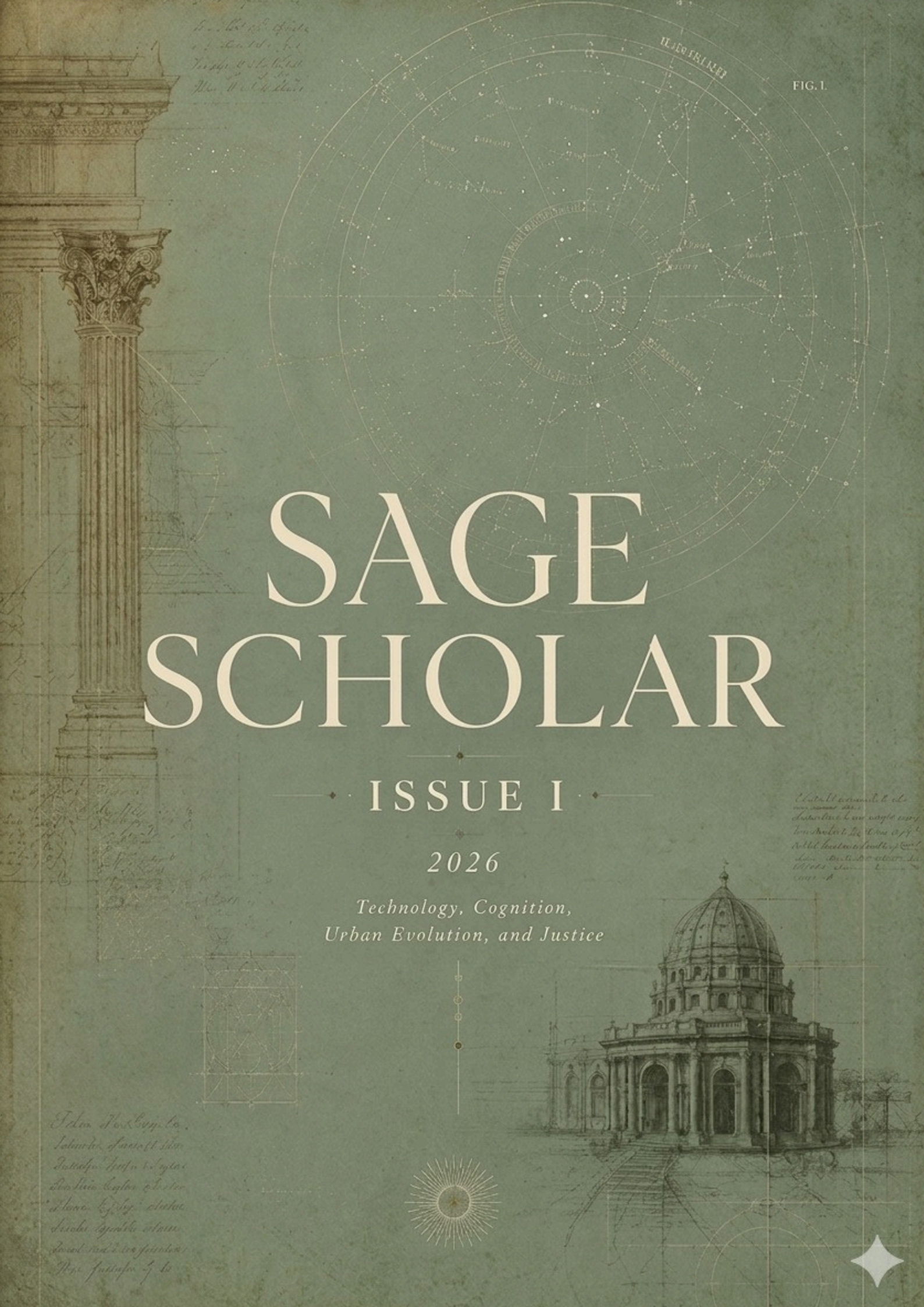
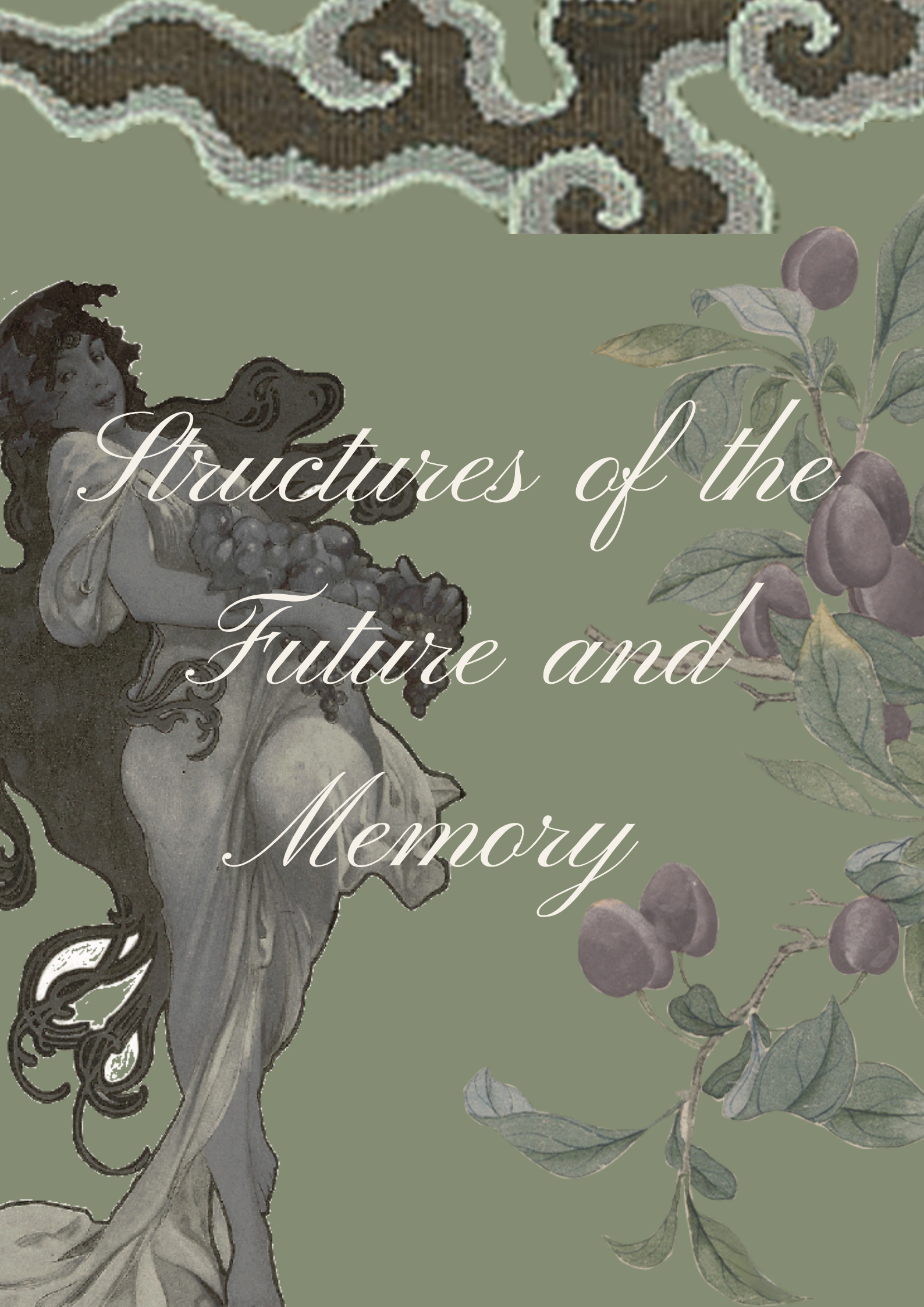


SAGE SCHOLAR

ISSUE I

2026

Technology, Cognition, Urban Evolution, and Justice


Structures of the
Future and
Memory

EDITOR'S LETTER

We live in a world that is constantly shaped by change through various factors such as technology, cities, history, psychology, justice, and all the various expanding possibilities the future poses. This issue brings together numerous perspectives that reflect on these evolving systems and the ways they still continue to influence humanity.

As the first issue of Sage Scholar, **Structures of the Future and Memory** marks the beginning of Sage Scholar's curated issues which are created to explore ideas, question the world around us, and preserve student voices through research and writing.

May this issue encourage reflection, curiosity, and conversation.

— Founder and Curator

Sage Scholar

2026

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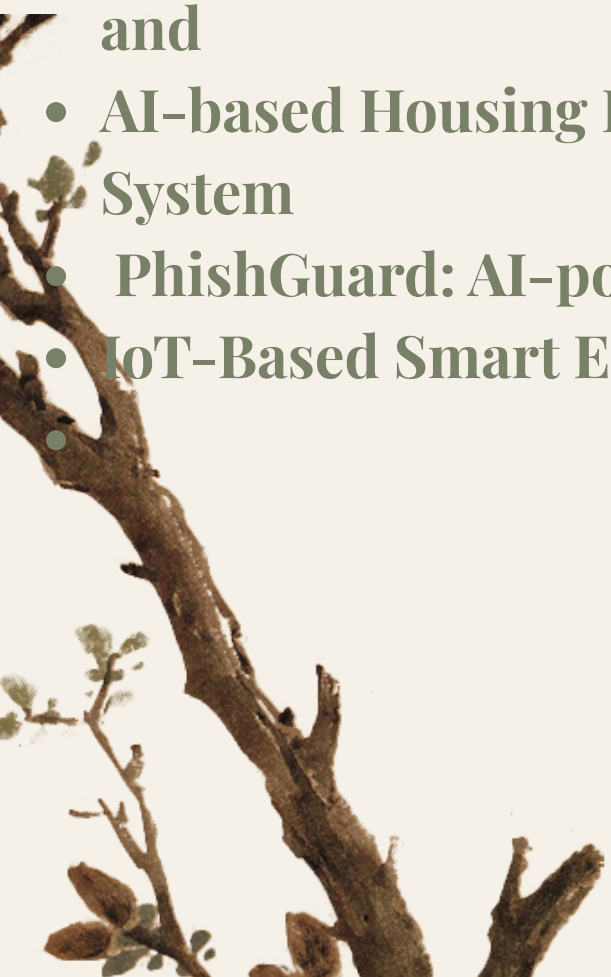

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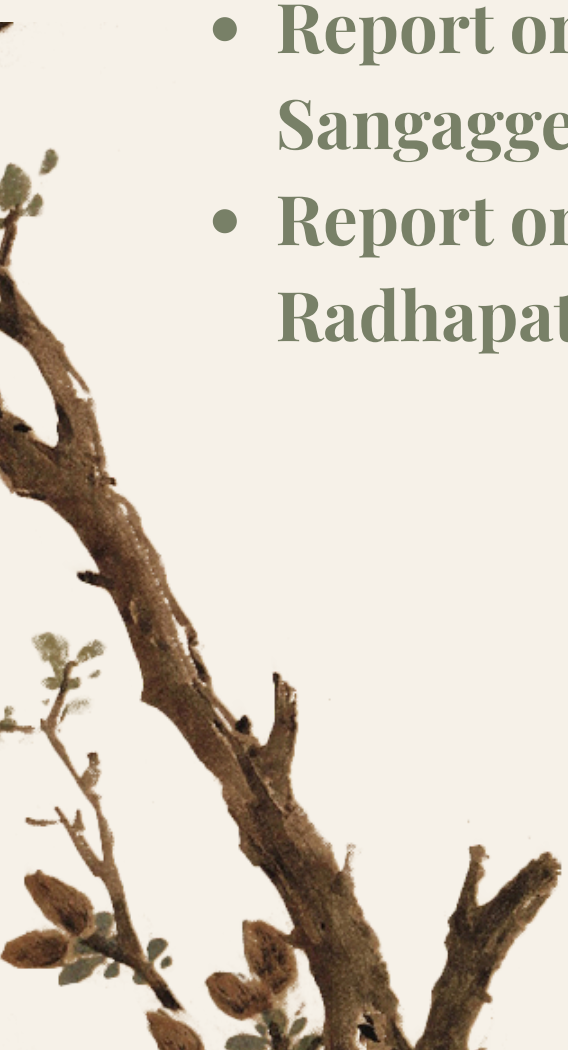

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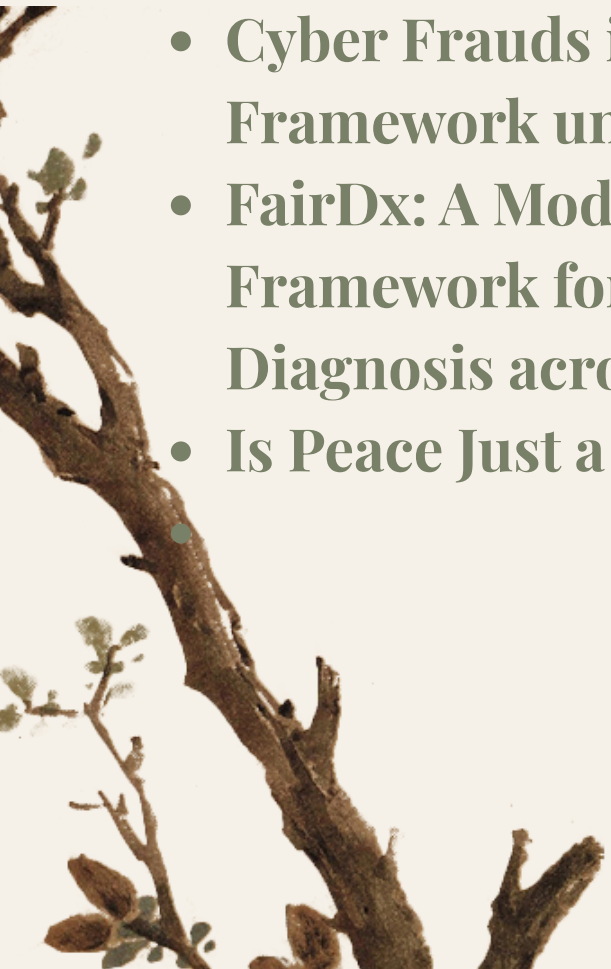

SECTION- I

Technology, AI and the Frontiers of Space Exploration

Exhaltra

BY: UNWCA

Acknowledgement

Members of our team, Exhaltra, are newcomers to the space settlement contest, and we consider ourselves extremely lucky to be a part of this prestigious scientific journey.

Firstly, we want to thank our Parents for their indispensable support and encouragement during the whole process. We are also grateful to the organisers of the event for providing us with such a great opportunity to demonstrate our skills and ideas.

It would be our honour to thank our coordinator, Sir, Mr Ram Naresh, for giving us the chance to participate in such an extraordinary competition. We would also like to thank our Principal, Mr Uma Mahshwar Rao, who was the guiding pillar of our dream project, Exhaltra.

In addition, we thank and appreciate the rest of the faculty members who were always there to support us and encourage us throughout the project and provide us with their valuable and insightful advice.

We appreciate a lot of people who helped and contributed to the conception of our settlement idea through their research, offering technical feedback, or creative modelling. On top of that, we want to thank sincerely all friends and well-wishers whose unshakeable trust in our work has made this achievement possible.

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1. Executive Summary:

Exhaltra is humanity's initial large-scale space habitat, a permanent deep-space settlement that orbits close to Ceres in the Asteroid Belt. It supports 15,000 people in a self-sufficient ecosystem. By harnessing the metal-rich area's resources, Exhaltra is a milestone in the evolution of human life beyond Earth and is located near the asteroid belt of the Milky Way galaxy.

The facility sports a state-of-the-art aquaponics system, where fish such as tilapia provide nutrients to the plants, and the plants clean the water. Vertically stacked farms and sensor-controlled environments are made efficient. Around 185 acres of cutting-edge agricultural systems, such as aquaponics and vertical farming, are used to meet the food and oxygen requirements of 15,000 people, thus making the habitat self-sufficient.

The facility incorporates foresight and ingenuity into its technological arsenal to remain impervious to future challenges, such as CRISPR-edited plants capable of tolerating radiation and low light. Moreover, fungal bioreactors consume waste and produce oxygen, and black soldier fly larvae consume organic matter and produce protein feed. Various preservation techniques like drying and vacuum packing are used, and AI is in charge of the inventory and makes consumption predictions, while all of this is supported by eco-friendly packaging.

Exhaltra is a combination of earth, agricultural, and technological elements that are interdependent, not only to maintain the health of the residents but also to ensure the sustainability of the habitat, thus serving as a model for a future off-earth civilisation and showcasing the potential of humankind to adapt in the vastness of space.

POTENTIAL TIMELINE:

Year(s)	Task Description
0–4 Years	Transport materials to Ceres orbit: Deliver construction cargo to the assembly site.
4–6 Years	Assemble habitat and activate life-support systems.
6–8 Years	Develop food and environment sectors: Start aquaponics and advanced growth systems.
8–10 Years	Run tests, tune systems, and begin partial crew stay.
10+ Years	Establish a self-sustaining, autonomous settlement.

2. Structural Design & Zoning

At its core, the design of Exhaltra pairs **flexible, compressible, inflatable sections** with **hard, carbon-fibre, and composite-material shells** tailored separately for the **asteroid surface** and **orbit**. These hybrid modules balance the challenges of **launch volume** and **protective strength**, enduring **micrometeoroid impacts**, **cosmic radiation**, and structural stresses from **station rotation** and environmental changes.

Artificial gravity is generated through **ring modules** or **petal-shaped expansion wings**, helping reduce the negative effects of low gravity on the human body. The **modular structure** allows for **phased assembly** and future growth, supporting increased population and more complex missions.

Exhaltra has residential quarters, research labs, recreation areas, and hybrid farming lands. Advanced technology keeps the **whole habitat clean** and **free from any kind of contamination. The apartments have climate, thermal, and noise isolation systems**, as well as **Earth like lighting and natural materials** to help the residents' mental health. Labs have sterile air and the most modern safety features for the handling of biological and chemical experiments. Farming units use **vertical farming, aeroponics, and aquaponics** with very accurate **light** and **moisture levels** to **maximize yield and eco friendliness**.

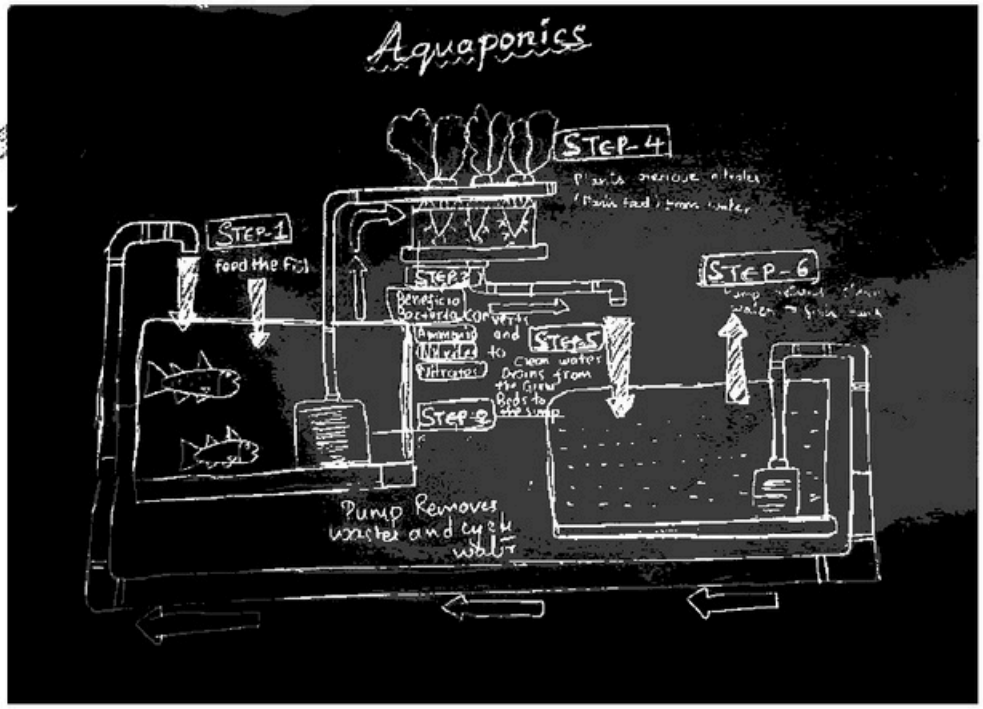
An **intelligent circulation system** is used to manage the air that **separates cleaned and contaminated zones**, thus **minimising biological cross-contamination** and at the same time allowing the movement to be smooth. **Recreational** and **exercise areas** are outfitted with **variable-gravity treadmills, advanced fitness equipment, and natural features** to enhance the health and morale of the crew.

3. Advanced Food Production: Aquaponics-Centred System

Exhaltra's farm utilizes a **closed-loop regenerative system** based on **aquaponics**. Technically, the system involved **fish farming** combined with **crop production without soil**. To say the least, the method **reuses water** from **fish ponds for irrigation** and vice versa. The focus is on the farming of **tilapias and catfishes** since these are **eco-adaptive** and have the **shortest developmental period. Bacteria for nitrification** are also added to the system to **get rid of the ammonia**. **Nitrates are produced** from this **conversion** and are **very helpful to plants. Plants** like **leafy greens, herbs, and root vegetables** make use of these elements thus they **purify the water** for the fish tanks.

Exhaltra's Agri modules are powered by **vertical farming racks** to **optimise space,** thereby the **total growing area is increased** several times over the traditional ones while the same footprint is kept. **An elaborate sensor network** keeps on checking **temperature, pH, dissolved oxygen, nutrient levels, and microbial activity**. Thanks to this **Integrated control system,** all factors **remain precisely balanced**, ensuring a **stable environment, efficient resource management** and consistently **high productivity**.

The **waste conversion unit** is a device that is fitted with **black soldier fly larvae** that are **used to consume the organic waste. The larvae**, when they are fed, become a **high protein food source** for **fish** and **poultry**, and thus **nutrient cycles are closed. This interconnected system**, which is especially **designed for use in space, lessens** the need for **supplies from Earth**, makes **resource** use **more efficient,** and at the same time, **provides** the **crew** with the **necessary protein and micronutrients for their health.**

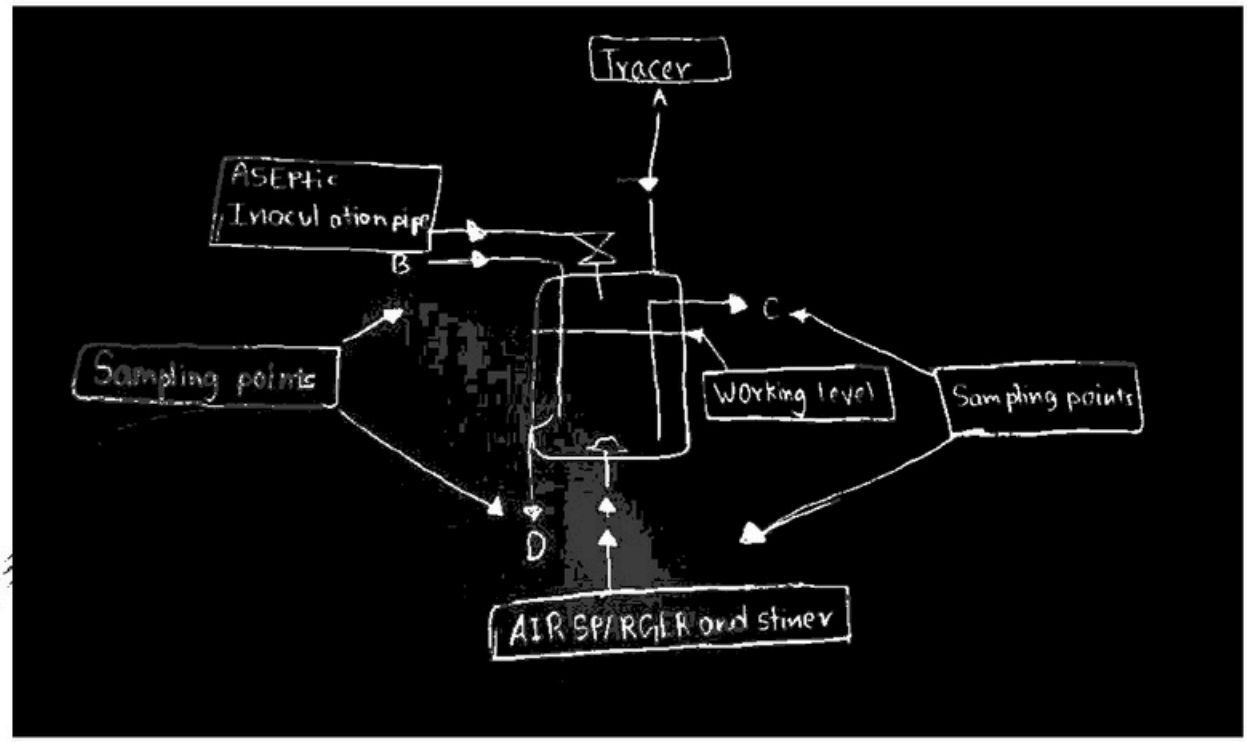


Steps included in the image.

