the treatment of TB?

What should be given to a child when she or he is suffering from Diarrhea?

Have you ever participated in any meeting / program organized by your government or community on health, hygiene, water, sanitation?

Have you observed any changes in your community by health camps, community meetings, rallies, street plays etc? Who organized those?

Have you ever tried any form of substances (alcohol, tobacco, drugs etc?) Do you think that such drugs or substance dependence could be cured?

If they had dependence, have you noticed any change in your health after quitting habit of substance abuse?

Have you ever stopped anyone from taking tobacco? What was the response of that person? Do you think quitting is possible? If yes, how?

What interventions may be effective in helping adolescents who have delayed sexual and reproductive health initiations? Do such young people need medical intervention?

Do you face any menstrual hygiene related problems? (Probe on typology of problems being faced by them-white discharge, RTIs etc.)

Are there people who use home based remedies for such menstrual hygiene and reproductive health ailments? If yes, what do they do? (Probe for home based remedies)

Whom do you seek support from if you face any menstrual hygiene and reproductive health related ailments? (Probe for Qualified Doctors support or quack etc)

What is HIV? What is AIDS? How does it spread? How does it not spread (Touching kissing, eating together etc.)? How can we prevent HIV/AIDS?

What type of protection does that condom give us? (Probe for respondents' knowledge on triple protection from condom-unwanted pregnancy, STI and RTIs and HIV)

When you fall sick (general ailments like cold fever, viral etc) whom do you approach for medical aid? *(Probe for the answers: quack, registered medical professional etc.)*

Do you visit health facility (Govt. or Pvt.)? If yes, why do you visit a particular health facility (Govt. or Pvt.)? Normally, for which ailments do you resort to doctor's support?

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