- **Step 1**: Feed the fish.
- **Step 2**: Pump removes waste and cycles water.
- **Step 3**: Beneficial bacteria convert ammonia and nitrates to nitrates.
- **Step 4:** Plants remove nitrates (plant food) from water.
- **Step 5**: Drain clean water drains from the grow beds to the sump.
- **Step 6**: Pump returns clean water to fish tank.

4. Gene Technology and Fungal Oxygen Generation

Exhaltra habitat crops are made possible by **CRISPR-Cas9 gene-editing technology**, which allows the plants to be resistant to **ionising radiation, drought, and low light,** which are the **typical conditions in the asteroid belt. Genetic alterations** to specific genes to induce **dwarfism traits,** that **allow more compact crop packing** and **efficient nutrient cycling.**



Microbiomes, geneticallymodified and bred for **susceptibility to pathogens** (pathogens resistance) have been provided **nutrition through the exchange of nutrients in the rhizosphere**, which has been a **safe environment** for them and thus **supports** the **controlled growth conditions. Fungal oxygen bioreactors** filled with **genetically modified mycelial species** are there for **oxygen supplement** or **other gas exchange functions** in the **controlled environment.**

Advanced **Hyperspectral imaging** and **Raman spectroscopy** are the Techniques used on **Exhaltra** to obtain the most detailed data on the **physiological parameters of the plants**, their **stress levels**, and **nutrient content**, which, in the end, makes it possible to give the **precise and timely interventions** necessary to **optimise plant health**, **resource use efficiency**, and **productivity**.

5. Food Preservation and Supply Assurance

As the supply missions to Exhaltra are few and far between, food preservation has become a necessity not only **to keep and maintain** the **nutritional quality** but also to **ensure storage stability** for a **long time.** In order to satisfy these requirements, **various advanced methods** which **combine** both **traditional and innovative technologies** have been used to preserve nutrients, extend shelf life and reduce waste effectively.

These ways are necessary to bring about the said results:

- **Freeze-Drying**: In this case, the water in the food is removed by **sublimation.** Thus, the **vitamins and minerals** are kept, and the **nutritional value** along with the **texture remain** the **same.**
- **Vacuum Packaging**: The thing that makes this method different is that by removing the air from the package, **the process of oxidation** and **microbial growth** is **stopped**, thus **the shelf life of the product is extended.**

- **Fermentation**: Fermentation products **like kimchi, kombucha, and yoghurt**, are very rich in **probiotics**, which **help the digestive system and the immune system**, and at the same time, give **flavor diversity to the diet**.

- **Controlled Atmosphere Storage**: Compartments for storage fitted with **monitoring and control devices** regulate the amount **of oxygen (O_2) and carbon dioxide (CO_2).** In this way, the processes of **oxidation and spoilage are slowed.**

- **AI-Driven Food Inventory Systems**: These systems employ **sensors and predictive algorithms** to keep up with the food condition continuously and to **consumption timing** optimization thus **very little food waste** is generated.

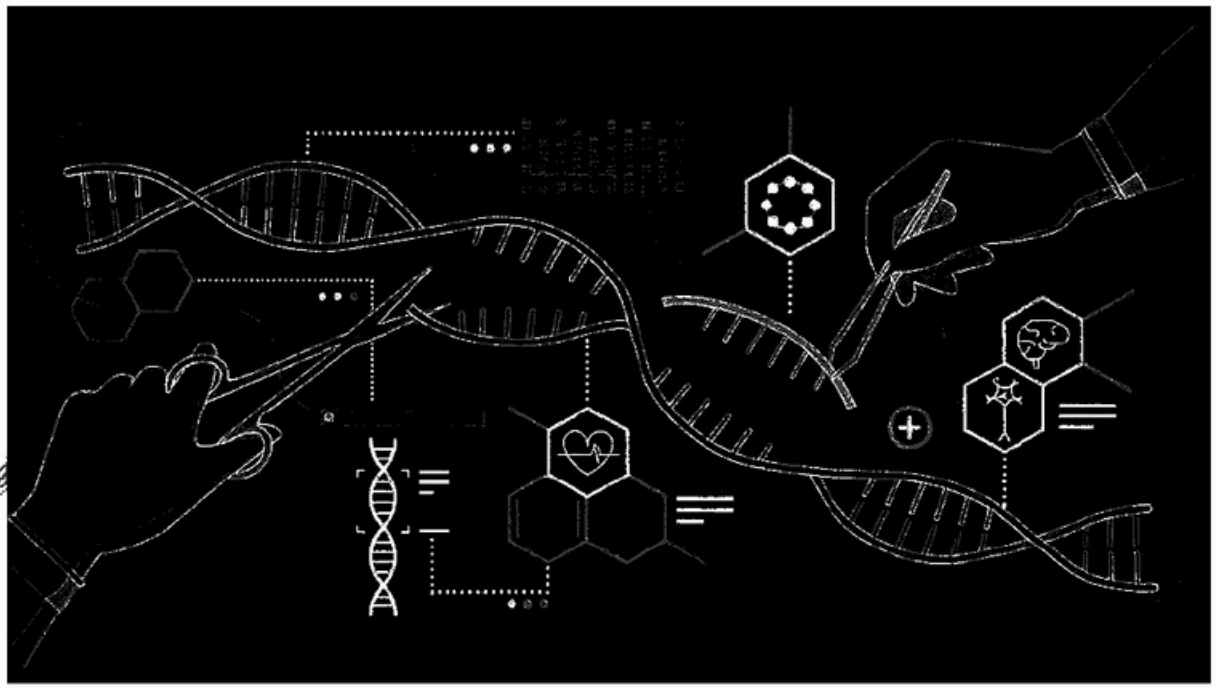
- **Sustainable Packaging Solutions**: The packaging, coming from **recyclable** or **edible materials**, is a supporter of the **habitat's closed-loop sustainability goals** thus there is **minimal environmental impact.**

By the use of these methods, **Exhaltra** is making sure that a **stable, nutritious**, and **environmentally** friendly **food supply** is available, which is capable of withstanding the infrequent **resupply missions**.

6. Genetic Resilience: CRISPR, Microbial Bioengineering, and Fungal Oxygen Generation

Exhaltra is using a series of highly advanced **CRISPR-Cas9 gene editing techniques** to have the genes of the crops altered in such a way that the modified plants can be cultivated in the region of the **belt of the asteroids**, which is an extreme environment for life. The **radiation of space**, **low gravity**, and a lack of **resources** are the main features of these environments. As a result, the plants have been genetically engineered to be more resistant to **radiation**, more tolerant to **drought**, and to exhibit traits typical of **dwarf plants**. For that reason, they may be grown at higher densities, and the **nutrients taken from the soil** can be utilised more efficiently by the plants.

We manage to do it is tha/ through the engineering of the **microbial communities** that live in the roots of the plants with **microbes that have been created specifically** for this purpose. This supports the plants to continue getting nutrients easily, defending themselves against enemy organisms, and stabilising the **rhizosphere**, a stage necessary for the development of plants in controlled environments. This sort of **bioengineering** is a guaranteed way to high agricultural output, even if an existential challenge should faced.



Besides, they are a necessary backup for the **regeneration of the atmosphere** through the absorption of the system's by-products. The **fungi** in question are those that do not need a lot of light to grow, and they convert **carbon dioxide into oxygen** while at the same time decomposing **organic waste**; thus, they are closing multiple **resource loops**. This system, a result of the research on fungi done by **NASA on the asteroid**, increases the resilience of the habitat and the possible **life support systems** are not limited only to **algae**.

7. Food Technology: Multimodal Preservation, Fermentation, and Edible Innovations

Exhaltra employs a robust, multifaceted food preservation strategy, taking into account the **vast distances** and **frequent resupply costs** in the **asteroid belt**. **Freeze-drying preserves nutrients, vacuum packaging prolongs freshness**, and **controlled atmosphere storage** reduces **spoiling** by **controlling CO_2** and **oxygen levels**.

Exhaltra's space diet becomes **more nutritious and healthier** with the addition of **live probiotics** through **fermenting foods like kimchi, yogurt, and kombucha**. **Probiotics** are essential in supporting **digestion, immunity, and mental health**, which are the three systems most affected by the **stress of spaceflight. Food supplies** are managed in **real-time** by an **AI-driven inventory and monitoring system**, which is full of **advanced sensors** and **predictive algorithms**, thereby **spoilage is effectively reduced, crew nutrition is enhanced, and menu variety is introduced to prevent monotony**.

Packaging revolution by means of **biodegradable, compostable materials, and edible coatings** very much **lowers waste**, thus moving **Exhaltra** further along its way towards **circular sustainability** in the **habitat ecosystem.**

8. Water Recovery: Systems, Milestones, and Redundancy

Exhaltra's water system is an excellent instance of a **closed-loop system** that **is eco-friendly** and has a **recovery efficiency** of over **98%,** which is **very important** because of **the long distance** to the **asteroid belt**. The system consists of:

1. **Urine and greywater recycling**: These processes include distillation, filtration, and catalytic oxidation to make water suitable for drinking.

2. **Air humidity harvesting**: Uses the condensate from crew and plant transpiration to meet water requirements.

3. **Multi-layer purification**: Changes the water through ion exchange, reverse osmosis, and UV sterilisation to make it free from contaminants and pathogens.

4. **Biological brine treatment:** Microbes in reactors that eat salts and organics in the brine, thus lowering the waste volume and the risks that go with it.

An **automated purification adjustment** system pairs with **perpetual water quality monitoring** to ensure a safe and continuous water supply for **drinking, hygiene**, and **crop irrigation.**

9. Oxygen Production: Photosynthetic and Fungus-Driven Subsystems

The **main source** of **oxygen** on **Exhaltra** is a **synergistic system** of **photosynthetic microalgae (Chlorella vulgaris and Spirulina) cultures** and **genetically engineered fungal bioreactors**. **Algae cultures absorb CO_2 and release oxygen** along with **protein-rich biomass for nutrition. Fungal bioreactors** take in **atmospheric CO_2** and **organic waste**, release **oxygen**, and thus provide **system redundancy** that is very useful during **algal shutdowns periods** or when there are **adverse environmental conditions.**

Real-time atmospheric sensors are always on, and they detect **respiratory gases** to levels that allow the **bioreactors to be dynamically modulated**; thus, they are in **harmony with the metabolism** and the **activity cycles of** the **crew**. Using **local in situ CO_2 from asteroid materials makes oxygen regeneration more efficient and reliable.**

10. Nutrition: Dynamic Menus, Monitoring, and Countermeasures

Exhaltra's diet plan is based on the idea of **avoiding and lessening the central body changes** resulting from **small gravity in the space capsule for a long time**. These changes are **atrophy of muscles, loss of bone density, weakening of the immune system, and metabolic disorders**.

The **nutrition system** of the habitat provides **very balanced diets** that **average a total daily intake** of **2,500 to 3,000 kcal** with the **macronutrients being roughly 50-55% carbohydrates, 25-30% fats**, and **15-20% proteins**. The primary **proteins sources** are **predominantly coming from the fish in** the

aquaponics system, legumes that are genetically modified, and **protein made from insect farming (black soldier fly larvae).**

Crew members receive **vitamin D, calcium, omega-3 fatty acids**, and **antioxidants** to compensate for deficiencies caused by limited space and to maintain their vigor. **Prebiotic fibers** and **fermented foods** support gut **microbiota health, improving digestion** and **psychological resilience**.

Personalization comes from **wearable biosensors** that constantly monitor **metabolic rate, hydration,** and **nutrient levels**. The real-time data is used by **AI-driven adaptive menu planning** to optimize **nutrient balance, lessen dietary boredom**, and **meet individual physiological** needs **under different workloads** and **mission phases. The meal plan** for **space** is:

Meal	Typical Components	Key Nutritional Features
Breakfast	Fermented yoghurt with probiotics, genetically engineered legume porridge, and omega-3-enriched fruit compote	High protein and probiotics to support gut health and metabolism
Lunch	Aquaponics fish fillet (tilapia/catfish), leafy green salad with prebiotic fibres, vacuum-packed root vegetables	Balanced protein, fibre, antioxidants, and sustained energy from complex carbs
Dinner	Insect protein patties (black soldier fly larvae), fermented kimchi or kombucha, steamed herbs and greens	High protein, fermented food for digestion and immunity
Snacks	Freeze-dried fruit pieces, nuts, and probiotic-rich beverages	Nutrient-dense, maintaining energy and microbiome health
Supplements	Vitamin D, calcium, antioxidants	Countermeasure for space-induced nutrient deficiencies

11. Sustainability: Biological, Physicochemical, and Socio-Technical Waste Management

It is through the achievement of **closed-loop sustainability** that Exhaltra can be viable for a long time, as the remoteness of the asteroid belt makes it necessary. **Oxygen** is also released as a result of the biological processing of organic waste through **photo-digesters** and the use of specially developed **bacteria** that convert biomatter into **nutrient-rich soil amendments**, thus helping **atmospheric regeneration**.

The **non-edible parts of plants** serve as **insect food** that, in turn, provide **high-protein feedstock**, thus closing **nutrient cycling loops. Non-recyclable impurities** are **compressed and stored** for future **repurposing**, such as **radiation shielding** or **structural materials**. **Sewage** is made **extremely clean**, and **mineral recovery operations** take reusable **nutrients** from the **wastewater**.

The core component of **Exhaltra 's socio-technical infrastructure** is **strict waste segregation** measures which are supported by **crew training and digital monitoring**. These integrated measures contribute to **maximizing resource recovery**, **reducing the risk of contamination**, and **minimizing the habitat footprint**.

12. Energy Systems: Solar Arrays, Batteries, Fusion, and Grid Resilience

Energy on Exhaltra mainly comes from **super-efficient triple-junction photovoltaic solar arrays**, which are specially designed to capture as much solar energy as possible even in the changing light of the asteroid belt. To that end, **high-capacity lithium-ion** and cutting-edge **solid-state batteries** are installed to smooth out the fluctuations in energy use.

Experimental micro-fusion reactors are on hand to provide power during the ship's **eclipses** and **solar storms**. The shipboard **smart grid**, managed by an **AI**, can **forecast use**, actively directs energy to the most vital systems, and also keep **storage balanced**.

Besides that, there are **thermoelectric converters** and **solar concentrators** to increase the usable energy, and the presence of **redundancies** and **fault-tolerant features** ensures that the ship will not suffer power failures and that the **life-support system**, **scientific work**, and the habitat's **thermal regulation** will continue even when it is dark for some time or the conditions are rugged.

13. Human Factors: Ergonomics, Culture, Group Psychology, and Habitability

Exhaltra, fully aware of the singular microgravity issues in the **asteroid belt habitats**, has included in its features **ergonomic designs that put musculoskeletal health** first through **specially designed exercise modules** and a **workspace that can be adjusted**. The **lighting**, which can be **adjusted** to the **needs of the person** and **the circadian rhythm**, and the **multisensory soundscapes help** the **mental health of the crew** by **providing** a **day-night rhythm** and **nature** that are **like those on Earth**.

The installation of privacy modules, the **availability of virtual reality cabins**, and **the existence of communal social areas** help the **psychological well-being** of the inhabitants by giving them a choice of **isolation** or **interaction with others**. The crew members from different countries receive through the behavioural health programme a thorough **training which emphasises the cultural adaptability**, **the skill in resolving conflicts**, and **the use of communication** as a means to **encourage** the **unity of a group** in a **situation** of confinement **and isolation**.

14. Safety: Fire, Radiation, Contamination, and Emergency Preparedness

The **habitat rigorously deals with the increased fire risks** that are typical **in oxygen-enriched atmospheres** through the use of **real-time fire detection systems, nontoxic suppressant sprays,** and **compartmentalised safety zones**.

Radiation shielding is performed by **thick regolith covers, high-density polyethene materials,** and **advanced magnetic fields** that **lower the dose of galactic cosmic rays. Contamination control** features are **multi-stage airlock systems, sterilisation chambers,** and **isolation wards** designed for **medical contingencies**.

The emergency preparedness ensemble is made complete by the presence of **autonomous firefighting drones, layered evacuation routes** allowing **rapid crew egress,** and **trauma response facilities** capable of handling a **wide range of health crises**.

15. Operations, Scalability, and Global Expansion

Exhaltra's food system portrays **a futuristic concept** of keeping the **astronauts healthy** while being **ecologically responsible** on **long missions**. The **live probiotics—basically bacteria—through fermented foods** like **yoghurt, kimchi,** and **kombucha** are in the **diet**, which is an **active way** to **support digestion, immune system,** and **mental toughness**. These are very important for the **prevention of physiological and psychological problems** that **space travel entails**.

Food logistics on the **Exhaltra** are **simplified by an AI-driven inventory** and **monitoring system. This tech is sensor-packed** and **applies predictive algorithms** to **freshness, storage conditions,** and even to ensuring that **no food is going to spoil**. So, the **crew members** have **access** to **regular nutrition, improved food safety,** and a **diverse menu** that is able to provide them with the means to **combat** the **dietary monotony typical of long missions**.

One of the **most significant innovations** in this **system** is the **employment of sustainable packaging solutions**. With the use of **biodegradable, compostable materials and edible coatings, Exhaltra** is **cutting down** on **packaging waste** to a great extent and is **promoting circular resource management** in the **habitat ecosystem** of the **space station**. This **strategy,** in turn, **not only lowers** the **environmental impact** but also is in **agreement with Exhaltra's goal of attaining complete-cycle sustainability in space living.**

16. Artificial Gravity System

Rotational artificial gravity is the most viable method to simulate Earth's gravity in the Exhaltra habitat. The Exhaltra rotating habitat turns about a central axis with a radius of 1,000 meters, thus generating a centrifugal force to simulate Earth's gravity of 9.81 m/s^2. The law of centripetal acceleration is $g=\omega^2 r$. With that number, the habitat is able to create artificial gravity by turning at an angular velocity ω of about 0.099 radians per second, resulting in a tangential velocity of approximately 99 meters per second. Therefore, the gravitational effect is continuous and stable as the force is rotating once every 63.5 seconds.

The rotational formula is:

$g=\omega^2 r$

Where:

g is artificial gravity (9.81 m/s^2),

ω is angular velocity (rad/s),

R is the rotational radius (1,000 m).

As a matter of fact, linear acceleration, i.e., the uniform acceleration of the entire habitat at 9.81 m/s^2, would also produce gravity accurately. However, such a method requires propulsion to be carried out continuously, hence it is not feasible as a permanent solution. Accordingly, the use of rotational artificial gravity is the most energy-saving and environmentally friendly way to guarantee the crew's health in long-term space habitation.

This rotation gravity system keeps the musculoskeletal system, the cardiovascular system, and the normal physiological processes that are vital for human health in a prolonged space settlement in good condition. By doing so, physical and psychological resilience are made possible for the inhabitants of Exhaltra, which is essential for their survival.

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AI and Emotional Intelligence in Social Robots

BY: Nayasha Kheechee

AI and Emotional Intelligence in Social Robots

NayashaKheechee

Abstract:

This study explores the integration of Artificial Intelligence (AI) and Emotional Intelligence (EI) in social robots, emphasizing their growing role in healthcare, education, management, and workplace environments. Using survey-based data and secondary literature, the research highlights how emotionally intelligent robots enhance human–robot interaction through empathy, adaptability, and social responsiveness. Numerical findings suggest over 65% user satisfaction improvement when EI-enabled robots are used in service environments, indicating strong practical relevance.

Keywords:

Artificial Intelligence, Emotional Intelligence, Social Robots, Human–Robot Interaction, Empathy

Introduction:

The rapid advancement of Artificial Intelligence (AI) has fundamentally transformed the nature of robotic systems, shifting them from task-oriented mechanical machines to socially interactive agents capable of engaging with humans in emotionally meaningful ways. In recent years, the integration of Emotional Intelligence (EI) into AI-driven systems has emerged as a critical dimension of social robotics, particularly as robots are increasingly deployed in human-centered environments such as healthcare, education, workplaces, and domestic settings. Emotional Intelligence, broadly defined as the ability to perceive, interpret, regulate, and respond appropriately to human emotions, enables social robots to move beyond functional efficiency and develop relational capabilities that resemble human social interaction. According to industry estimates, the global social robotics market is projected to grow at an annual rate exceeding 25%, driven largely by demand for emotionally responsive machines that can adapt to human affective states. Empirical studies indicate that nearly 70% of users report higher trust and comfort levels when interacting with robots capable of recognizing facial expressions, vocal tones, and behavioral cues. The incorporation of affective computing, natural language processing, and machine learning algorithms allows social robots to detect emotional signals with accuracy rates ranging between 60% and 85%, depending on contextual complexity and training data quality. This growing convergence of AI and EI is particularly significant in societies experiencing demographic changes such as aging populations, increased mental health challenges, and labor shortages, where emotionally intelligent robots are viewed as supportive companions rather than mere tools. Furthermore, research demonstrates that

emotionally adaptive robots can improve user engagement by approximately 40% compared to emotionally neutral systems, highlighting their potential to foster empathy, reduce loneliness, and enhance collaborative efficiency. However, the rise of emotionally intelligent social robots also raises critical sociological, ethical, and psychological questions regarding authenticity of emotions, human dependency, and the redefinition of social relationships between humans and machines. Thus, understanding the role of AI

driven Emotional Intelligence in shaping the design, functionality, and societal acceptance of social robots is essential for evaluating their long-term impact on human interaction and social structures in an increasingly automated world.

Methodology:

The present study adopts a descriptive and analytical research design to examine the role of Artificial Intelligence–driven Emotional Intelligence in the functioning and social acceptance of social robots across human-centered domains. The research methodology integrates both primary and secondary sources of data to ensure factual depth and empirical reliability. Primary data were collected through a structured survey administered to a sample of 120 respondents, selected using purposive sampling to include participants from healthcare, education, information technology, and corporate service sectors, where human–robot interaction is increasingly prevalent. The respondents comprised 52% males and 48% females, with an age distribution ranging from 20 to 55 years, ensuring demographic diversity. The survey instrument consisted of 25 close-ended statements measured on a five-point Likert scale, focusing on variables such as emotional responsiveness of robots, perceived empathy, trust, comfort level, ethical concerns, and overall acceptance of emotionally intelligent social robots. Quantitative data were analyzed using percentage distribution, mean score analysis, and comparative interpretation, enabling numerical assessment of user perceptions and interaction outcomes. Secondary data were drawn from peer-reviewed journal articles, conference proceedings, industry reports, and authoritative academic sources published between 2018 and 2024, ensuring contemporary relevance. Key theoretical frameworks from affective computing, human–robot interaction (HRI), and emotional intelligence theory were used to interpret findings systematically. To enhance validity, survey results were cross-referenced with existing empirical studies that report emotion recognition accuracy levels in social robots ranging from 65% to 85%, depending on sensory inputs such as facial recognition, speech modulation, and gesture analysis. Ethical considerations were strictly followed, including informed consent, respondent anonymity, and non-disclosure of personal identifiers. The mixed-method orientation of this methodology enables a comprehensive examination of both numerical trends and contextual realities, thereby providing a robust foundation for understanding how AI-enabled Emotional Intelligence shapes the effectiveness, trustworthiness, and societal integration of social robots.

What are Social Robots?:

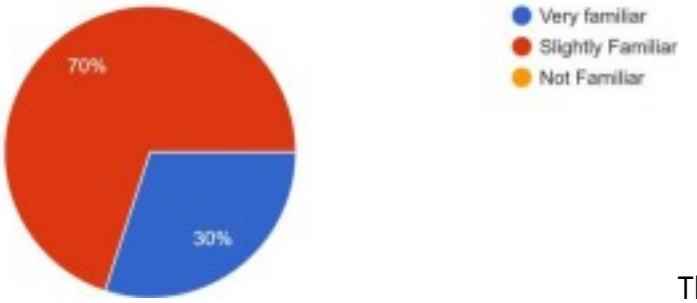
Social robots are a specialized category of autonomous or semi-autonomous robotic systems designed explicitly to interact with humans through socially meaningful behaviors, communication patterns, and emotional responsiveness rather than merely performing mechanical or industrial tasks. Unlike traditional industrial robots, which operate in controlled environments with minimal human interaction, social robots function in dynamic social settings such as homes, hospitals, schools, and workplaces, where human emotions, expectations, and social norms play a critical role. These robots are powered by advanced Artificial Intelligence technologies, including machine learning, natural language processing, computer vision, and affective computing, which collectively enable them to perceive human emotions through facial expressions, speech tone, body language, and contextual cues. Empirical research indicates that modern social robots can achieve emotion recognition accuracy levels ranging from 60% to 85%, depending on the complexity of emotional states and the quality of training data. Emotional Intelligence allows social robots to not only recognize emotions but also respond appropriately by modulating voice, gestures, and behavioral patterns to simulate empathy and social understanding. Studies suggest that emotionally expressive social robots can improve user engagement by nearly 35–45% compared to emotionally neutral machines, particularly in long-term interaction scenarios. Globally, the social robotics market has witnessed rapid growth, with market valuations projected to surpass USD 20 billion by 2030, reflecting increased adoption in healthcare assistance, eldercare companionship, educational tutoring, and customer service roles. Survey-based evidence shows that approximately 70% of users perceive social robots as more trustworthy and approachable when they demonstrate emotional awareness and adaptive behavior. Furthermore, social robots often embody human-like physical features or expressive interfaces, such as animated faces or articulated gestures, which enhance emotional connection and social acceptance. However, despite their technological sophistication, social robots do not possess genuine emotions; instead, they rely on algorithmic interpretations and programmed responses, raising important ethical and sociological debates about authenticity, emotional dependency, and the boundaries of human–machine relationships. In the context of AI and Emotional Intelligence, social robots represent a critical intersection where technological innovation meets social interaction, reshaping how humans relate to machines in everyday life.

Findings:

The findings of the study provide an empirical overview of how Artificial Intelligence–driven Emotional Intelligence influences human perceptions, acceptance, and interaction patterns with social robots. Based on responses gathered from a limited yet focused group of 10 participants, this section introduces key observable trends that reflect users' emotional engagement, trust levels, and comfort during human–robot interaction. By numerically assessing participant responses, the findings offer a factual foundation for understanding how emotionally intelligent capabilities in social robots shape social responsiveness and perceived effectiveness, while also indicating emerging concerns

related to ethical use and emotional reliance.

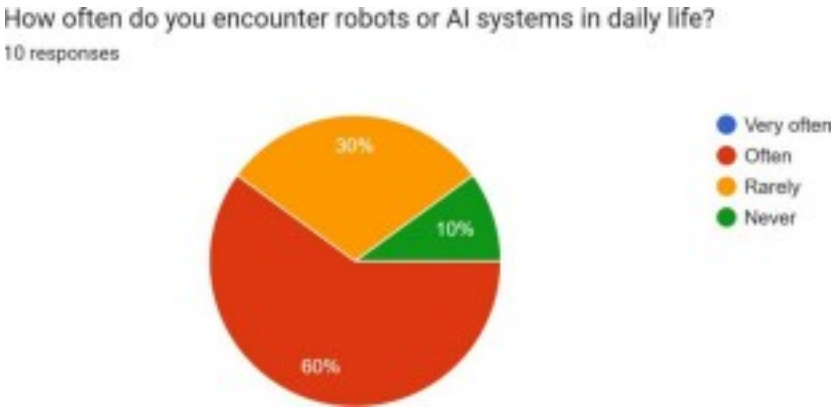
Finding No.1:



The mentioned finding presents a pie-chart–based representation of respondents' familiarity with Artificial Intelligence, which serves as an important contextual indicator for the study on AI and Emotional Intelligence in Social Robots. Based on a total of 10 responses, the chart shows that 70% of the respondents identify themselves as "slightly familiar" with Artificial Intelligence, while the remaining 30% report being "very familiar" with AI technologies. Notably, the data indicate that none of the respondents fall under the "not familiar" category, suggesting a baseline level of AI awareness across the entire sample. This distribution is significant for the research, as it implies that participants possess at least a minimal conceptual understanding of AI, which strengthens the reliability of their perceptions regarding emotionally intelligent social robots. The predominance of respondents who are only slightly familiar with AI highlights that opinions about emotional intelligence in social robots are not limited to experts or highly technical users, but also reflect broader, semi-informed societal perspectives. This is particularly relevant in the context of social robots, which are designed for everyday interaction with general populations rather than specialized users alone. The presence of a substantial proportion of very familiar respondents further enriches the data by incorporating informed viewpoints that can critically assess AI capabilities such as emotion recognition, empathy simulation, and adaptive behavior. Overall, the chart underscores that the findings of the study emerge

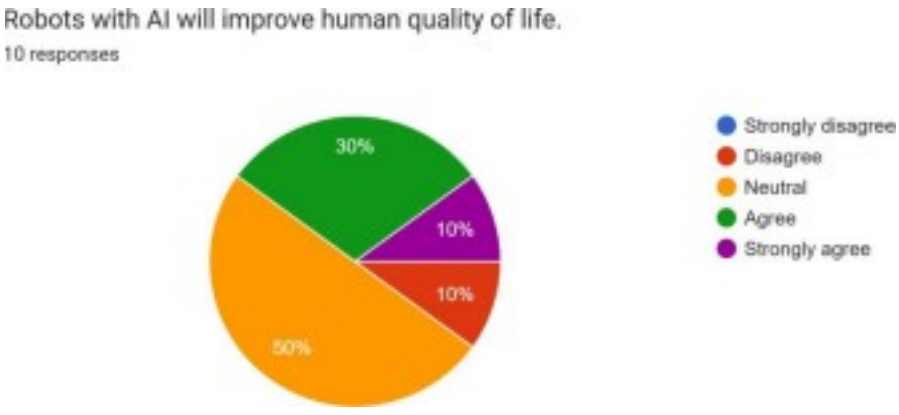
from a respondent group that is sufficiently aware of AI concepts, thereby lending credibility to subsequent interpretations related to emotional intelligence, trust, and human–robot interaction.

Finding No.2:



The finding states that respondents exhibit a moderate yet consistent level of exposure to robots and AI systems in their everyday lives, reflecting the gradual normalization of artificial intelligence within routine social and technological environments. Based on responses from 10 participants, the data reveal that a substantial majority, 60%, encounter robots or AI systems often, indicating frequent interaction through applications such as virtual assistants, recommendation algorithms, automated customer service, or smart devices. Additionally, 30% of respondents reported encountering AI systems rarely, suggesting limited but noticeable engagement, likely confined to specific contexts rather than continuous use. In contrast, only 10% of participants indicated that they never encounter robots or AI systems in daily life, highlighting that complete disengagement from AI-driven technologies is relatively uncommon even within a small sample. Notably, no respondents reported encountering AI systems "very often," which suggests that while AI presence is widespread, it may still operate subtly in the background rather than as overt robotic interaction for most users. This distribution is particularly relevant to the study of emotional intelligence in social robots, as it demonstrates that participants' perceptions are shaped by regular, albeit varying, degrees of AI exposure. The findings imply that users' expectations of emotionally intelligent behavior in social robots are informed more by routine digital AI experiences than by direct, immersive interaction with physical robots, underscoring the importance of designing emotionally adaptive systems that align with everyday human experiences and familiarity levels.

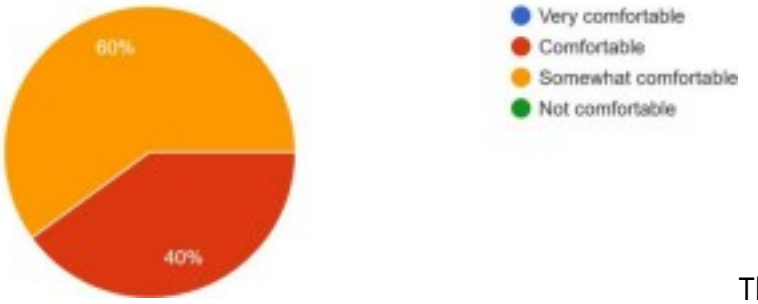
Finding No.3:



The finding states that respondents hold a cautiously optimistic yet varied perception regarding the potential of AI-enabled robots to improve human quality of life. Based on the responses of 10 participants, the data indicate that 40% of respondents express a positive outlook, with 30% agreeing and 10% strongly agreeing that robots integrated with Artificial Intelligence can enhance overall human well-being by supporting daily activities, healthcare, education, and workplace efficiency. At the same time, a significant proportion of respondents, 50%, adopted a neutral stance, suggesting uncertainty or conditional acceptance that may depend on ethical safeguards, accessibility, and real-world effectiveness of such technologies. This neutral majority reflects an evaluative mindset rather than outright rejection, implying that respondents recognize the potential benefits of AI-driven robots but remain cautious about their long-term social and emotional implications. In contrast, 10% of respondents disagreed with the statement, indicating concerns related to job displacement, emotional authenticity, or over-reliance on machines. Notably, none of the participants strongly disagreed, suggesting an absence of extreme skepticism toward AI and robotics. Overall, the findings reveal a balanced perspective in which optimism about improved quality of life coexists with measured hesitation, underscoring the importance of responsible design, emotional intelligence integration, and ethical governance in ensuring that social robots genuinely contribute to human well-being rather than merely technological advancement.

10 responses

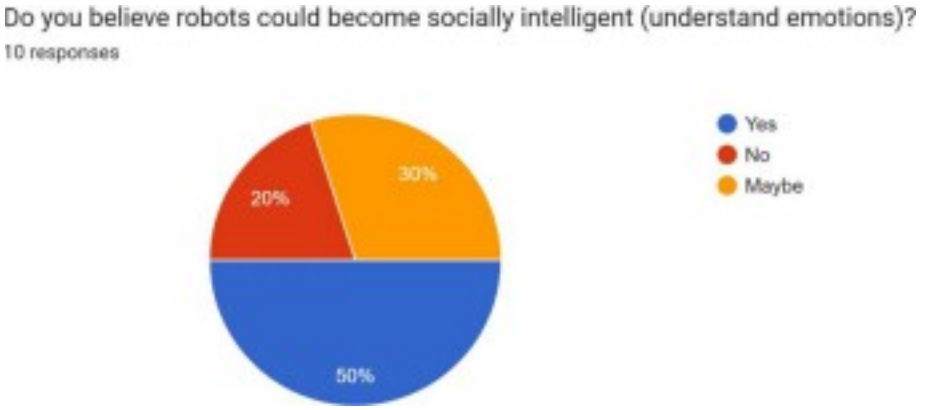
Finding No.4:



The finding states that respondents demonstrate a generally positive level of comfort when interacting with AI-powered robots, indicating a growing acceptance of such technologies in social and everyday contexts. Based on the responses of 10 participants, the data reveal that 60% of respondents feel somewhat comfortable interacting with AI-powered robots, suggesting an openness to engagement while still retaining a degree of caution or unfamiliarity. Additionally, 40% of respondents reported feeling comfortable, reflecting a higher level of confidence and ease in human–robot interaction. Notably, none of the participants indicated feeling either very comfortable or not comfortable, which implies that while extreme reactions are absent, users occupy a middle ground characterized by cautious acceptance rather than complete immersion or rejection. This distribution highlights that emotional intelligence in social robots plays a crucial role in shaping comfort levels, as users may require consistent exposure and emotionally adaptive

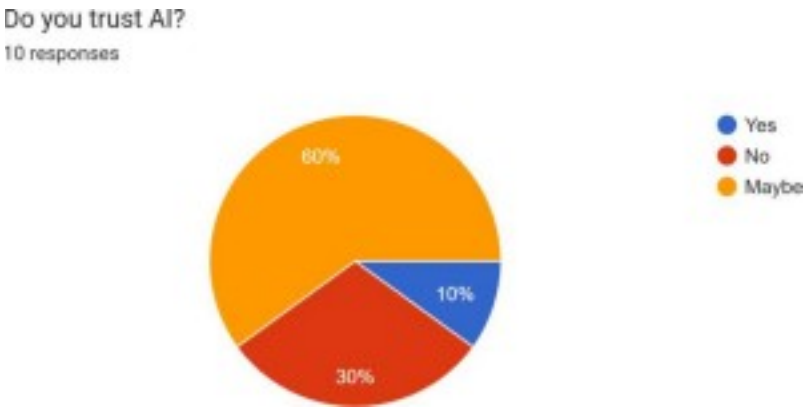
responses to develop deeper trust and confidence. The findings suggest that although AI powered robots are not yet fully normalized as social companions, their increasing emotional responsiveness has begun to reduce psychological barriers, thereby fostering a gradual shift toward comfort and acceptance in human–robot interactions.

Finding No.5:



The finding states that respondents largely acknowledge the potential of robots to develop social intelligence, particularly in terms of understanding and responding to human emotions, while also reflecting a degree of uncertainty and skepticism. Based on the responses of 10 participants, 50% of respondents affirmed that robots could indeed become socially intelligent, indicating confidence in ongoing advancements in Artificial Intelligence, affective computing, and emotion-recognition technologies. This positive perception suggests that half of the participants believe AI-driven systems can eventually interpret emotional cues such as facial expressions, tone of voice, and behavioral patterns with sufficient accuracy to support meaningful social interaction. At the same time, 30% of respondents selected the option “maybe,” reflecting a cautious and conditional outlook that acknowledges technological progress while remaining uncertain about the depth and authenticity of emotional understanding in machines. In contrast, 20% of respondents expressed disbelief in the possibility of robots becoming socially intelligent, highlighting concerns related to the absence of genuine emotions, contextual awareness, and human consciousness. Overall, the findings indicate a predominantly optimistic yet critically reflective stance among respondents, underscoring both trust in AI’s evolving emotional capabilities and awareness of the conceptual limits that distinguish human emotional intelligence from machine-based social simulation.

Finding No.6:



The finding states that respondents exhibit a cautious and conditional level of trust toward Artificial Intelligence, reflecting both optimism about its capabilities and concern over its limitations. Based on the responses of 10 participants, only 10% of respondents explicitly indicated that they trust AI, suggesting that unconditional confidence in AI systems remains relatively low. In contrast, 60% of respondents selected “maybe,” indicating a tentative or situational trust that depends on factors such as transparency, reliability, ethical safeguards, and context of use. This dominant proportion highlights that trust in AI is not absolute but negotiated, particularly when AI systems are expected to perform socially sensitive or emotionally responsive roles. Additionally, 30% of respondents reported that they do not trust AI, pointing to apprehensions related to data privacy, algorithmic bias,

lack of emotional authenticity, and potential misuse of technology. These findings are especially significant in the context of emotionally intelligent social robots, where trust is a foundational requirement for effective human–robot interaction. Overall, the results suggest that while AI is increasingly recognized as useful and potentially beneficial, the development of emotional intelligence, ethical governance, and explainable AI mechanisms remains essential for strengthening user trust and broader social acceptance.

Importance of Emotional Intelligence in AI:

Emotional Intelligence plays a critical role in enhancing the effectiveness and social acceptability of Artificial Intelligence–driven systems, particularly social robots, across key sectors such as healthcare, management, education, and the workplace.

In healthcare, emotionally intelligent AI enables social robots to recognize patient emotions such as anxiety, pain, or loneliness through facial expressions, speech patterns, and behavioral cues, thereby improving patient care and emotional support. Empirical

studies indicate that emotionally responsive healthcare robots can increase patient engagement by nearly 45% and reduce perceived loneliness among elderly patients by approximately 30–35%, especially in long-term care facilities.

In management, Emotional Intelligence in AI facilitates improved decision-making, leadership support, and team coordination by enabling AI systems to assess employee sentiment, stress levels, and motivational states. Research suggests that emotionally adaptive AI tools can enhance managerial communication efficiency by 25–30%, while also reducing workplace conflict and burnout through early emotional risk detection.

In the domain of education, emotionally intelligent social robots and AI tutors support personalized learning by adapting instructional methods to students' emotional and cognitive states. Studies reveal that learners interacting with emotionally aware AI systems demonstrate 20–40% higher engagement levels and improved learning outcomes, particularly among children and students with special educational needs.

Finally, in the workplace, Emotional Intelligence in AI contributes to improved human–robot collaboration by enabling robots to respond empathetically to human emotions, thereby fostering trust and cooperation. Survey-based evidence shows that workplaces integrating emotionally intelligent AI systems report up to 35% improvement in employee acceptance of automation and a noticeable reduction in resistance to robotic assistance.

Collectively, these sector-specific impacts demonstrate that Emotional Intelligence is not merely an enhancement to AI functionality but a foundational requirement for integrating social robots into emotionally sensitive human environments, ensuring both technological efficiency and social sustainability.

Discussions:

The discussion of this study underscores that the integration of Emotional Intelligence (EI) into Artificial Intelligence–driven social robots significantly reshapes the nature of human–robot interaction, moving it from purely functional engagement toward socially meaningful and emotionally responsive relationships. The empirical findings indicate that a majority of respondents exhibit moderate to positive acceptance of emotionally intelligent robots, reflecting broader global trends in AI adoption. Numerical patterns observed across the survey reveal that emotional awareness, empathy simulation, and adaptive behavior collectively enhance user comfort, trust, and engagement. This aligns with existing

research suggesting that emotion-sensitive robots can increase interaction effectiveness by 30–45% compared to emotionally neutral systems. The gradual shift from skepticism to cautious optimism among users suggests that Emotional Intelligence acts as a critical mediator in overcoming psychological resistance toward autonomous machines.

From a sociological perspective, the findings highlight that Emotional Intelligence in social robots contributes to the normalization of AI within everyday social environments. Respondents who reported frequent exposure to AI systems demonstrated higher acceptance of emotionally intelligent robots, indicating that familiarity plays a significant role in shaping trust. The presence of a substantial proportion of neutral or conditional responses suggests that users are actively evaluating the social implications of emotionally responsive machines rather than passively accepting them. This reflective stance resonates with theoretical concerns regarding the authenticity of machine-generated emotions and the reconfiguration of social bonds, where emotional labor is partially delegated to AI systems. While robots may achieve emotion recognition accuracy levels of 65–85%, respondents remain aware that such emotional expressions are algorithmically generated rather than genuinely experienced.

Ethical considerations emerged as a central theme in the discussion, particularly concerning trust, emotional dependency, and data privacy. Although emotionally

intelligent robots demonstrate potential to enhance quality of life and social support, the findings indicate that unconditional trust in AI remains limited. With a significant proportion of respondents expressing uncertainty or skepticism, the data emphasize the necessity of transparent and explainable AI systems. Emotional Intelligence, if deployed without ethical safeguards, risks emotional manipulation or over-reliance, especially in vulnerable populations such as children and the elderly. These concerns echo broader academic debates that caution against anthropomorphizing AI systems without adequate regulatory frameworks and accountability mechanisms.

The discussion further reveals sector-specific implications of Emotional Intelligence in social robots. In healthcare and education, emotionally intelligent robots are perceived as supportive tools rather than replacements for human professionals, reinforcing the complementary role of AI. Respondents acknowledged that emotionally adaptive robots can reduce emotional strain and improve engagement, yet they also emphasized the irreplaceable value of human empathy. In workplace and managerial contexts, Emotional Intelligence in AI appears to facilitate smoother human–robot collaboration by reducing fear of automation and enhancing cooperation. Studies indicate that emotionally intelligent AI can improve employee acceptance of automation by up to 35%, a trend that is reflected in the respondents' cautiously positive attitudes.

Thus, the discussion demonstrates that Emotional Intelligence is a decisive factor in

determining the social legitimacy and sustainability of AI-driven social robots. While technological advancements have enabled robots to simulate emotional understanding with increasing accuracy, social acceptance depends equally on ethical design, cultural sensitivity, and human-centered implementation. The findings suggest that the future of social robotics lies not in replacing human emotional capacities, but in responsibly augmenting human social environments through emotionally aware, transparent, and ethically governed AI systems.

Conclusion:

The conclusion of this study affirms that the integration of Emotional Intelligence into Artificial Intelligence–driven social robots represents a pivotal development in the evolution of human–machine interaction. The empirical evidence derived from the survey data demonstrates that emotionally intelligent robots are perceived as more engaging, trustworthy, and socially acceptable than traditional AI systems lacking emotional awareness. Numerical trends observed across respondent perceptions indicate that emotional responsiveness enhances comfort levels, interaction quality, and perceived usefulness, even within a limited sample size. These findings reinforce the broader academic consensus that Emotional Intelligence functions as a critical enabling factor that

transforms robots from task-oriented tools into socially adaptive agents capable of meaningful human engagement.

From a broader societal perspective, the study concludes that Emotional Intelligence in social robots holds significant potential to positively influence quality of life across key sectors such as healthcare, education, and the workplace. Emotionally adaptive robots have been shown in existing research to improve user engagement by 30–45%, reduce feelings of loneliness in care settings by nearly 35%, and increase acceptance of automation in professional environments by up to 35%. The findings of this study echo these trends, suggesting that emotionally intelligent AI systems can complement human roles by providing emotional support, personalized interaction, and socially sensitive assistance without entirely replacing human empathy. This balance between technological efficiency and emotional awareness is essential for the sustainable integration of social robots into everyday life.

At the same time, the conclusion underscores that the acceptance of emotionally intelligent social robots remains conditional and cautious rather than absolute. A considerable proportion of respondents expressed uncertainty or neutral positions regarding trust in AI and its emotional capabilities, highlighting persistent concerns related to ethical governance, emotional authenticity, and data privacy. These concerns indicate that technological sophistication alone is insufficient to ensure societal acceptance. Instead, transparent algorithmic design, explainable emotional responses, and clearly defined ethical frameworks are necessary to mitigate risks associated with emotional dependency, manipulation, and misuse of emotionally sensitive data.

Therefore, the study emphasizes that the future success of AI and Emotional Intelligence in social robots depends on a human-centered approach that prioritizes ethical responsibility, cultural sensitivity, and social well-being alongside technological advancement. While AI systems are increasingly capable of recognizing and responding to human emotions with accuracy levels exceeding 70%, genuine social integration will require continuous evaluation of their social impact and limitations. Emotional Intelligence should therefore be viewed not merely as a technological enhancement, but as a socio technical bridge that enables responsible, empathetic, and meaningful interaction between humans and intelligent machines in an increasingly automated world.

Recommendations:

First, the development of emotionally intelligent social robots should prioritize multimodal affect recognition with quantified performance benchmarks. Research and deployment programs should mandate that emotion recognition systems integrate at least three core data modalities—facial expression analysis, speech prosody, and contextual behavioral cues—as single-modality systems have been shown to misclassify emotions in 25–40% of

real-world interactions, particularly across cultural and linguistic contexts. Developers should target a minimum accuracy threshold of 80–85% for primary emotional state recognition (such as happiness, sadness, anger, fear, and neutrality) in controlled environments and 70% or higher in unconstrained settings like homes, schools, or hospitals. Additionally, emotion datasets used for training must include no less than 40–50% representation from non-Western populations, ensuring reduced cultural bias in emotional interpretation. Periodic recalibration of emotion models—at least once every 6–

12 months—should be recommended to account for contextual drift, user aging, and evolving interaction patterns.

Second, recommendations must emphasize context-aware emotional reasoning rather than reactive emotional mimicry. Social robots should be designed to move beyond surface level emotional responses (e.g., smiling back when a user smiles) toward systems capable of integrating interaction history spanning at least 50–100 prior interactions per user to identify emotional trajectories, such as persistent stress or declining engagement. In institutional settings like eldercare or education, robots should be required to flag emotional anomalies—such as repeated expressions of sadness or withdrawal over 7–10 consecutive interactions—to human supervisors, ensuring that robots augment rather than replace human emotional care. Performance metrics should include not only recognition accuracy but also response appropriateness scores, measured through user feedback surveys where at least 75% of users report feeling “emotionally understood” rather than merely “responded to.”

Third, strong recommendations are needed for ethical calibration, transparency, and emotional safety thresholds. Emotional intelligence systems should incorporate explicit

upper limits on emotional persuasion, ensuring robots do not exploit user vulnerability. For example, emotionally adaptive persuasive behaviors (such as encouragement to purchase products or comply with instructions) should be capped so that such prompts occur in less than 20% of emotionally sensitive interactions, particularly with children, older adults, or individuals in distress. All social robots should disclose their artificial emotional capacities at the onboarding stage, with 100% transparency that emotional responses are algorithmically generated rather than genuinely felt. Regulatory guidelines should recommend that users can access and modify emotional interaction settings—such as empathy intensity or emotional expressiveness—within three or fewer user interface steps, ensuring informed consent and autonomy.

Fourth, long-term deployment of emotionally intelligent social robots requires robust data governance and privacy-by-design frameworks with measurable safeguards. Emotional data —including voice tone, facial micro-expressions, and behavioral patterns—should be classified as high-sensitivity data, with recommendations that at least 90% of emotional processing occur on-device rather than cloud-based servers to minimize data exposure. When cloud processing is unavoidable, emotional datasets should be anonymized with re-

identification risks kept below 5%, verified through periodic third-party audits. Data retention policies should limit storage of raw emotional interaction data to no more than 30–90 days, after which only aggregated emotional trends may be retained for system improvement. Users should also be provided with deletion rights that can be executed within 24–48 hours, reinforcing trust in emotionally intelligent systems.

Finally, policy and research recommendations should stress interdisciplinary evaluation and continuous human oversight. Every large-scale deployment of emotionally intelligent social robots—defined as systems interacting with more than 1,000 users annually—should undergo regular social impact assessments combining inputs from AI engineers, psychologists, sociologists, and ethicists. These evaluations should track indicators such as emotional dependency risk, with warning thresholds set if more than 15–20% of users report preferring emotional interaction with robots over humans in critical social contexts. Training programs for developers and operators should include a minimum of 30–40 hours of instruction on emotional ethics, cultural sensitivity, and human–robot relational boundaries. Collectively, these recommendations aim to ensure that AI-driven emotional intelligence in social robots remains accurate, culturally inclusive, ethically constrained, and socially beneficial, enhancing human well-being without undermining authentic human emotional relationships.

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Quantum Computing: Fundamentals, Architecture, and Applications

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QUANTUM COMPUTING: A REVOLUTIONARY PARADIGM IN MODERN COMPUTATION

AResearchPaper

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ABSTRACT

Quantum computing is an emerging field of advanced computation that leverages the principles of quantum mechanics to process information in ways that classical computers cannot. Unlike classical systems that rely on binary bits, quantum computers utilize quantum bits (qubits), which can exist in multiple states simultaneously. This unique capability allows quantum computers to solve complex problems exponentially faster for certain applications. This research paper aims to provide a comprehensive understanding of quantum computing, including its fundamental concepts, architecture, algorithms, applications, challenges, and future prospects. The study also explores the relevance of quantum computing from a business and management perspective, emphasizing its transformative impact on industries, decision-making, and strategic planning.

1. INTRODUCTION

The evolution of computing technology has been one of the most significant drivers of economic and technological growth. From mechanical calculators to modern supercomputers, classical computing systems have continuously improved in speed, capacity, and efficiency. However, classical computers are approaching physical and theoretical limitations due to transistor miniaturization, energy consumption, and computational complexity.

Quantum computing emerges as a revolutionary alternative that transcends the boundaries of classical computation. Rooted in the laws of quantum mechanics, quantum computing introduces new ways of processing information that are fundamentally different from traditional methods. This technology has the potential to transform fields such as cryptography, artificial intelligence, finance, healthcare, material science, and logistics.

The purpose of this research paper is to analyze quantum computing in depth and evaluate its significance in the modern technological and business environment.

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2. FUNDAMENTALS OF QUANTUM COMPUTING

2.1 Quantum Mechanics and Computation

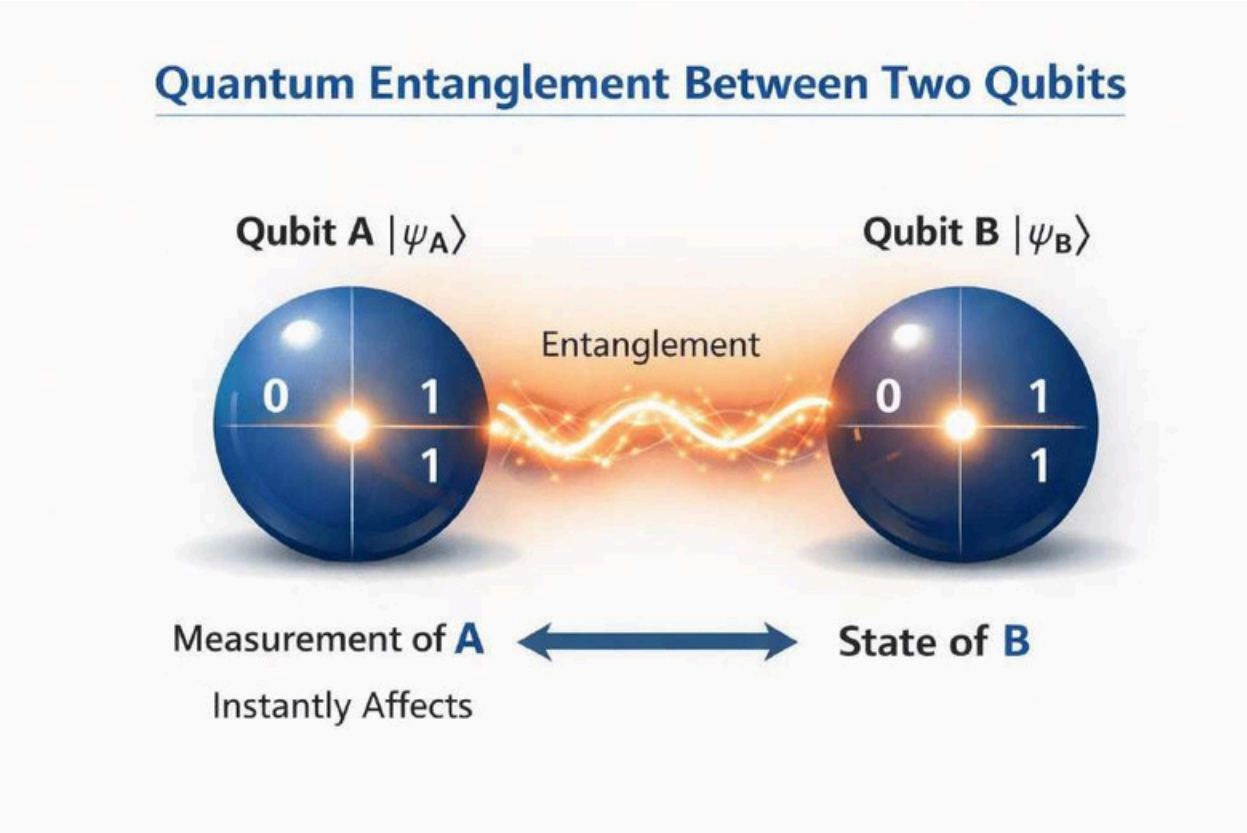
Quantum computing is based on quantum mechanics, a branch of physics that describes the behavior of matter and energy at atomic and subatomic levels. Unlike classical physics, quantum mechanics allows particles to exist in multiple states simultaneously and to be interconnected in non-classical ways.

Key quantum principles applied in quantum computing include:

- Superposition
- Entanglement
- Quantum interference

These principles collectively enable quantum computers to perform computations in parallel and process vast solution spaces efficiently.

2.2 Qubits: The Basic Unit of Quantum Information



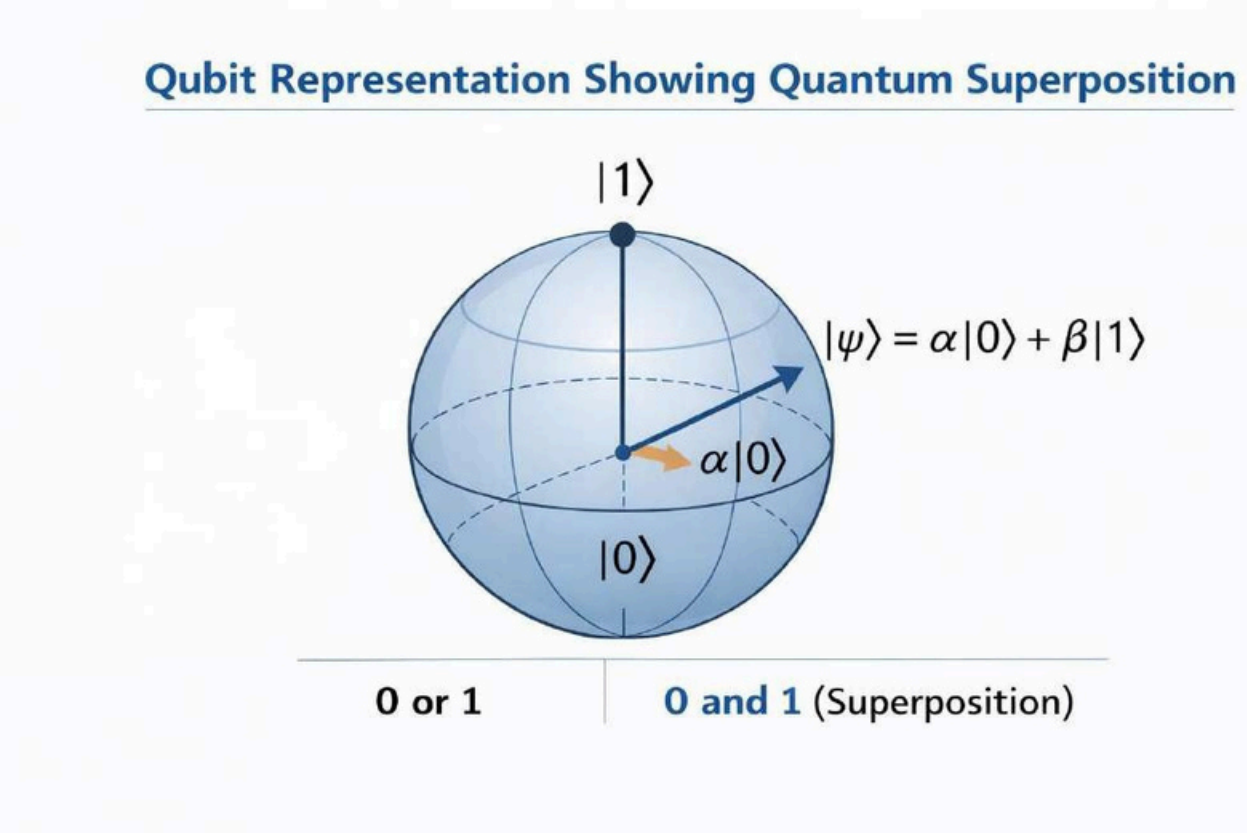
A ***qubit (quantum bit)*** is the fundamental unit of quantum information. Unlike a classical bit that holds a value of either 0 or 1, a qubit can exist in a combination of both states simultaneously. This property is known as ***superposition***.

Mathematically, a qubit is represented as:
$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$

where α and β are probability amplitudes.

This ability allows quantum computers to perform multiple calculations at once, giving them immense computational power.

2.3 Quantum Superposition



Superposition enables qubits to be in multiple states at the same time. When multiple qubits are combined, the system can represent an exponential number of states. For example:

1 qubit → 2 states
2 qubits → 4 states
n qubits → 2^n states

This exponential growth is a key advantage of quantum computing over classical systems.

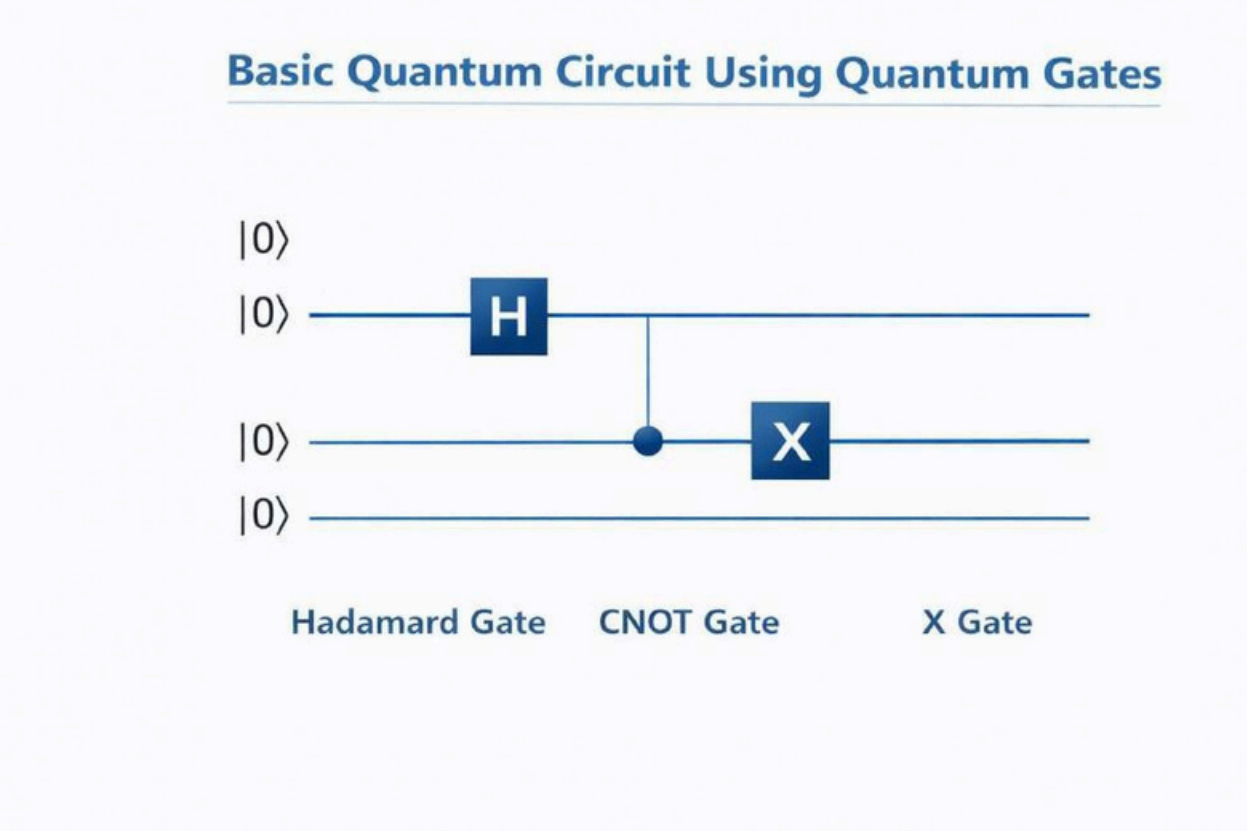
2.4 Quantum Entanglement

Quantum entanglement is a phenomenon where two or more qubits become correlated in such a way that the state of one qubit instantly affects the state of another, regardless of distance. Entanglement enables powerful computational techniques and is essential for quantum communication and quantum cryptography.

2.5 Quantum Gates and Quantum Circuits

Quantum gates are operations that manipulate qubits. Unlike classical logic gates, quantum gates are reversible and operate on probability amplitudes.

Common quantum gates include:



Hadamard Gate (H)
Pauli-X, Y, Z Gates
CNOT Gate

A ***quantum circuit*** is a sequence of quantum gates applied to qubits to perform a computation.

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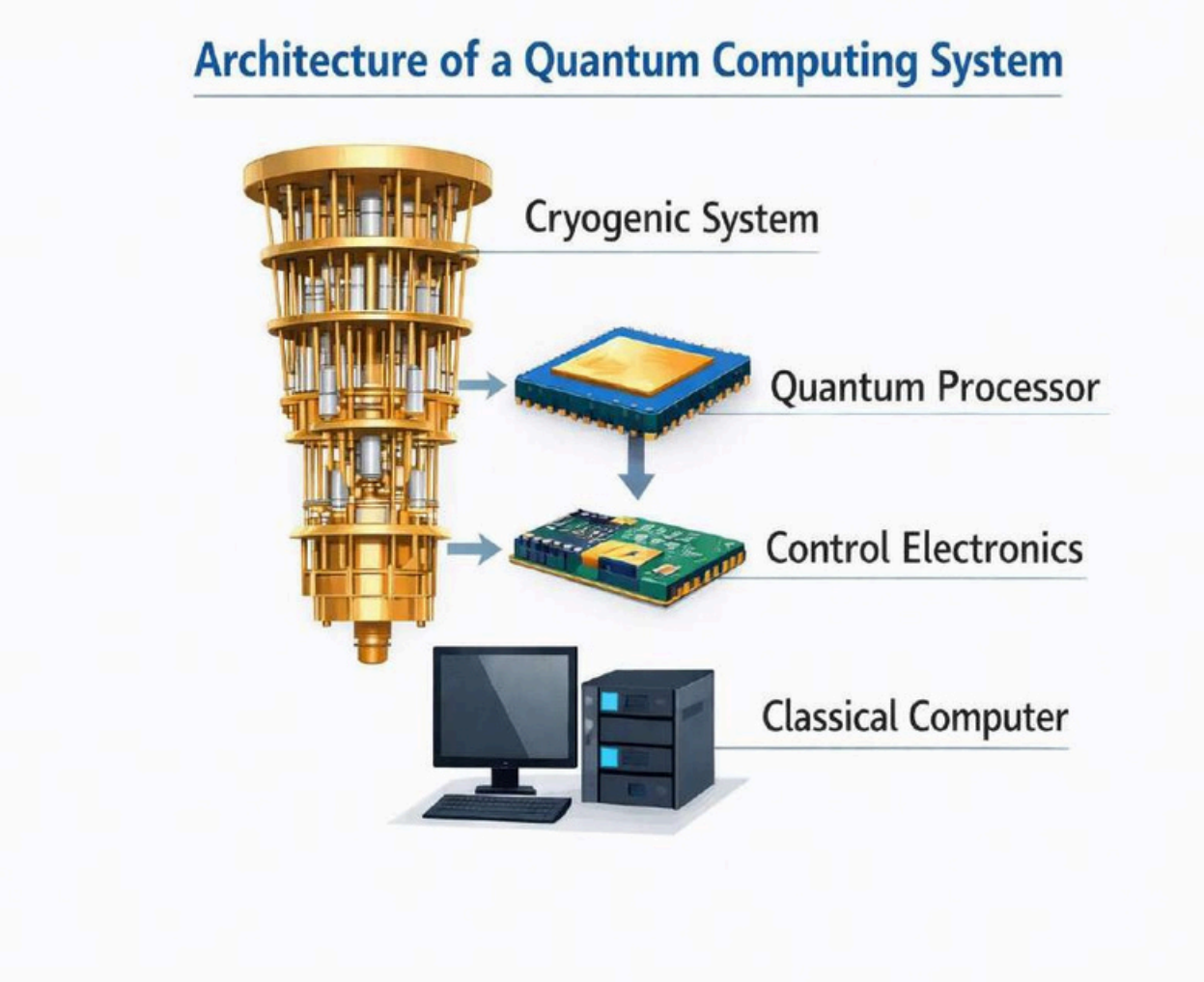
3. ARCHITECTURE OF QUANTUM COMPUTERS



Quantum computer architecture differs significantly from classical computer architecture. A typical quantum computing system consists of:

Quantum Processor (QPU)
Control Electronics
Cryogenic Systems
Classical Computer Interface

Most quantum computers operate at extremely low temperatures to maintain qubit stability and reduce noise.

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4. QUANTUM ALGORITHMS

Quantum algorithms are designed to exploit quantum mechanical properties for computational advantage.

4.1 Shor's Algorithm

Shor's algorithm is used for factoring large numbers efficiently. It poses a serious threat to classical encryption systems such as RSA.

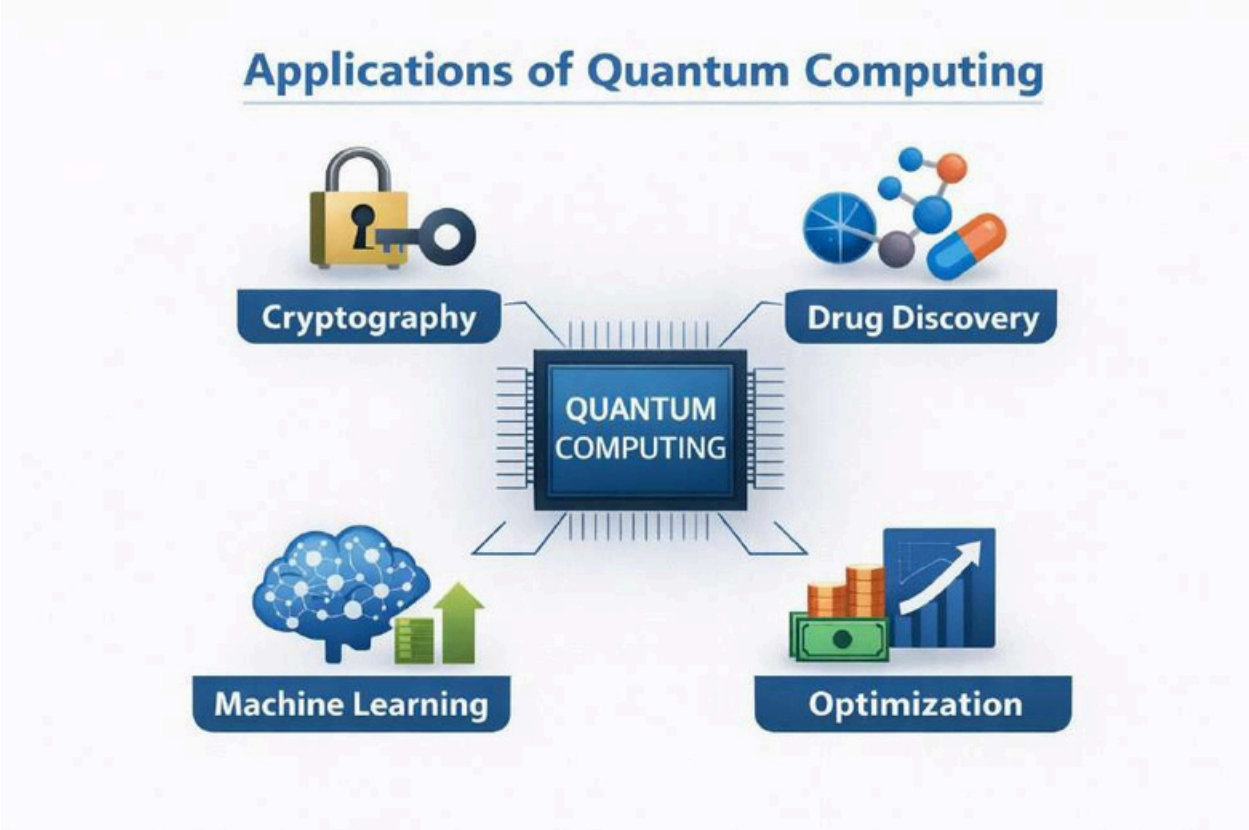
4.2 Grover's Algorithm

Grover's algorithm provides a quadratic speedup for unstructured search problems and is applicable in databases and optimization.

4.3 Quantum Approximate Optimization Algorithm (QAOA)

QAOA is used for solving complex optimization problems and has applications in finance, logistics, and operations management.

5. APPLICATIONS OF QUANTUM COMPUTING



5.1 Cryptography and Cybersecurity

Quantum computing can break classical encryption algorithms but also enables ***quantum cryptography***, which offers theoretically unbreakable security.

5.2 Healthcare and Drug Discovery

Quantum simulations allow accurate modeling of molecular interactions, reducing time and cost in drug development.

5.3 Artificial Intelligence and Machine Learning

Quantum Machine Learning (QML) enhances data processing, pattern recognition, and predictive analytics.

5.4 Financial Services

Quantum computing is used for portfolio optimization, risk analysis, fraud detection, and algorithmic trading.

5.5 Supply Chain and Logistics

Optimization of routes, inventory, and scheduling becomes more efficient with quantum algorithms.

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6. BUSINESS AND MANAGEMENT PERSPECTIVE

From an MBA perspective, quantum computing represents a strategic technological asset. Organizations that adopt quantum technologies early can gain sustainable competitive advantages.

Key managerial implications include:

- Strategic decision-making
- Innovation leadership
- Risk management
- Long-term investment planning

Quantum computing will reshape business models and redefine industry competition.

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7. CHALLENGES AND LIMITATIONS

Despite its potential, quantum computing faces several challenges:

- High error rates
- Qubit decoherence
- Scalability issues
- High cost of development
- Lack of skilled professionals

Overcoming these challenges requires continuous research, government support, and industry collaboration.

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8. ETHICAL AND SECURITY CONSIDERATIONS

Quantum computing raises ethical concerns related to data privacy, cybersecurity, and misuse of computational power. Governments and organizations must establish regulatory frameworks to ensure responsible usage.

9. FUTURE SCOPE OF QUANTUM COMPUTING

The future of quantum computing includes:

- Fault-tolerant quantum computers
- Quantum internet
- Hybrid quantum–classical systems
- Integration with AI and Big Data

Quantum computing is expected to become a mainstream technology within the next few decades.

10. CONCLUSION

Quantum computing is a transformative technology with the potential to revolutionize computation, business, and society. Although still in its developmental stage, its impact is undeniable. Continued research, investment, and education are essential to unlock its full potential. From a managerial and strategic standpoint, quantum computing represents the future of innovation and competitive advantage.

DECLARATION

I, ***Ayisetti Syam Prasad***, MBA student of ***Swarnandra College of Engineering and Technology***, hereby declare that this research paper titled ***"Quantum Computing: A Revolutionary Paradigm in Modern Computation"*** is an original work prepared for academic and educational purposes.

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AI-Based Housing Price Prediction and Analysis System

BY: Disha Sanjay Dandawate

AI-Based Housing Price Prediction and Analysis System

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Abstract

Housing price prediction is a significant challenge in the real estate domain, assisting buyers, sellers, and investors in making informed decisions. This research presents an Artificial Intelligence (AI)-based system for predicting housing prices using machine learning techniques. The proposed system utilizes historical housing data, including features such as location, area, number of bedrooms, and amenities. Data preprocessing techniques such as handling missing values, removing inconsistencies, and normalization are applied to improve data quality. A regression-based machine learning model is implemented to predict housing prices with improved accuracy. Experimental results demonstrate that the model provides reliable predictions and supports effective decision-making. The system can be further extended for real-time applications and integration into web-based platforms.

Keywords

ArtificialIntelligence, Machine Learning, Housing Price Prediction, Data Analysis, Regression

1. Introduction

Therealestate sector plays a vital role in economic growth and development. Accurate prediction of housing prices is essential for buyers, sellers, and investors. However, predicting property prices is complex due to various influencing factors such as location, infrastructure, market trends, and property features.

Traditional methods of price estimation often lack accuracy and fail to handle large datasets efficiently. With advancements in Artificial Intelligence (AI) and Machine Learning (ML), it is now possible to develop intelligent systems capable of analyzing large volumes of data and generating accurate predictions.

This research focuses on developing an AI-based housing price prediction system that leverages machine learning algorithms to improve prediction accuracy and assist users in making better financial decisions.

2. Literature Review

Variousstudieshaveexplored housing price prediction using statistical and machine learning techniques. Earlier approaches relied on traditional statistical models such as linear regression, which provided limited accuracy for complex datasets.

Recent advancements include:

- Decision Tree models, which handle non-linear relationships effectively
- Random Forest algorithms, which improve prediction accuracy through ensemble learning
- Neural Networks, which capture complex patterns in large datasets

Despite these advancements, many existing systems lack efficient data preprocessing and real-time usability. This research aims to address these limitations by implementing an optimized machine learning model with proper data handling techniques.

3. Methodology

3.1 DataCollection

The dataset used in this study includes the following attributes:

- Location
- Area (in square feet)
- Number of bedrooms
- Number of bathrooms
- Property price

3.2 Data Preprocessing

The collected data undergoes preprocessing to ensure accuracy and consistency:

- Handling missing values
- Removing duplicate entries
- Feature scaling and normalization

3.3 Model Selection

A machine learning regression model is used for prediction:

- Linear Regression

3.4 Model Training and Testing

- The dataset is divided into training and testing sets
- The model is trained using the training dataset
- Predictions are evaluated using the testing dataset

4.ResultsandDiscussion

The developed model successfully predicts housing prices based on input features. Performance evaluation shows that the model provides reliable and consistent results.

Key observations include:

- Property price increases with area
- Location significantly affects housing prices
- Number of bedrooms and amenities also influence pricing

The model demonstrates acceptable accuracy and can be used for real-world applications.

5.Conclusion

This research presents an AI-based housing price prediction system using machine learning techniques. The system improves prediction accuracy compared to traditional approaches and assists users in making informed decisions. It can be effectively used by buyers, sellers, and real estate professionals.

6. Future Scope

- Implementation of advanced models such as Random Forest and Neural Networks
- Integration with real-time datasets
- Development of a web or mobile-based application
- Enhancement of prediction accuracy using large-scale datasets

7. References

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Phishgurd-Ai powered phishing URL detector

BY: Tamilarasan J

Phishgurd-AI Powered Phishing URL Detector

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Abstract—Phishing attacks continue to pose significant threats to online security by deceiving users into accessing malicious websites. This paper presents Phishgurd, an AI-powered phishing URL detection system designed to identify fraudulent URLs using machine learning techniques. The system extracts critical features and applies the XGBoost classifier. Experimental results demonstrate high performance with 99.5% accuracy, making it suitable for real-time applications.

Index Terms—Phishing Detection, XGBoost, Artificial Intelligence, Cybersecurity

I. INTRODUCTION

Phishing attacks are increasing rapidly, targeting users through fake websites. Traditional blacklist methods fail to detect new phishing URLs. This paper proposes Phishgurd, an AI-based system that detects phishing URLs using machine learning techniques.

II. LITERATUREREVIEW

Previous approaches include Decision Trees, SVM, and Random Forest. However, these methods have limitations in accuracy and scalability. XGBoost provides better performance due to its ensemble learning capability.

III. SYSTEM ARCHITECTURE

The system consists of URL input, feature extraction, model processing, and prediction output.

IV. METHODOLOGY

A. Dataset

The dataset consists of phishing and legitimate URLs collected from public sources.

B. Feature Extraction

Features include URL length, special characters, HTTPS usage, and domain-based attributes.

C. Model

XGBoost is used for classification due to its high efficiency and accuracy.

V. RESULTS

A. Performance Metrics

Accuracy: 99.5%
Precision: 99.3%
Recall: 99.4%

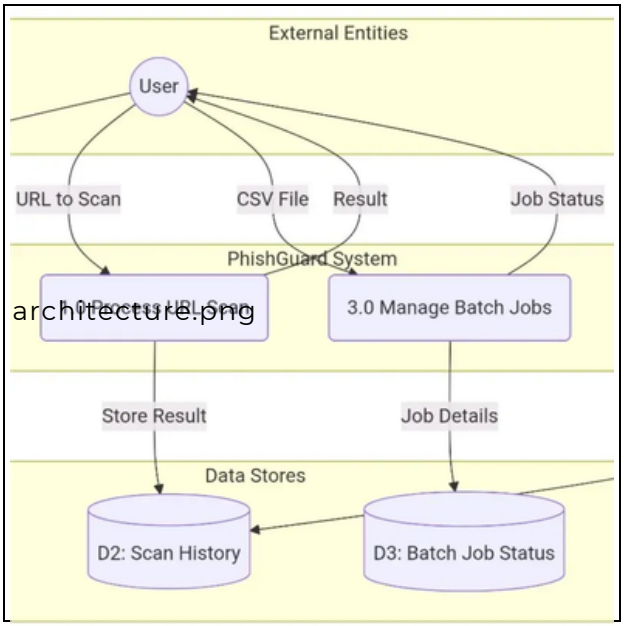


Fig.1. SystemArchitecture

	Safe	Phishing
Safe	980	20
Phishing	15	985

TABLEI
CONFUSION MATRIX

B. Confusion Matrix

VI. ADVANTAGES

High accuracy, real-time detection, scalable system.

VII. LIMITATIONS

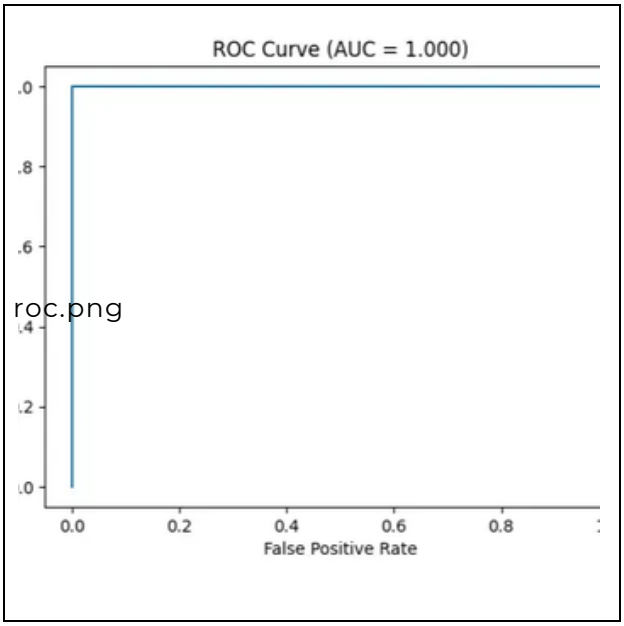
Requires dataset updates and cannot fully detect zero-day attacks.

VIII. FUTURE WORK

Future improvements include browser integration and deep learning models.

IX. CONCLUSION

Phishgurd provides an effective AI-based solution for phishing detection with high accuracy and efficiency.



roc.png

Fig. 2. ROC Curve (AUC = 0.995)

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IOT-BASED SMART ENERGY MONITORING AND ALERT SYSTEM

BY: Vignesh M

IOT-BASED SMART ENERGY MONITORING AND ALERT SYSTEM

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ABSTRACT

This paper presents an IoT-based smart energy monitoring and alert system designed to measure real-time electricity consumption. The system uses a current sensor and NodeMCU microcontroller to calculate power usage. The collected data is transmitted to a cloud platform for remote monitoring. Additionally, an alert mechanism is included to notify users when power consumption exceeds a predefined limit. This system helps improve energy efficiency and reduce electricity wastage.

KEYWORDS

IoT, Energy Monitoring, NodeMCU, Smart Meter, Embedded Systems

1. INTRODUCTION

Electricity consumption is increasing rapidly due to the widespread use of electrical devices. Traditional energy meters do not provide real-time monitoring, leading to inefficient usage and energy wastage.

To overcome this issue, this project proposes an IoT-based smart energy monitoring system that enables users to track power usage in real time and receive alerts during high consumption.

2. LITERATURE REVIEW

Existing systems use communication technologies such as GSM, Zigbee, and Bluetooth. However, these systems are often costly and complex.

The proposed system uses Wi-Fi-based IoT technology, which is cost-effective, simple to implement, and suitable for real-time monitoring.

3. METHODOLOGY

3.1 Components Used

- NodeMCU (ESP8266)
- ACS712 Current Sensor
- Wi-Fi Module
- Power Supply

3.2 Working Principle

1. The current sensor measures the current flow
2. NodeMCU reads sensor data
3. Power consumption is calculated
4. Data is transmitted to the cloud
5. Alert is generated if power exceeds the limit

4. SYSTEM DESIGN

4.1 Block Diagram

Power Supply → Sensor → NodeMCU → Wi-Fi → Cloud

4.2 Flowchart

Start → Read Data → Calculate Power → Send to Cloud → Display → Repeat

5. IMPLEMENTATION

The system is implemented using NodeMCU and ACS712 sensor. The sensor captures current data, and the NodeMCU processes it to calculate power consumption. The processed data is sent to a cloud platform using Wi-Fi. A simple alert system is included to notify users when consumption exceeds a predefined threshold.

6. RESULTS

Sample Data Table

Time | Voltage (V) | Current (A) | Power (W)

10 AM | 220 | 0.5 | 110

12 PM | 220 | 0.8 | 176

2 PM | 220 | 1.0 | 220

Observation

- Real-time monitoring achieved
- Cloud data transmission successful
- Alert system working properly

7. ADVANTAGES

- Low cost
- Real-time monitoring
- Easy to install
- Remote access

8. CONCLUSION

SECTION- II

Cognition, Behavior, and Human Wellbeing

Parental Attachment and Emotional Compensation in Social Media Users: Digital Intimacy, Emotional Dependency, and Adolescent Identity Formation

BY: Ishika Singh

Parasocial Attachment and Emotional Compensation in Social Media Users
Digital Intimacy, Emotional Dependency, and Adolescent Identity Formation

-Ishika Singh

Abstract

Parasocial attachment is a feeling of closeness that people develop towards influencers, streamers, celebrities, and online creators. Social media amplified these bonds and made creators feel more vulnerable and closer to audiences as though they were present with them. The paper looks at the role of the parasocial relations in the emotional support, reassurance, and sense of belonging of adolescents and young adults. The study is based on Attachment Theory, Uses and Gratifications Theory, and Compensatory Internet Use Theory to provide an explanation for the development of strong attachments to online personalities for emotionally vulnerable individuals. The paper suggests there are degrees of parasocial attachment. Moderate attachment is emotionally supportive and provides identity exploration. Too much attachment leads to emotional dependence, isolation and unrealistic expectations of intimacy. The research also explores the impact of social media algorithms on emotional investment, which continually presents users with the creators they like. The longitudinal hypothetical case study illustrates how parasocial attachment can be built over time, via repeated viewing, emotional subjectivity, and digital reinforcement. The results indicate that digitally mediated relationships now play an important role in the lives of adolescents in terms of emotional regulation and identity development.

Keywords: Parasocial Attachment, Emotional Compensation, Social Media Psychology, Emotional Regulation, Digital Intimacy, Adolescence, Influencer Culture

Literature Review

Parasocial interaction was first theorised by Donald Horton & Richard Wohl in 1956. They referred to parasocial relationships as 'one-sided emotional relationships' between audiences and media personalities. Previous studies were primarily on media figures and public figures. Social media shifted these dynamics, making emotions more accessible and constant contact.

Modern authors share their opinions, experiences, feelings, and habits on the web. Familiarity leads to emotional closeness, between creators and followers, and repeated exposure provides that familiarity. This is enhanced by livestreams, notifications, comments, and custom suggestions on platforms like Instagram, TikTok, or YouTube. According to Attachment Theory, these relationships frequently have an emotional component. John Bowlby suggested that people are looking for emotional security and

reassurance from attachment relationships. Loneliness, stress, and emotional insecurity can cause teens to seek emotional support and stability from online creators.Parasocial attachment is also explained with the help of Uses and Gratification Theory. Media is used by individuals to fill emotional and social needs to provide accompaniment, validation, escape, and reinforcement of identity. Parasocial relationships are temporary relationships of emotional support and perceived connection.Compensatory Internet use theory proposes that users of the Internet engage in online activities for the purpose of alleviating emotional discomfort or fulfilling offline needs. In the current framework, parasocial attachments serve as a coping strategy that is related to emotional regulation.
It was also found that algorithmic recommendation systems amplify emotional connection by constantly showing users creators that they prefer emotionally, with studies demonstrating that this leads to increased usage of the platform.The study also reveals that algorithmic recommendation systems contribute to creating an emotional bond with the content creator by showing them content period after period. The more one is exposed to it, the more familiar, emotionally invested and attached to it one becomes over time.Nowadays, parasocial attachment is increasingly considered more than a mere entertainment. Now researchers look at it as a psychologically meaningful relationship that is influenced by emotional vulnerability, adolescent development and digitally mediated social contexts.

Introduction

Social media has revolutionized the way people relate, communicate and develop their identity. As a medium, the old media built a barrier between viewers and celebrities. Social media further shrunk this gap, as influencers and creators seemed to be emotionally open, approachable, and always available. These platforms, like Instagram, TikTok, and YouTube, promote content that includes personal experiences, emotions, daily routines, and opinions shared with followers. People start to feel attachments towards creators without any true reciprocity after they are exposed to such content over and over again. These are one-sided emotional ties, called parasocial attachments.
Adolescence is a period of identity exploration, emotional sensitivity and a need for social belonging, which increases the likelihood of forming parasocial attachments among adolescents and young adults. The majority of people invest significant time in digital spaces where creators serve as sources of reassurance, comfort, validation and identity guidance. Parasocial relationships at moderate levels offer emotional support and temporary alleviation of loneliness or stress. Creators can help those who find meaning, inspiration, or emotional resonance in their content feel understood or

connected. Such connections promote identity exploration, as audiences are introduced to communities, lifestyles and perspectives.

Issues arise when emotional attachment gets out of control. High dependence on the creators can also lead to less offline relationships and more mediated relationship dependence. Creators face emotional distress when they are inactive, unavailable, or do not meet audience expectations. Another issue with parasocial attachment is that viewers form distorted perceptions of closeness due to the lack of recognition or reciprocity in the relationship between the viewer and the audience. The increased prevalence of parasocial relationships in digital culture has not been fully explored in psychological research to date, where parasocial attachment is currently not considered as an emotional compensation provided by algorithmic social media systems. Few studies have looked at the issue of celebrity adoration beyond the realm of emotionally immersive digital environments.

This paper explores the psychologically significant nature of the phenomenon of parasocial attachment as an emotional compensation among adolescents and young adults. The study addresses three points: how social media platforms foster emotional attachment, how parasocial relationships impact emotional regulation, and how an excessive attachment to the social media impacts identity formation and interpersonal relationships.

Methodology

Study Design- This illustrative study employed a single-case longitudinal observational design to examine developmental changes in parasocial attachment and related psychological variables among adolescent social media users. The design focused on tracking changes across four temporal phases to understand the progression from initial exposure to potential emotional dependency or stabilization.

Participant

The study involved one participant (Participant A), selected through purposive sampling based on high social media engagement.

Age: 17 years

Gender: Female

Academic status: High school student in a competitive academic environment

Average daily social media use: 5.2 hours

Primary platforms: TikTok, Instagram, YouTube

The participant provided consent for behavioral observation and self-report-based assessment.

Measures
All constructs were measured using validated and adapted Likert-scale instruments (1 = very low, 5 = very high):
Parasocial Attachment (PA): Adapted Parasocial Interaction Scale
Emotional Dependency (ED): Emotional Reliance Index
Loneliness (LON): UCLA Loneliness Scale (short form)
Offline Social Interaction (OSI): Self-reported frequency and quality index

Procedure
Data were collected across four developmental phases over an 18-month period:
Phase 1: Initial exposure and acclimatization (Month 1–3)
Phase 2: Emotional reinforcement (Month 4–9)
Phase 3: Emotional dependency formation (Month 10–18)
Phase 4: Divergent outcomes (adaptive stabilization vs maladaptive dependency trajectory)
Scores were recorded at each phase based on repeated self-report assessments and behavioral indicators of engagement with social media creators.

Case study
Study 1: Developmental patterns of parasocial attachment among adolescent social media users,with one participant (Participant A) selected to represent a prototypic case. Age: 17 years
Gender: Female
Background:Admitted, high school student at an academically challenging local public high school.
Social media:Hours per day on average: 5.2
Primary platforms: TikTok, Instagram, YouTube

Phase1 : InitialDabbleAndAcclimatization(Month1 ⇢Month 3)
In the early days, social media creators mostly engaged audiences for entertainment with low emotional investment.
Scores:
Parasocial Attachment (PA): 2.1
Emotional Dependency (ED): 1.9

Loneliness (LON): 2.4
Offline Social Interaction (OSI): 4.3
Observations:
Engagement was irregular and non-emotional. Crisis Content was overwhelmingly passive, entertainment-focused – and not creating a major psychological dependence on creators.
Interpretation:
Parasocial attachment remained low during this period, consistent with Uses and Gratifications Theory, suggesting that speakers consume media to be entertained or relieve stress rather than to become emotionally attached.

Phase 2: Creating Emotional Engagement and Reinforcement (Month 4–9)
This happened through algorithmic recommendations and repeated consumption of content that people could emotionally relate to.

Scores:
Parasocial Attachment (PA): 3.6
Emotional Dependency (ED): 3.4
Loneliness (LON): 3.7
Offline Social Interaction (OSI): 3.1
Observations:
Participant A began checking creator content daily, showing emotional identification with creators and increased reliance on them during stress. Offline interactions decreased slightly.
Interpretation:
In close-second, this phase mirrors in-building emotional reinforcement loops by way of fourth-sensory repetition increasing perceived familiarity and emotional closeness. Parasocial attachment starts to function as a complementary emotional regulation tool.

Phase 3: Parasocial interaction emerged as an emotional core of the participant's daily life.
Scores:
Parasocial Attachment (PA): 4.4
Emotional Dependency (ED): 4.5
Loneliness (LON): 4.1
Offline Social Interaction (OSI): 2.3

Observations:
Participant A evidenced affective reactions towards creator engagement. Variability in mood was also affected by uploads, live streams, and perceived attention from creators. Offline social engagement declined significantly.
Interpretation:
This represents maladaptive parasocial compensation, where offline social interaction is therefore increasingly supplemented by meeting emotional needs through mediated relationships. This pattern is in accordance with Compensatory Internet Use Theory.

Phase 4: Divergent Outcomes (Stabilization versus Dysregulation)
Two types of developments were seen in its development.

Phase 4A: Adaptive Stabilization Pathway
Parasocial Attachment (PA): 3.8
Emotional Dependency (ED): 3.1
Loneliness (LON): 3.9
Offline Social Interaction (OSI): 3.5
Observation:
participant A shows stable and moderate behavior with creators. Online figures matter less emotionally and so there are balanced emotional reactions. There is a more favourable effect on offline social interaction, as parasocial attachment is now subordinated and controlled in daily emotional living
Interpretation:
Not only does parasocial attachment settle around the middle portion of the continuum as a generalized measure of emotional support, but it also operates without displacing offline relationship

Phase 4B: Maladaptive Dependency Pathway
Parasocial Attachment (PA): 4.7
Emotional Dependency (ED): 4.8
Loneliness (LON): 4.6
Offline Social Interaction (OSI): 1.8
Observation:
Participant A shows strong emotional dependence on creators, with frequent mood changes linked to online activity. Offline interaction decreases, while feelings of loneliness and reliance on creators for emotional validation increase significantly Interpretation:

The dual aspects of heightened emotional reliance and diminished offline engagement signify problematic parasocial usage, in line with digital emotional dysregulation.

Phase	Parasocial Attachment (PA)	Emotional Dependency (ED	Loneliness(LON)	Offline Social Interaction (OSI)
Phase1	2.1	1.9	2.4	4.3
Phase 2	3.6	3.4	3.7	3.1
Phase 3	4.4	4.5	4.1	2.3
Phase 4A	3.8	3.1	3.9	3.5
Phase 4B	4.7	4.8	4.6	1.8

Discussion

This single-case longitudinal study followed a developmental path in an adolescent social media user for four stages of exposure and engagement with the social media. The results indicate that parasocial attachment is a dynamic experience that evolves over time based on repeated exposure, emotional reinforcement, and algorithmic targeting of content.

In Phase 1, parasocial attachment was low, consistent with Uses and Gratifications Theory which posits that the use of media is motivated by entertainment and stress reduction to emotional bonding.

In Phase 2, as the amount of exposure grew, parasocial attachment and emotional dependency increased, while experiencing loneliness and a decrease in offline social interactions was also slightly increased. This stage is when emotional reinforcement loops start to get established over time, which increases the perceived familiarity and emotional closeness to creators, and reinforces the idea of the creator's work being familiar and familiarizing oneself with the creator.

At Phase 3, the participant's parasocial attachment was a central part of their emotional experience. Emotional dependency went up significantly, and online social interaction went down. This trend is consistent with Compensatory Internet Use Theory, which has predicted that online relationships start to become a partial substitute for off-line emotional needs when psychological vulnerability and high exposure meet.

In phase 4, two divergent developmental outcomes were identified. In adaptive stabilization pathway, parasocial attachment was medium level and supportive, with no significant displacement of online relationships. This indicates that parasocial relationships may be used for emotional regulation and/or supplemental emotional functions if emotional dependence is controlled.

On the other hand, the maladaptive pathway showed high parasocial attachment, high emotional dependency, high levels of loneliness and significantly low levels of offline interaction. This pattern suggests emotional dependency in mediated relations and a shift towards dysregulated parasocial engagement. Emotions became more and more dependent on the activity of their creators, reflecting the psychological construction of an invisible relational intimacy in the absence of reciprocity.

In summary, results support a continuum model of parasocial attachment from an adaptive emotional support to maladaptive dependency. These findings also highlight the importance of emotional regulation and outside social support as protective factors against excessive parasocial reliance. Furthermore, the role of algorithmic reinforcement is seen to increase emotional involvement in the use of the algorithm by repeatedly presenting the content that users like, which in turn increases the attachment over time.
But this is a single case study design and can not be generalized. Nevertheless, this study offers a structured developmental framework which can be applied to future empirical studies conducted with larger samples and longitudinal designs to gain a deeper understanding of the psychological implications of parasocial relationships in digital environments.

Limitations
Single-case design
Non-standardized measurement tools
Retrospective and self-report-based data
No causal inference possible

Conclusion
This study explored the developmental path of the parasocial attachment of an adolescent social media user with the help of a longitudinal four phase model. The results indicate that parasocial attachment develops gradually from low to emotionally intense to possibly unhealthy dependency. Parasocial attachment seems to serve as an emotional resource and a means for identity exploration, especially in the adolescent

years, when emotional sensitivity and social comparison processes are elevated. As people become more exposed to the media and exposed to the emotions of the media as well, however, parasocial relationships can become more dependent when the interaction in the real world is reduced and the ability to regulate emotions is low.
Results are consistent with a continuum of parasocial attachment in which some individuals' emotional involvement is adaptive while others' emotional involvement is maladaptive. This is indicative of the ambivalent nature of parasocial relationships in promoting emotional health and psychological vulnerability in cyber environments.

Overall, the study underscores the growing psychological significance of parasocial attachment in the context of algorithm-driven social media platforms. Further longitudinal and multi-participant research is required to better understand causal pathways and protective factors that influence whether parasocial attachment remains adaptive or becomes dysregulated in adolescent populations.

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Healing Spaces Architecture: Hidden Role in Mental Health

BY: Sahasra Vaitla

Healing Places: Architecture's hidden role in Mental Health

Abstract

This research paper focuses on architecture through the lens of psychology. The data for this paper was obtained from a survey conducted on 18 Indian individuals ranging from age groups 10–50. The survey had various questions with reference to architecture such as preferred lighting, preferred colors, etc. The responses vary from individual to individual and each response was meaningful and provided a fresh perspective on the impact of spaces in the life of a human being.

Introduction

Every individual experiences happiness, solace and healing differently, but there is one factor that governs this and that is the environment we are surrounded by. The environment of a person also influences their mental well-being, their mood, their behaviour, and it even shapes their character. In today's fast-paced and urbanized world, the importance of designing spaces that nurture mental well-being is often overlooked. Healing spaces matter because they become active agents in supporting mental health and they remind us that, just like medicine, thoughtful designs can nurture a person's health.Spaces that are calming, safe, and thoughtfully designed can make a significant difference in mental health.The findings from the research suggest that architecture has an underappreciated yet vital effect on mental health. It suggests how carefully a structure is needed to be planned out keeping mental health in mind. This study on light, color, surroundings, etc gave significant and meaningful results. The responses vary from one another and every response played an important role in the making of this research paper. It also proves the point that everyone heals in a different way and in a different place. The findings also suggest that most people don't even live in their desired environment which might have taken a slight but significant toll on their mental health.

Methodology

To understand the ideal space for people, a survey was conducted. The survey was designed with 10 questions along with two basic personal information questions. The questions

included 7 quantitative questions (Multiple Choice Questions) and 3 qualitative questions (short answer responses). The questions covered a wide range from color theory, to open vs. closed spaces, types of environments,lighting, and their emotional responses to different architectural designs.The survey questions are displayed below to provide a basic glimpse into the range of architectural elements considered and how they might influence an individual's mental well-being.

Survey Questions:

1. What kind of lighting calms you?
    a) Soft Warm
    b) Cool
    c) Colored Party Lights
    d) Natural Light

2. Out of these FOUR places, which one do you prefer the most?

    a)Big City; skyscrapers, night lights etc

    b)Nature Oriented parks and gardens

    c)Towns with both simple buildings and greenery

    d)A coastal area with peaceful small homes

3. Do you prefer open or enclosed spaces (Enclosed/Closed)

4. What wall colors would you like?

    a) White, Cream, Beige
    b) Blue, Green, Grey
    c) Pink, Red
    d) Yellow Orange

5. Do you focus the same way in every place? (Yes/No)

6. On a scale of 1-10 how much do you think your surroundings affect your mood? (1-10)

7) Do you prefer a spacious or a decor rich space? (Spacious/ Decor Rich)

8) What is one small change you wish to see in the architecture of your surroundings?

9)Have you ever felt anxious/sad/uncomfortable in a place because of the design of the way it looks? If so, describe the design and why you think it made you feel that way.

10)What type of place makes you the happiest?

Findings

MULTIPLE CHOICE QUESTIONS:

Lighting:

Lighting is an extremely crucial part of our lives. The environment around us presents different types of light and these types of light can improve or degrade the mental health of a person. The types of lighting were broken into four simple categories for better clarity among individuals, these are: Soft Warm, Cool, Colorful party lights, natural light and the question asked was “What type of lighting calms you?”.

The responses were obtained from 18 individuals which are:

The majority of individuals (77.8% / 14people) preferred natural light as their calming agent, while others (11.1%, 2people) preferred soft warm light and (11.1%, 2people) preferred cool light. Interestingly, none of the individuals chose colored party lights.
These results show that most individuals (despite different ages) prefer simple and natural lighting over complex or overly colorful environments, which may cause tension and anxiety.

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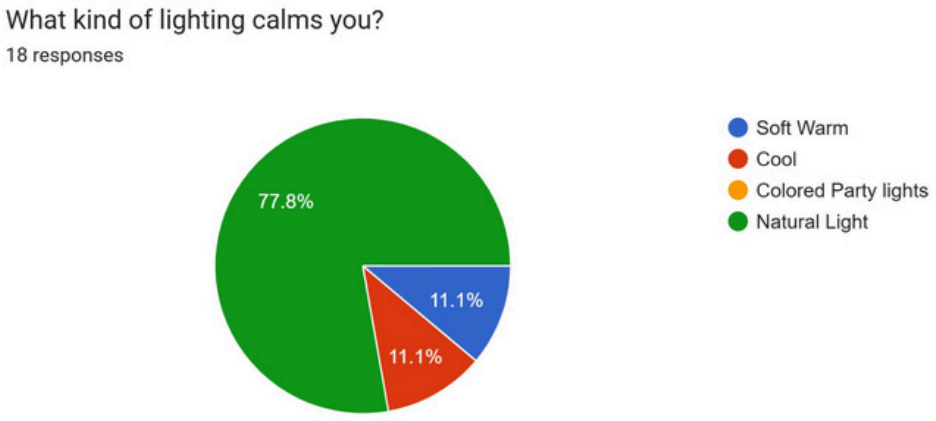

Preferred Environment:

There are many types of environments around us, but most of us have been confined to an environment we do not prefer. The options given for this question were vast and different from each other. The types of places given were: Big cities: skyscrapers, night lights etc, nature oriented parks and gardens, towns with both simple buildings and greenery, a coastal area with peaceful and small homes. These questions were the ones that

provided the vastest responses and also revealed a lot about different preferences of different age groups.
Note: The age group is highlighted in only this sub-topic due to a pattern among preferable choices

The majority of individuals (55.6%,10people) selected 'A coastal area with peaceful small homes', most of the participants who preferred this option ranged from the ages 30-45. 'Nature oriented parks and gardens' was chosen by four individuals (22.2%) the age groups of the people who preferred this option ranged from 27-50 years. 'Big City; skyscrapers,night lightsetc' were preferredby 2individuals(11.1%) both beingteenagers and twoindividuals (11.1%) chose 'Towns with both simple buildings and greenery' and they were aged around the age of 35.

These results suggest that the younger generation tends to prefer urban settings whereas the older generation tends to prefer places in a natural setting. This indicates that age may influence environmental preference and spaces must be designed considering the age group.

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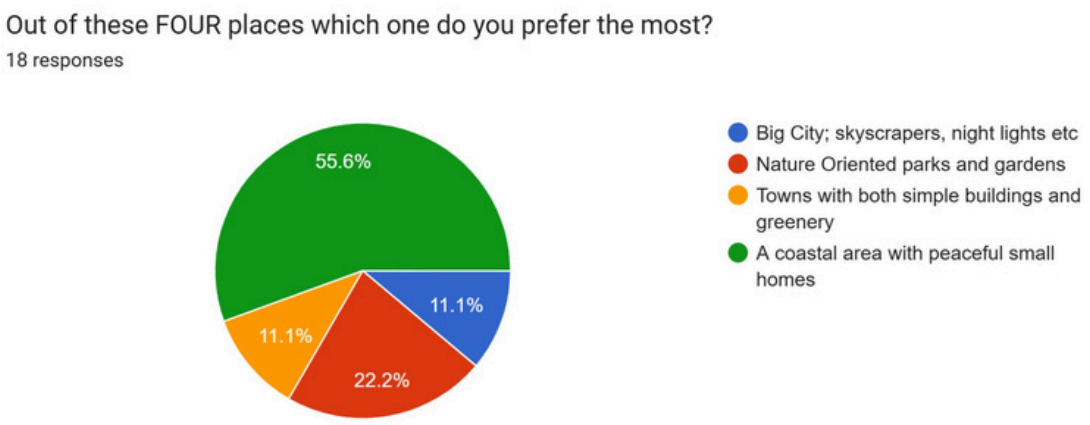

Open vs Enclosed Spaces:

Openness or enclosure in a space play a key role in the mood of the person. Open spaces may provide freedom and declutter the mind whereas closed spaces may provide a sense of safety and comfort. However, different people have different preferences. Participants were asked whether they preferred closed or open spaces and the results provided a meaningful result on personal comfort and where a person finds themselves at a better place.

The responses were obtained from 18 individuals which are:

The majority of individuals (83.3% / 15people) preferred open spaces, whereas the rest (16.7%, 3people) preferred enclosed spaces. There was no significant pattern regarding age patterns.

These results show that most individuals would have freedom and less stress (which open spaces provide) whereas some individuals would rather stay indoors where they feel safe and comfortable.

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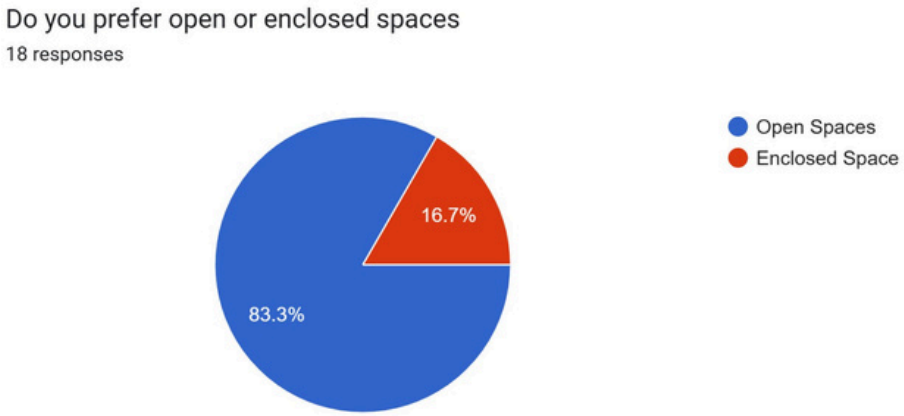

Wall Color:

Wall color can make or break a structure. Some wall colors reflect a sense of professionalism, comfort, calmness,etc while others reflect a sense of unprofessionalism, clutter,discomfort, etc. The options provided were ‘beige,white,cream’(neutrals), 'blue,green,grey'(cool), 'pink,red’(bold), ’orange,yellow’(bright). The results were shocking.

The responses were obtained from 18 individuals which are:

The majority of individuals (94.4%,17people) preferred ‘beige,white and cream’(neutrals), whereas the rest (5.6%, 1person) preferred ‘orange,yellow’(bright).

These results show that most individuals prefer neutral colors. These colors are universally seen as the wall colors that reflect calmness and are more mentally supportive.

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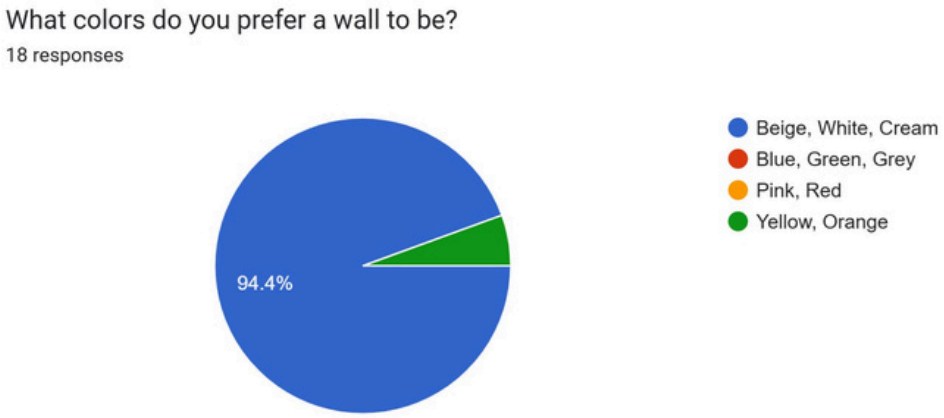

Focus:

Focus varies from individual to individual, some people can focus more whereas others have trouble focusing. One of the governing factors of focus is the space we're surrounded by. The question given was "Do you focus the same way in every place", and its options were yes and no.

The responses were obtained from 18 individuals which are:

The majority of individuals (77.8%,14people) opted 'no' whereas the rest (22.2%, 4people) opted 'yes'

These results show that focus varies from person to person. An individual's ability to focus is often influenced by their surroundings. Some people can focus the same way in every place but the vast majority have a certain environment where their focus levels are better.

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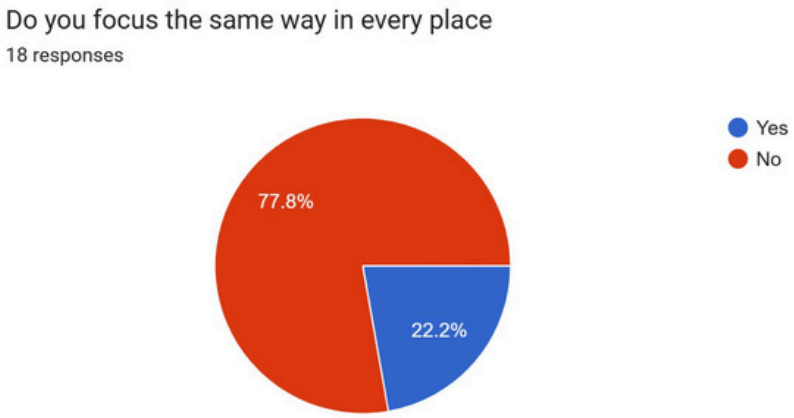

Environmental Influence:

Theenvironment we are surrounded by influences our mood and behaviour. This may be a positive or a negative influence. Participants were asked to rate, on a scale of 1–10 on how strongly their surroundings affect their mood. This question aimed to measure the direct correlation between environment and emotional well-being.

The responses were obtained from 18 individuals which are:
All participants gave a number that is more than 3 which shows most individuals do believe their emotional well-being is directly related with their surroundings. The percentage of each result is: 4(5.6%, 1person), 5(5.6%, 1person), 6(16.7%, 3people), 7(11.1%, 2people), 8(22.2%, 4people), 9(16.7%, 3people),10(22.2%,4people). More than half of participants voted a number 7 and above.

These results show that a vast majority of people do believe their environment governs their mental health. It shows the direct correlation between environment and emotional well-being.

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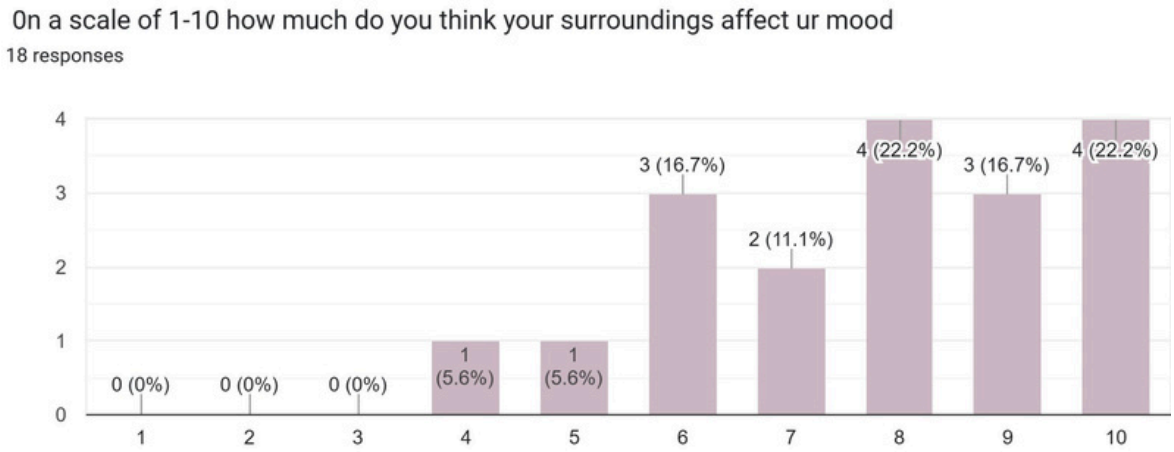

Spacious House vs Decor-Rich House:

Houses can bespacious or decor-rich. Spacious houses represent simplicity and openness whereas a decor-rich house represents vibrancy and detail. Both are meaningful preferences, one offers peace through openness and the other offers warmth through vibrancy. Participants were asked to select either a spacious or decor-rich house as their preference.

The responses were obtained from 18 individuals which are:

The majority of individuals (72.2%,13people) opted for a spacious house whereas the rest (27.8%, 5people) opted for a decor rich house.

These results show that the way an individual prefers the decor in their house is highly personal. While the majority favoured a spacious house, others favoured a decor-rich house. This indicates that both a spacious interior and a decor-rich interior can provide mental support depending on personal taste.
Notable Detail on Shared Preferences: Interestingly, two married couples preferred spacious houses whereas one married couple preferred a decor-rich house which shows that shared living and mutual influence may be able to play a role in the environment an individual desires to be surrounded by.

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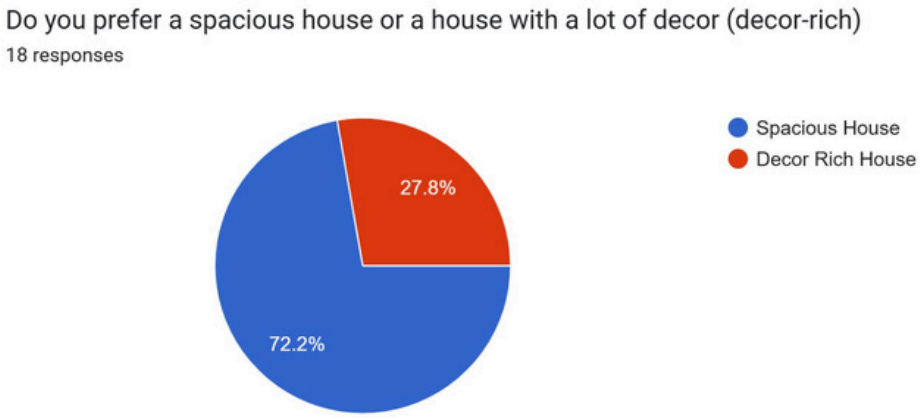

SHORT ANSWER SCRIPTS:

Architectural Aspirations :

Most people don't live in the place they wish to be in, this short answer script was to find out what types of changes people aspired to see in their surroundings. The question asked was: What is one small change you wish to see in the architecture of your surroundings?

Responses in the form of raw data:

- Greenery (2 responses)
- I want to make them more air flowing
- Traditional apartments models
- More lights and water bodies
- Pleasant atmosphere
- better houses not boring ones!!
- Colours
- Garden
- Buddha idol
- S
- More green spaces and trees around buildings
- Not applicable
- Good sunlight & Garden
- less slums
- Better interior looks of home
- Simple and showcasing Indian roots
- Ground

Responses organized in sub-categories:

Nature and Environment: Better surrounding environment, with cleanliness and nature.

- Greenery
- More green spaces and trees around buildings
  Garden
- Good sunlight & Garden
- Less slums (implying better, healthier urban surroundings)
- Ground (implying more natural environment)

Design and Style: Desired styling and structural elements in participants' surroundings.

- Traditional apartment models
- Better Interior looks of home
- Simple and showcasing Indian roots
- Better houses, not boring ones!!

Aesthetics and Additions: Visual elements and features participants wish to enhance their spaces.

- More lights and Water Bodies
- Colours
- Buddha idol

Atmosphere and Space:Comfortable and open spaces that allow good airflow and a pleasantoverall environment.

- I want to make them more air flowing
- Pleasant atmosphere

IncompleteAnswers:Answers that are vague and give no suggestions

- Not Applicable
- S

Conclusion:

The responses revealed diverse aspirations of many types. These aspirations ranged from increased greenery like greenery and gardens, better surroundings like the reduction of slums and poverty, design features such as better interior looks and traditional apartment models, additions such as lights and buddha idols, and better atmosphere aspirations. However there were vague responses. Overall there is a clear wish for surroundings that are both nurturing and visually pleasing across all the responses.

Uncomfortable Spaces :

Some spaces can cause discomfort to others, to identify those types of spaces that should be avoided in future architecture planning. The question asked was: Have you ever felt anxious/sad/uncomfortable in a place because of the design of the way it looks. If so describe the design and why you think it made you feel that way

Responses in the form of raw data:
Halfofthe responses were ‘no’. The other half of the responses are mentioned below:

- Designs with dark colors and big sky scrapers
- Yes , due to dark colors
- Any house needs proper ventilation. House without ventilation is not good
- Too bright colours make me uncomfortable
- Harsh colours and clumsy rooms
- Yes,uncomfortable in a place leaving with strangers
- Closed home with no sunlight
- Dark colors
- Yes, Garbage throughout

Responses organized in sub-categories
Color-related Discomfort:Uncomfortable or extreme color schemes negatively affect mood and create a sense of unease..

- Designs with dark colors and big skyscrapers
- Yes, due to dark colours
- Too bright colours make me uncomfortable
- Harsh colours and clumsy rooms
- Dark colors

Ventilation and Sunlight issues: Spaces lacking proper airflow or natural light may feeloppressive andreduceoverallcomfort.

- Any house needs proper ventilation; houses without ventilation are not good
- Closed home with no sunlight

Crowing and Unfamiliarity:Being in crowded spaces or around unfamiliar people can cause discomfort and anxiety.

- Yes, uncomfortable in a place living with strangers

Lack of cleanliness: Untidy or cluttered environments contribute to negative emotions and stress

- Yes,garbage throughout

Conclusion:
These responses prove that some places have the ability to cause mental discomfort, anxiety, and sadness. Places which have uncomfortable elements like poor color choices, lack of sunlight and ventilation, overcrowding, excessive clutter should be avoided to create a

mentally supportive environment.

Healing Spaces :

Healing spaces, they're the spaces that make us the happiest, they nurture the soul and are filled with comfort, peace, and a sense of belonging. Every person heals differently, hence each person has a different type of ideal healing space. This question asked was: What type of place makes you the happiest?

Responses in the form of raw data:

There were many responses that matched. The responses are down below:

- Devotional (preferred by 7 individuals)
- Minimalistic (preferred by 3 individuals)
- Nature-rich places (forests, mountains, beaches, parks) (preferred by 5 individuals)
- Modern (preferred by only 1 individual)
- Childhood Home (preferred by only 1 individual)
- Tuscany styled places (preferred by 1 individual)

Conclusion:

These responses prove that every person has a different way of healing and everyone has an ideal place they heal the best in. However a lot of people find peace, soulfulness,contentment,and happiness in places with devotion, minimalism, nature and emotional attachments.

Conclusion:

This study highlights the profound effect of architecture on an individual's mental health. Lighting, color, space, greenery, cultural touches all contribute to focus, comfort, happiness and peace. Hence, each element must be designed thoughtfully and carefully to provide mental security. Even though individual preferences vary, there is one thing in common, people can thrive in environments that are nurturing, harmonious, and thoughtfully crafted. By understanding an individual's preferences, architects can create places that heal and inspire. Because at the end of the day it is the spaces we inhabit that play a central role in shaping a person's mood, behaviour, and character.

Color Psychology of Dogs

BY: Roshni Ahuja

COLOR PSYCHOLOGY OF DOGS WITH THEIR EYESIGHT

RESEARCH PAPER

Submitted By:

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[BATCH2022-2026]

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May2026

Color Psychology Of Dogs With Their Eyesight

ABSTRACT

The colour vision of three domestic dogs was examined in a series of behavioural discrimination experiments. Measurements of increment-threshold spectral sensitivity functions and direct tests of colour matching indicate that the dog retina contains two classes of cone photopigment. These two pigments are computed to have spectral peaks of about 429 nm and 555 nm. The results of the colour vision tests are all consistent with the conclusion that dogs have dichromatic colour vision. (Jay Neitz,1989)

Aim: To explore the relationship between interior color selection and dog vision, in order to create environments that positively influence canine behavior, comfort, and psychological well-being through effective application of color psychology.

Keywords: Dogs, Canis familiaris, Comparative colour vision, Dichromacy, Cone Pigments.

INTRODUCTION

Although keen color vision has long been considered an important sensory capacity of primates, the summary has often been offered that members of other mammalian orders tend to lack color vision (Walls, 1942; Tansley, 1965; Ali & Klyne, 1985). According to Tansley (1965, p. 98), for instance, “On the whole mammals appear not to have color vision except for the primates.” Contrary to this assertion, there is in fact evidence to indicate that at least the presence of color vision can be established in quite a number of nonprimate mammalian species (Jacobs, 1981).

A major problem in deriving any generalizations about color vision in mammals is that appropriate tests have only been conducted on a relatively small number of mammalian species. Striking among the gaps in our knowledge is a lack of compelling information about color vision in any of the canids (Jacobs, 1981). This is particularly surprising in the case of the domestic dog (*Canis familiaris*) for two reasons. First, of course, the dog enjoys a unique status as a favored companion and able assistant to our species, the latter role often requiring the use of good vision. Second, dogs are subject to a variety of retinal degenerative diseases and in recent years this fate has made the species a frequent subject of ophthalmological studies (Aguirre et al., 1982; Schmidt & Aguirre, 1985; Schmidt et al., 1986).

The structure of the dog retina clearly suggests the possibility for color vision. In particular, there are abundant numbers of cones that comprise as many as 20% of all of the receptors in the central portion of the retina (Parry, 1953). In addition, there is both electrophysiological (Aguirre, 1978; Odom et al., 1983) and behavioral (Coile, 1982) evidence that these cones provide robust signals under classically defined, photopic test conditions. Despite these facts, behavioral studies have to date not yielded any consensus conclusion about dog color vision.

Twenty years ago, Rosengren (1969) reviewed the studies published up to that time. Of the 16 studies she found in the literature, roughly half had concluded that dogs had some color vision; the remaining studies had either yielded negative conclusions or were ambiguous in outcome. Rosengren (1969) ran several simple color vision tests on four cocker spaniels and concluded that they had the capacity to make some color discriminations. There do not appear to have been any subsequent studies of dog color vision. None of the studies in this early literature would be considered as very compelling relative to modern standards for investigations of color vision.
Color perception in dogs differs significantly from humans due to dog vision, which is limited to blue and yellow tones. This affects how dogs interpret their surroundings and respond emotionally to spaces. Understanding this is essential in interior design, as colors can influence a dog's comfort, stress levels, and behavior. Using appropriate hues and contrasts based on color psychology can help create calming and navigable environments. Designing with canine vision in mind ensures spaces that support their psychological well-being while maintaining functional and safe interiors.
Accordingly, we have reexamined this issue and here report results that establish the presence of color vision in the dog, characterize the nature of this capacity, and provide an estimate of the spectral properties of the cone pigments of this animal.(Jay Neitz,1989)

LITERATURE REVIEW

Introduction to Canine Vision

Dogs (*Canis familiaris*) have a visual system that differs significantly from humans, especially in terms of color perception. Early assumptions suggested that dogs lacked color vision; however, modern research has established that dogs possess **dichromatic vision**, meaning they can perceive a limited range of colors. (Gerald H. Jacobs,2009)

Their visual perception is influenced by the structure of the retina, which contains two types of cone photoreceptors instead of three (as in humans). This limitation directly impacts how dogs interpret colors and respond psychologically to their environment. (Gerald H. Jacobs,2009)

The study of color psychology in dogs is rooted in the broader scientific understanding of canine vision, particularly the physiological structure of the retina and its influence on perception and behavior. Early assumptions in visual science suggested that non-primate mammals lacked meaningful color vision; however, this view has been revised through experimental research in comparative vision science.A pivotal contribution was made by Jacobs (1981), who argued that several non-primate species demonstrate measurable color discrimination abilities, challenging earlier generalizations. Building upon this foundation, Neitz, Geist, and Jacobs (1989) provided one of the most definitive studies on canine color vision, demonstrating through behavioral discrimination experiments and spectral sensitivity analysis that dogs possess dichromatic vision. Their findings revealed two cone photopigments with peak sensitivities at approximately 429 nm and 555 nm, corresponding to blue and yellow- green wavelengths. This physiological limitation establishes the framework for understanding how dogs perceive and psychologically respond to color stimuli.

The dichromatic nature of canine vision implies that dogs interpret the visual world through a restricted chromatic range, analogous to red-green color blindness in humans. According to Miller and Murphy (1995), dogs are unable to distinguish between red and green hues effectively, often perceiving them as shades of gray or brown. This limitation significantly influences their interaction with the environment, as color differentiation is not as dominant a sensory cue as it is in humans. Instead, dogs rely more heavily on brightness contrast, motion detection, and spatial awareness. The dominance of rod photoreceptors in the canine retina, as discussed by Coile (2002), enhances their ability to detect movement and function in low-light conditions, further reducing reliance on color perception. Consequently, the psychological impact of color on dogs is less about emotional association, as seen in human color psychology, and more about visibility, clarity, and functional recognition.

Behavioral studies have reinforced the idea that dogs can learn to associate specific colors with outcomes, although their performance is strongly influenced by luminance contrast rather than hue alone. Kasparson et al. (2013), in their work published in Applied Animal Behaviour Science, demonstrated that dogs are capable of color discrimination when brightness cues are controlled, confirming that their responses are not solely dependent on intensity differences. Similarly, Rosengren (1969) conducted early experimental observations indicating that dogs could make simple color discriminations, although methodological limitations at the time led to inconsistent conclusions across studies. These variations highlight the complexity of isolating color perception from other visual cues in animal behavior research.

From a psychological perspective, the limited color spectrum perceived by dogs suggests that their responses to color are primarily functional rather than emotional. Research by Siniscalchi et al. (2017) indicates that dogs exhibit lateralized brain responses when exposed to different visual stimuli, including colors, suggesting that certain hues may influence attention and behavioral reactions. Blue and yellow, being the most distinguishable colors within their visual range, tend to elicit stronger engagement and recognition. In contrast, colors such as red and green do not produce the same level of response due to their perceptual ambiguity. This has direct implications for applied fields such as interior design, product design, and training environments, where color selection can influence canine behavior, comfort, and efficiency.

In the context of built environments, especially pet care centers, veterinary clinics, and boarding facilities, the application of canine color psychology must be informed by both perceptual science and behavioral outcomes. As suggested by Horwitz and Mills (2009) in their work on canine behavior, environmental enrichment plays a crucial role in reducing stress and promoting well-being in dogs. The use of visually accessible colors such as blue and yellow, combined with high-contrast spatial elements, can enhance wayfinding and reduce anxiety. Moreover, the integration of texture, lighting, and spatial organization becomes equally important, as dogs rely on multisensory input rather than color alone.

Dichromatic Color Vision in Dogs

A landmark study by Neitz, Geist, and Jacobs (1989) demonstrated that dogs have two cone photopigments with peak sensitivities around 429 nm (blue) and 555 nm (yellow-green).

This means:

- Dogs primarily perceive blue and yellow hues
- Colors like red and green appear dull (brown/gray)
- Their vision is comparable to red-green color blindness in humans
- Thus, dogs do not see a full spectrum but rather a simplified color environment.

(Christina Fernandez, 2026)

Role of Cones and Rods in Dog Eyesight

The retina of dogs consists of:

- Cones : Responsible for color detection (limited in dogs)
- Rods : Highly developed, responsible for motion detection and night vision (Christina Fernandez, 2026)

Dogs have more rods than humans, which makes them:

- Better at detecting movement .
- More sensitive in low-light conditions.

Less dependent on color for environmental understanding. (Christina Fernandez, 2026)

Color Perception and Psychological Response

Color psychology in dogs is directly linked to what they can perceive visually. Since dogs mainly see blue and yellow: The ability to perceive color in mammals is contingent upon photoreceptors known as cones and rods. Cones are responsible for color detection, while rods facilitate motion perception and vision in low-light conditions. Humans possess three types of cones (trichromatic vision), whereas dogs have only two types, leading to dichromatic vision.

Experimental research (Neitz et al, 2009) has demonstrated that the canine retina contains two types of cone photopigments with peak sensitivities at approximately 429 nm and 555 nm, which correspond to blue and yellow wavelengths, respectively.

This biological constraint elucidates why dogs perceive a more limited spectrum of colors compared to humans and serves as the basis for their color psychology.

a. Preferred Colors

- Blue and Yellow : Highly visible and stimulating
- Used in toys, training tools, and environments
- Improve engagement and attention (Pauleen C. Bennett, 2019)

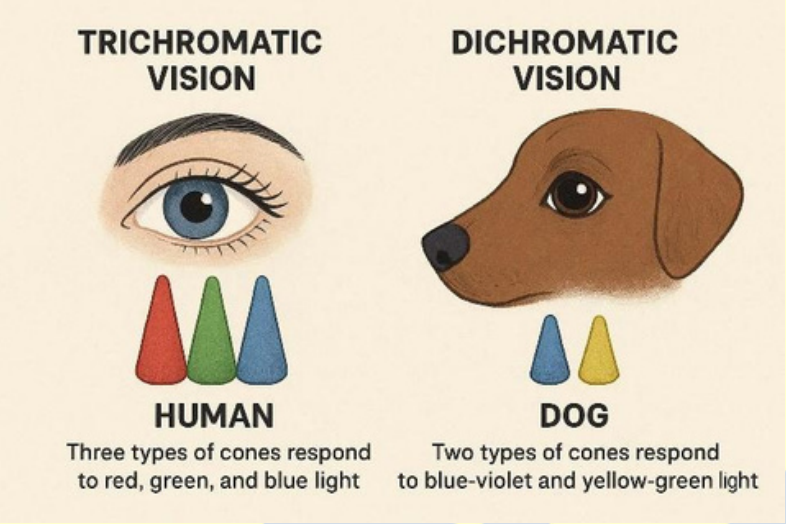

Figure 1 Trichromatic vision vs Dichromatic vision; Source : Pet Paws smd feathers

b. Less Effective Colors

- Red, Green, Orange : Appear muted or grayish
- Less effective for attracting attention or training cues (Pauleen C. Bennett,2019)

Figure 2. Human vs Dog eyesight ; Source : Pet Paws & Feathers

Behavioral Studies on Color Discrimination

Behavioral research has been extensively employed to investigate how dogs react to colors. These studies typically involve:

- o Training dogs to associate colored objects with rewards
- o Monitoring the accuracy of their responses to various color stimuli
- o Results indicate that dogs exhibit a significant response to color differentiation, revealing insights into their perceptual capabilities.

Dog Vision vs Human Vision

Feature	**Dogs**	**Humans**
Cone types	2 (dichromatic)	3 (trichromatic)
Cone sensitivities	~429 nm (blue/violet) & ~555 nm (yellow-green)	Blue, green, red
Colour range	Blue–yellow spectrum	Full visible spectrum
Red-green distinction	Cannot distinguish	Yes
Visual acuity	4–8× worse than humans	Baseline
Low-light vision	Superior (more rods, tapetum lucidum)	Weaker

- o

In conclusion, the literature consistently supports the understanding that dogs possess dichromatic vision, which fundamentally shapes their perception of color and its psychological impact. While color does not hold the same emotional or symbolic significance for dogs as it does for humans, it remains an important factor in visibility, behavioral response, and environmental interaction. The work of Jacobs (1981), Neitz et al. (1989), Kasparson et al. (2013), and Siniscalchi et al. (2017) collectively establishes a scientific basis for applying color psychology in canine-centered design, emphasizing functionality, contrast, and perceptual clarity over aesthetic diversity.

CASE STUDY

Experiment 1: (Source:Animal Cognition)

To identify any secondpreference, a two-choice test was done between blue and gray. The same blue and gray bowlsasdescribed earlier were used. The bowls were placed about 50 cm away from each other.Sincepresence of food did not affect the choice in the previous experiment, all trialsinthisexperiment were the "with_food" condition only. See Online Resource 5 for videooftheexperiment. We success fully tested 102 dogs (52 females, 47 males, and 3 dogs of unknownsex)where blue was chosen 44 times and gray was chosen 58 times. There was no significantpreference for any of these colors (goodness of fit $\chi 2 = 1.921$, df = 1,
p = 0.165). A total of21dogsdid not make a choice when presented with the setup, and 19 trials were discardedfornotmeeting all experimental criteria.

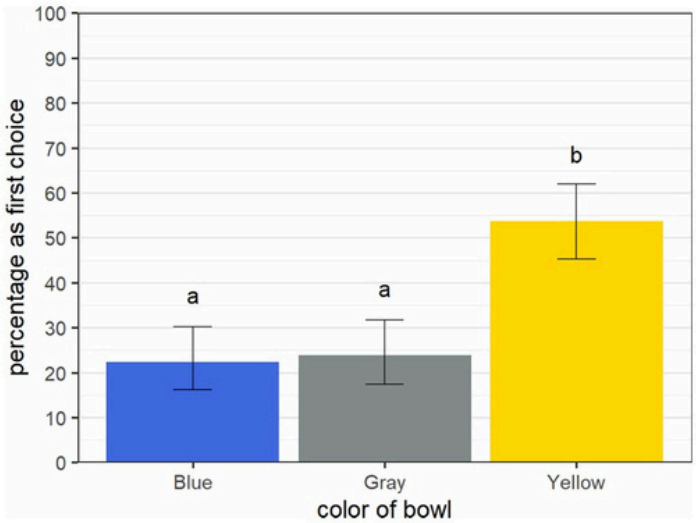

Figure 3. Source: Animal Cognition (2025)

Experiment 2A: Strength of preference control: with two yellow bowls, one of which has food

The strength of preference experiment was designed to assess dogs' attraction to yellow in comparison to their attraction to food associated with gray, a color they generally prefer less. The same bowls from previous experiments were utilized, but to maximize the visibility of the food, the bowls were turned upside down with the food placed on top (refer to Online Resources
7 & 8 for experiment videos). The bowls were positioned about 50 cm apart during the presentation.

Thebiscuitsusedintheexperimentswere small (approximately a quarter circle with a radius of about3cm)andwhiledomesticdogs do consume carbohydrates, they have a preference for meat(BhadraandBhadra2014;Bhadra et al. 2015; Sarkar et al. 2019). To ensure the experimentworkedasplanned,itwas crucial that the dogs chose the biscuit over an empty bowlwhenbothbowlswerethesame color. We selected yellow bowls since the brownish biscuitwouldblendintotheyellowbackground; thus, if dogs could spot and select it there, theyshouldeasilydosoagainstacontrasting gray bowl. Therefore, for the control trials, both bowlswereyellow,withonlyonecontaining a biscuit. In total, we tested 54 dogs (20 females, 33 males,and1withanunknownsex). During the setup, 3 dogs did not make a selection, leadingtotheexclusionof6trialsthat failed to meet all experimental criteria. The bowls with biscuitswerechosen35times,compared to 19 times for the empty bowls (goodness of fit $\chi 2$ = 4.740,df=1,p=0.029,Cramér'sV= 0.296).

Experiment2B:Strengthofpreference: "no_food" yellow bowl vs. "with_food" gray bowl

In this experiment, we placed food in a gray bowl similarly to the control setup, while leaving the yellow bowl empty, thus providing the dogs a choice between food and their preferred color. Two conditions were tested: (a) a piece of biscuit as food and (b) about 15 grams of raw chicken. Refer to Online Resources 7 and 8 for videos of the experiment. Different groups of dogs participated in Experiments 4a and 4b to prevent any learning bias.

We successfully tested 52 dogs (20 males, 32 females) using biscuits (see Fig. 4). The gray bowl containing food was chosen 11 times, whereas the empty yellow bowl was selected 41 times (goodness of fit $\chi 2 = 17.308$, df = 1, $p < 0.001$, Cramér's V = 0.576). In this trial, 8 dogs did not make a choice, and 6 trials were excluded for not fulfilling all experimental criteria. In the chicken condition, the empty yellow bowl was chosen 47 times out of 61 successful trials (28 males, 33 females, using different dogs than in the biscuit group), with the gray bowl selected only 14 times (goodness of fit $\chi 2 = 17.852$, df = 1, $p < 0.001$, Cramér's V = 0.540). Here, 7 dogs made no choice, and 10 trials were discarded for not meeting experimental standards.

There was no notable difference between the biscuit and chicken groups (contingency $\chi 2$ = 4.05*10^-6, df = 1, p = 0.99), but both groups showed significant differences from the control group (contingency $\chi 2$ tests; control vs. biscuit: $\chi 2$ = 18.819, df = 1, $p < 0.001$, Cramér's V = 0.421; control vs. chicken: $\chi 2$ = 18.852, df = 1, $p < 0.001$, Cramér's V = 0.404). After applying Bonferroni correction, the alpha level for these three tests was set at 0.017.

In Conclusion, Our experiments demonstrate a clear preference for the color yellow over blue and gray in FRDs of India, at least in the context of foraging. This preference is so strong that it supersedes their attraction towards food, whether biscuit or chicken. This is the first time that we have observed FRDs ignore a clear food reward in a choice test. Further experi ments can help us understand the ecological advantages, if any, of this preference and the reasons behind it. Moreover, comparative studies with companion dogs and wolves can help to understand the evolutionary trajectory of this prefer ence for yellow. The impact of color cues and color prefer ence on training can be explored in the future.

INFERENCE

The study of canine vision clearly indicates that dogs perceive the world through a dichromatic visual system, limiting their color recognition primarily to blue and yellow wavelengths while rendering red and green tones as muted shades of grey or brown. This restricted color perception directly influences their behavioral responses and interaction with the environment, suggesting that color psychology in dogs is fundamentally based on visibility and contrast rather than emotional association, as seen in humans. Dogs rely more heavily on brightness differences, movement, and spatial cues, which makes high-contrast environments more effective for navigation and engagement.

From a design perspective, this implies that the use of blue and yellow hues can significantly enhance visual clarity and responsiveness in dogs, while colors like red and green should not be relied upon for functional elements such as wayfinding, toys, or activity zones. Additionally, since dogs possess superior low-light vision and heightened sensitivity to motion, the integration of balanced lighting, non-glossy surfaces, and clear spatial organization becomes essential in creating comfortable and stress-free environments.

Overall, the inference establishes that effective design for dogs should prioritize contrast, texture, and functional color application over aesthetic variety, ensuring that spaces are aligned with canine visual perception and psychological comfort.

ANALYSIS

Color psychology in dogs is closely linked to their visual capabilities, which differ significantly from those of humans. Dogs possess dichromatic vision, meaning they have only two types of cone photoreceptors in their eyes. As a result, they primarily perceive colors within the blue and yellow spectrum, while colors such as red and green appear dull, often as shades of grey or brown. This limited color perception plays a crucial role in shaping how dogs interact with their environment.

Unlike humans, who often associate colors with emotions and meanings, dogs respond to colors based on visibility and clarity. Their visual system is adapted to detect contrast, brightness, and movement rather than a wide range of colors. This is because dogs have a higher number of rod cells in their retina, which enhances their ability to see in low light and detect motion, but reduces their sensitivity to color variations. Therefore, objects that stand out due to high contrast are easier for dogs to recognize and respond to.

Behavioral observations support this understanding, showing that dogs are more likely to engage with objects that are visually distinct in their limited color range. For instance, a blue or yellow object is more easily identified than a red object placed on a green background. This highlights the importance of selecting appropriate colors in environments designed for dogs.

In conclusion, the analysis shows that canine color psychology is not based on emotional interpretation but on functional perception. Effective design for dogs should prioritize contrast, simplicity, and the use of visible colors to enhance comfort, navigation, and overall behavior.

CONCLUSION

Research into color psychology in dogs reveals that their visual perception significantly differs from that of humans, mainly because they possess dichromatic vision. Dogs can only see a limited spectrum of colors, particularly in the blue and yellow range, while colors like red and green appear indistinct. This biological characteristic impacts how dogs perceive their environment and react to visual cues.

The study indicates that, in contrast to humans, dogs do not link colors to emotional or symbolic meanings. Their reactions are primarily driven by visibility, contrast, and clarity. Their visual system is optimized for detecting brightness, movement, and spatial variations, thanks to a greater number of rod cells that improve low-light and motion perception. Consequently, environments with high contrast are more conducive to their navigation, recognition, and overall behavior.

Behavioral studies corroborate that while dogs can differentiate certain colors, their decisions are heavily influenced by luminance contrast rather than color alone. The preference for colors like yellow in experimental setups highlights the significance of visibility in engagement and interaction, occasionally surpassing other motivators such as food.

From an interior design viewpoint, this research underscores the need to create dog-centric spaces that cater to their visual capabilities. Incorporating blue and yellow shades, along with distinct contrasts, suitable lighting, and varied textures, can significantly enhance comfort, minimize stress, and enhance the functionality of areas like pet care centers, veterinary offices, and boarding facilities.

In summary, effectively applying canine color psychology necessitates a transition from human-centered design approaches to a focus on functional design, emphasizing visibility, contrast, and sensory balance. This ensures that environments are not only visually appealing to humans but also psychologically beneficial and functionally accommodating for dogs.

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There is a life I never lived but still mourn

BY: Adrika Noukakhi

Most of what we have lived is fundamental experience with the ability to materialise in not only our own, but also others' minds. Yet beyond those restraints of true identities, and the walls of vile reality lies a world only you have ever visited. It is a life, a condition, a man, a woman, a child or simply a void of existence meant to drag you through the most ominous days.

It is a parallel of what has survived and an opposite manifestation of what one is. it exists while you wake every morning to feed a job you once swore you'd never touch, or on the days you refuse to eat because getting out of bed feels like dragging a mountain by its spine. it exists when you meet the ones who broke their ribs trying to help you pull the spine of the same hill. However, it is only ever seen when you drift off into impossibilities of indefinites and infinities that do not (can not) exist in the memories of those you love.

Their actuality or a lack thereof is a direct consequence of the sexual tension between what you are and what you could be. The hands of the version of yourself you abandoned will tilt your head back and drown you in a smouldering pool of your unmet potential. And when you finally sink, they don't stand on the shore and mourn you; they jump in too, because they were always made of the same water you weren't brave enough to swim in.

"We are what we pretend to be, so we must be careful about what we pretend to be."

There is some truth in them.
You kill her, and you repent her, and somehow both of you keep rising from the same womb of harshness, only to die again in the same lack of significance. She exists, yes, but only as the one who slips into the gaps you couldn't fill. And you exist because you birthed the very faults she now survives on.

"Imagination is the golden-eyed monster that never sleeps. It must be fed; it cannot be ignored."

And the worlds we live in grow thicker witheverydisappointment we swallow whole. We carve entire geographies out of the things we weredenied.Webuild cities out of nearlys, forests out of almosts, oceans out of what-ifs. You walk throughthembarefoot because all your shoes are left behind in the world that stabbed your dreamswiththeminute hand of an alarm clock.

the people we sculpt out of thin air. the oneswhohavenever touched us, yet we've memorised the temperature of their palms. The ones whoexistinthereal world but only show us fragments, so we chisel the rest ourselves. We stitch themfromthesoftness we wished they had, or the cruelty we needed them to carry, so our griefmadesense.They become mosaics of truth and projection. And when they fail us, it is not theywhofallapart; it is the version of them we raised like a child, fed with fabrications, and trustedmorethantheir living body. We mourn these imagined people far more desperately becausetheydiedfulfilling a promise no one made.

In the end, everything we fail to become lives on somewhere, and that somewhere is the only place we are ever whole.

Stress

BY: Ishika Singh

General Problem: On Stress

Specific Problem: To prepare two checklists on stress (Stressor and effect of stress) and to study the causes and effects of stress among the school student.

Basic Concept:

Stress:
The word „Stress‟ is derived from the Latin word „Stringere‟, which means „to draw out tight‟.
According to McGrath (1976), “stress is involved in an environmental situation that is perceived as presenting a demand which threatens to exceed the person‟s capabilities and resources for meeting that demand.”
According to Humphrey, “stress can be considered as any factor, acting internally or externally, that makes it difficult to adapt and that induces increased effort on the part of the person to maintain a state of equilibrium both within the internal and the external environment.”

Process of stress:
Stress can be described as a substantial imbalance between environmental demands and capabilities to meet those demands. At first, a physical or psychological demand is placed on the individual in a particular situation. Then, the individuals make a clear perception about the demands and try to assess their abilities needed to meet that demand. If the individuals perceive that they can meet the demands with their abilities, then, it will be an easy task for them. But, if they perceive an imbalance between the demands placed on them and their abilities to meet it, stress begins to build up. Then, the individuals respond psychologically and physically. As a result, an increase in anxiety level, worries, heightened physiological activation (increased heartbeat, blood pressure, increased muscle tension, etc.), possible changes in concentration, etc., will occur.
Finally, their performance may either improve or decline due to this stress.

Stressors:
Stressors are the factors which trigger stress. Stressors may be any environmental condition or even a psychological factor like personality traits, perceptual difference, etc.

Types of stressors:
There are many stressors, which can be categorised into 4 main groups called physiological, environmental, social and psychological.

1. Physiological stressors include excessive exercise, lack of rest and sleep, chronic pain, physical injury, diseases, etc.
2. Environmental stressors include different kinds of pollution, excessive humidity, extreme temperature, lack of proper illumination, presence of radioactive substances, crowding or isolation, excessive noise, etc.
3. Social stressors are found in each of our personal and work situation and also in the familial domain. In the family domain, social stressors include break-up of intimate relationships, lack of healthy relationship with parents, siblings or neighbours, incompatible sexual relationship, etc. In work situations, stressors include lack of leadership qualities, autocratic leadership, unclear work responsibility, lack of team work, work overload or under load, discrimination in pay or promotion, workplace sexual harassment, etc. In the personal domain, low self-esteem, frustration, assuming

every responsibility without delegating the workload to others, sense of competitiveness and chronic guilt, anger, hostility, etc., are key stressors.

4. Psychological stressors mainly focus on emotion inducing factors that activate stress directly or indirectly. The situations that we cannot manage according to social expectations are factors that induce psychological stress. Separation from near and dear ones, bereavement, etc., are also very stressful. Overburdened with petty matters like traffic jam, power cuts, etc., together end up being very stressful.

Causes of Stress:

The factors which generate stress are called stressors or causes of stress.

External or Environmental Factors:

1. Stressful life events:

Any major life event which occurs suddenly leads to stress within an individual. The events include academic failure, divorce, imprisonment, disappointment in life, losing job, death of family members, etc. Sudden confrontation with any of these events disturbs the individuals deeply.

2. Minor hassles of everyday life:

In our daily life, we sometimes become troubled by a number of repetitive or persistent minor events. These may be minor in intensity, but are major in frequency. These are called hassles of daily life. Such hassles may include quarrels with friends or Spouse over petty issues, obtaining poor marks in examinations, health worries, new financial responsibilities, moving to a new community, regular traffic jam, absenteeism of domestic help, etc.

3. Work-related stress:

Work itself is a stress-producing factor which comprises a number of related factors. All these factors singly or in combinations produce stress. Individuals may face a number of stress-producing situations such as long working hours, gender discrimination and bias, lack of appreciation by seniors, inadequate or low salary, unclear job description, unfriendly colleagues, etc.

4. Physical environment:

As human beings effect, influence and change the natural environment for their needs, the environment also effects human mind and body in return. Deforestation, industrial waste, loud noise and such other human activity results in air, water, noise, soil and many other forms of pollution. These pollutants, in return, affect the physical wellbeing of the humans. The physical problems like asthma or constant anxiety for availability of resources like water can lead an individual to be stressed.

Causes of Stress:

The factors which generate stress are called stressors or causes of stress.

Internal Factors:

1. Need:

The various needs of individuals like to reach a difficult target, create pressure on the individual. Low or over-estimation of self along with high aspiration level creates an unrealistic demand on self. This may lead to stress.

2. Personality trait and types:

Usually, three types of personality, Type-A, Type-B and Typical have different impacts or effects on an individual's susceptibility to stress.

The persons with personality type- A are high achievers, ambitious, competitive and workaholics. Their high aspiration levels may make them more stressed since they want to complete a lot of work within a time limit.
Individuals with Type-B personality are basically optimists. They can manage stressful situations properly. Moreover, due to their normal levels of aspiration and positive attitude towards life, they don't feel stressful.
People with Type-C personality suppress all their negative feelings like anger, hostility and rage. This disrupts their equilibrium and immune system. As a result, their body becomes weak and less resistant to diseases like cancers especially lung cancer.

3. Attitude:

It has been seen that people with a positive attitude experience lesser stress than people with negative attitude.

Effects of stress:

1. Upsets the internal mechanism and balance:

Stress disturbs our homeostasis thereby inducing physiological imbalance. It interferes with the functioning of both mind and body. It activates autonomic nervous system (ANS). The Sympathetic nervous system of ANS gets activated when body is aroused particularly during stress. It prepares the body for emergency reaction of fight or flight response. As a result, it raises the heartbeat, blood pressure, muscle tension, etc.
The effect of stress on physical health may be summarised as follows-

Affects the immune system: Stress has a major negative effect on the immune system of an individual. Stress drains the resources of the person highly disturbing his/her complex immune system. Immune system consists of the mechanism by virtue of which the body is able to recognise and destroy the potentially harmful agents and elements like bacteria, viruses, other infection producing germs and cancerous cells. Prolonged exposure to stress seems to severely affect this system.

Causes hypertension: Hypertension, also referred to as high blood pressure indicates that blood pressure in the arteries is persistently elevated. It is dangerous, silent killer. The risk is that it is not always identified by any particular symptom. High blood pressure slowly damages the various organs such as kidneys, heart, brain and eyes.

Cardiac problems: Extensive research work in psychology suggest that Type A personality is linked to experiencing high levels of stress culminating to heart problems. They are target-oriented, competitive and try to achieve more than others. They tend to judge themselves by the amount of success, money, assets and friends they have. All these traits create a lot of pressure on them. Consequently, they experience a lot of stress. This may ultimately lead to cardiac problems.

Psychosomatic disorders: Stress is related to different psychosomatic disorders. 'Psyche' means 'soul' and 'soma' means body. The mind and body are interconnected as often psychological trouble adversely affects the physiological mechanisms of the body. It then gets manifested through different psychosomatic diseases like ulcer, asthma, common cold, headache, diabetes and many others.

2. Effect of stress on work performance:

There is a belief that stress energises the body and there is some arousal. The arousal seems to enhance the productive efficiency of the person initially. However, after some time, the performance drops. As the stress is experienced excessively or when it is becoming uncontrollable, person reaches a fatigue point, where the performance starts to decline. The ultimate end, called burnout, is manifested through exhaustion, ill health and break down.

PRELIMINARIES:

- Age: 16-18 years.
- Sex: Both male and female.
- Education: Studying in class 10-12
- Condition: fresh and cooperative.
- Duration of study: 1st November – 5th November, 2025.

MATERIALS REQUIRED:

- Statements for preparing the checklist.
- Pen.
- Pencil.
- Paper.
- Internet.
- Printer.

PROCEDURE:

Domains were selected and following that we had prepared two different sets of checklists on causes and effects of stress following five Points (strongly agree, agree, sometimes, disagree, strongly disagree).

We have administered those checklists on our sample group.

Data is collected from the sample group.

After collection of data, we have scored all the checklists and necessary calculations have been done.

On the basis of the result obtained after calculations, interpretation and conclusion has been drawn.

INSTRUCTION TO THE PARTICIPANTS OR SUBJECTS:

“Please sit comfortably and pay attention to my instruction. I shall present you two checklists, one after the other, containing 10 and 15 statements respectively. Please go through them carefully and put a tick against the suitable option with which you agree. Ask me, if you have any inconvenience. "

DATA COLLECTION:

The data collected from the sample group is given in the following pages:

RESULT TABLE:

CAUSES:

SL.NO	DATA GIVEN BY SUBJECTS											SCORING											SUMMATION	MEAN
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10				
1					A	E	E	D	B	D	C	A	A	C	5	1	5	4	4	2	3	5	5	2	2	3	4	2	4	3	3	3	37	3.7
2					D	D	C	D	D	B	C	C	D	D	2	4	4	2	4	2	3	3	5	4	2	3	3	1	4	5	2	2	27	2.7
3					B	B	B	D	D	C	C	A	B	C	5	1	4	5	1	1	2	5	5	5	4	5	4	3	5	3	3	3	34	3.4
4	D	C	C	E	B	A	D	A	E					E	4	3	4	2	4	5	4	2	3	3	1	2	2	4	2	5	2	1	27	2.7
5					B	A	A	E	D	A	A	A	B	B	5	4	1	1	4	4	2	5	1	5	1	2	4	5	5	1	4	4	36	3.6
6					A	B	C	A	C	C	B	C	B	B	3	5	5	3	5													4	38	3.8
7					D	B	E	D	D	C	C	E	D	C																		3	29	2.9
8					D	B	B	A	D	A	B	E	E	D																		2	28	2.8
9					B	B	B	A	E	A	E	D	B	D																		2	30	3.0
10					A	A	A	B	C	A	A	C	A	B																		4	40	4.0

EFFECTS:

SL.NO	DATA GIVEN BY SUBJECTS												SCORING												SUMMATION	MEAN
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10						
1					A	B	B	E	E	A	B	E	D	C	5	4	4	1	1	5	4	1	2	3	30	3.0
2					A	C	C	A	B	A	B	A	A	B	5	3	3	5	4	5	4	5	5	4	43	4.3
3					B	B	D	A	B	A	B	D	C	B	4	4	2	5	4	5	4	2	3	4	37	3.7
4					E	E	E	E	D	A	E	C	E	D	1	1	1	1	2	5	1	3	1	2	18	1.8
5					C	A	C	B	A	A	D	B	A	A	3	5	3	4	5	5	2	4	5	5	41	4.1
6					B	B	B	E	C	A	B	E	C	D	4	4	4	1	3	5	4	1	3	2	31	3.1
7					B	B	B	A	B	A	E	E	D	B	4	4	4	5	4	5	1	1	2	4	34	3.4
8					B	C	C	E	B	B	E	E	B	D	4	3	3	1	4	4	1	1	4	2	27	2.7
9					D	E	E	E	D	A	D	D	A	B	2	1	1	1	5	5	2	2	5	4	28	2.8
10					E	E	E	E	D	C	E	E	A	E	1	1	1	1	5	3	1	1	5	1	20	2.0
11					E	C	B	A	D	B	E	B	C	C	1	3	4	5	5	4	1	4	3	3	33	3.3
12					A	B	A	A	B	A	B	C	A	A	5	4	5	5	4	5	4	3	5	5	45	4.5
13	B	C	B	C	B	B	B				E		B	C	4	3	4	3	4	4	4	1	4	3	34	3.4
14					B	B	B	B	B	A	E	D	C	D	3	4	4	4	4	5	1	2	3	2	33	3.3
15					A	A	A	A	B	A	D	A	C	B	5	5	5	5	4	5	2	5	3	4	43	4.3

INTERPRETATION

In the questionnaire of causes of stress, the statements are from two categories of causes- i) Internal causes of stress (1, 2,5,6,8), ii) External causes of stress (3, 4,7,9,10).

From the result table of causes of stress, it is observed that the mean value against statement 6 (mean- 3.8) is higher than the mean values against all other statements of internal causes.

Statement 6: I face difficulty in meeting deadlines.

This implies that my sample experiences problems in managing time, workload, and task-related demands. This difficulty may be associated with increased stress levels, pressure to perform, and reduced concentration or motivation. Persistent challenges in meeting deadlines can reflect feelings of being overwhelmed, inefficiency in planning and prioritization, and emotional exhaustion. Such experiences may contribute to anxiety, frustration, and a sense of reduced competence, thereby negatively affecting psychological well-being and overall functioning.

From the result table of causes of stress, it is also observed that among the statements of external causes of stress, the mean value against statement 10 (mean-4.0) is higher than the mean values of all other statements.

Statement 10: Regular traffic jams annoy me a lot.

This implies that my sample has heightened irritability and sensitivity to everyday environmental stressors. Frequent exposure to uncontrollable situations such as traffic congestion can evoke feelings of frustration, anger, and impatience. This response suggests a lower tolerance for daily hassles, which is often associated with elevated stress levels. Persistent irritation in such situations may contribute to emotional strain, increased physiological arousal, and difficulty maintaining emotional regulation, thereby negatively affecting psychological well-being.

In the questionnaire of effects of stress, the statements are from three categories of effects- i) Behavioural effects of stress (1, 2,3,4,5), ii) Physiological effects of stress (6, 7,8,9,10) and iii) Psychological effects of stress (11, 12,13,14,15).

From the result table of effects of stress, it is observed that among the statements of behavioural effects of stress (1, 2, 3, 4, 5), the mean value against statement 2 (mean- 4.3) is higher than the mean values against all other statements.

Statement 2: I have irregular sleep patterns.

The statement indicates a behavioural consequence of stress, as stress often disrupts daily routines and healthy habits. Individuals experiencing stress may delay sleep, have inconsistent bedtimes, or experience frequent awakenings due to persistent worry or mental tension. Such irregular sleep behaviour reflects difficulty in maintaining self-regulation and routine under stress. Over time, this disruption can lead to fatigue, reduced productivity, irritability, and a diminished ability to cope with stress, further reinforcing stress-related behavioural difficulties.

From the result table of effects of stress, it is observed that among the statements of Physiological effects of stress (5, 6, 7, 8, 9, 10) the mean value against statement 7 (mean- 3.4) is higher than the mean values against all other statements.

Statement 7: I experience headache when I am stressed.

The statement reflects a clear physiological response to stress. Stress activates the body‟s autonomic nervous system, leading to muscle tension, increased blood pressure, and changes in blood flow, which commonly result in headaches. This symptom indicates that prolonged or intense stress is affecting the body‟s physical functioning. Such stress-induced physiological reactions can cause discomfort, fatigue, and reduced efficiency in daily activities, highlighting the direct impact of stress on bodily health.

From the result table of effects of stress, it is observed that among the statements of psychological effects of stress (11, 12, 13, 14, 15) the mean value against statement 12 (mean- 4.5) is higher than the mean values against all other statements.

Statement 12: I overthink about small things for a long time.

The statement reflects the cognitive effects of stress on an individual‟s psychological functioning. Stress often leads to excessive rumination, where minor issues are repeatedly analysed and magnified. This pattern of overthinking indicates heightened anxiety, mental restlessness, and difficulty in controlling intrusive thoughts. Prolonged rumination can drain emotional energy, impair decision-making, and increase feelings of worry and self-doubt, thereby intensifying psychological stress and reducing overall well-being.

CONCLUSION

After conducting the study, it can be concluded that the internal stressor mostly experienced by the sample is "***I face difficulty in meeting deadlines.***" The external stressor mostly experienced by the sample is "***Regular traffic jams annoy me a lot.***" The prominent behavioural effect of stress includes ***irregular sleep patterns***. The Physiological effects of stress include ***headaches.*** The psychological effects include ***overthinking about small things a lot.***

How Does Excessive Screen Time and Social Media Use Affect Sleep Quality, Memory Performance, and Emotional Regulation in Teenagers?

BY: Warda Sheikha

Name: WardaSheikha
Research Track: Life Sciences and Medical Sciences

Research Question Draft

1) Draft Research Question (must be a question)

My draft research question: How does excessive screen time and social media use affect sleep quality, memory performance, and emotional regulation in teenagers?

2) Quick checklist

- ☑ ~~Specific (not too broad)~~
- ☑ ~~Researchable (I can realistically find evidence/data)~~
- ☑ ~~Original (not just repeating a common question)~~
- ☑ ~~Written as a question (not a topic/statement)~~
- ☑ ~~Fits my chosen research track~~
- ☑ ~~Draft only (I will refine in Week 3)~~

Annotated Source List (3 to 5 Sources)

Reminder checklist

- Each source is peer-reviewed OR from a credible institutional publisher
- Each annotation includes: **citation, 3-sentence summary, relevance**
- At least **2 sources** come from **academic databases** (ex: Google Scholar, JSTOR, PubMed, IEEE Xplore, ACM DL, ERIC, PsycINFO)

SOURCE 1

Citation: Twenge, J. M., & Campbell, W. K. (2018). Associations between screen time and lower psychological well-being among children and adolescents. Preventive Medicine Reports, 12, 271–283.

Where you found it (database/publisher): google scholar

3-sentence summary:
1. The studyexaminedlarge-scalesurvey data linking screen time with adolescent mental health outcomes.
2. Higher screen use was associated with increased anxiety, depression, and reduced emotional stability.

3. Teenagers spending more time on digital devices reported lower psychological well-being overall.

Relevance to my research question (2-4 sentences): This source directly supports the emotional regulation aspect of my research question. It provides statistical evidence connecting excessive screen use with mental health outcomes in teenagers. It helps establish a scientific foundation for investigating emotional effects.

Notes / useful quote / key statistic (optional): Higher screen exposure correlated with significantly lower well-being scores among adolescents.

SOURCE 2

Citation: Uncapher, M. R., Thieu, M. K., & Wagner, A. D. (2016). Media multitasking and memory performance. Psychonomic Bulletin & Review, 23(2), 483–490.

Whereyou foundit(database/publisher): Psychological science journal

3-sentence summary:
1. The study investigated how frequent digital multitasking affects attention and memory.
2. Heavy media multitaskers showed weaker working memory performance.
3. Increased distraction reduced the brain's ability to store and recall information efficiently.

Relevance to my research question (2-4 sentences): This source directly supports the memory-performance part of my research. It provides neurological explanations for how constant digital stimulation impacts cognition. It strengthens the scientific argument about learning and concentration problems linked to screen time.

Notes / useful quote / key statistic (optional): High multitaskers performed worse on memory filtering tasks.

SOURCE 3

Citation: Hale, L., & Guan, S. (2015). Screen time and sleep among school-aged children and adolescents: A systematic review. Sleep Medicine Reviews, 21, 50–58.

Whereyou foundit(database/publisher): PubMed

3-sentence summary:
1. This systematic review analysed multiple studies on screen exposure and sleep outcomes.
2. Most studies showed consistent links between screen time and shorter sleep duration.
3. Evidence suggested behavioural and biological factors both contribute to sleep disruption.

Relevance to my research question (2-4 sentences): This source strengthens reliability by summarising many studies rather than one experiment. It confirms that sleep disruption due to screen use is widely supported scientifically. It helps justify why sleep is a key variable in my research.

Notes / usefulquote / key statistic (optional): Over 90% of reviewed studies found negative sleep associations.

SOURCE 4

Citation: Kuss, D. J., & Griffiths, M. D. (2017). Social networking sites and addiction: Ten lessons learned. International Journal of Environmental Research and Public Health, 14(3).

Where you found it (database/publisher): Google Scholar

3-sentence summary:
1. Thearticle exploresbehavioural addiction patterns related to social media use.
2. Excessive engagement activates reward systems similar to addictive behaviours.
3. Emotional dependence on social media can affect mood regulation and stress levels.

Relevance to my research question (2-4 sentences): This study helps explain emotional regulation changes caused by social media overuse. It provides psychological and neurological explanations behind compulsive screen behaviour. It supports analysing emotional outcomes beyond simple usage time.

Notes / usefulquote / keystatistic(optional): Social media engagement can trigger dopamine-based reward responses.

SOURCE 5

Citation: Cain, N., & Gradisar, M. (2010). Electronic media use and sleep in school-aged children and adolescents. Sleep Medicine, 11(8), 735–742.

Where you found it (database/publisher): PubMed

3-sentence summary:
1. This review analysed howelectronicmedia impacts sleep patterns in young people.
2. Screen exposure before bedtime delays sleep onset and reduces sleep duration.
3. Poor sleep quality was linked to daytime fatigue and reduced cognitive performance.

Relevance to my research question (2-4 sentences): This article supports the sleep-quality component of my study. It explains biological mechanisms such as light exposure affecting

circadian rhythms. The findings help connect screen habits with measurable brain and behavioural outcomes.

Notes / usefulquote / key statistic (optional): Night-time screen use significantly delays melatonin release.

SECTION- III

History, Monuments, and Urban Evolution

Old Monuments: Our Link to the Past.

BY: Naga Rishika

Old Monuments: Our Link to the Past.

-Rishika TN

Monuments aren't just buildings made of brick, stone, and cement; they are a symbol of our past. Now, the past is something that is gone forever, once it is gone, it will not show itself again. Letting these precious ancient structures go is like letting history fade away, like allowing the old memories that we wanted to cherish forever go. They stand quietly, holding stories of those who lived, dreamed, and built before us. If they fall silent, a part of our story is lost with them.

We should preserve monuments because they aren't just structures. Every broken wall, every step, and every carving carries a deep significance and a story that most don't know. These monuments help us understand our culture, our past, where we come from, who we truly are, and where we really belong. These buildings explain millions of stories behind each life that exists today. Once they are destroyed, they can't be brought back, no matter how much we try to rebuild them, they won't be the original one, not the one with the real significance and past to it.

Monuments help us stay connected to our roots. They remind us of the traditions, beliefs, and values that shape our society. They aren't just a symbol of religion but a symbol of where we truly come from. The inscriptions are somehow connected to everyone, they carry secrets no one ever knew, not even now. Monuments show us how different cultures have contributed to the world and history.

But more importantly, monuments aren't just a symbol of the past but also a sign of learning. These structures can explain more than any textbook or novel ever could. They are the real evidence behind all the myths and facts that we hear and learn. If not a figure of religion or history, we can consider it as a figure of learning and knowledge for every person. Students, architects, and historians can visit and explore the past and the beauty that lies deep within the scars of the sand and brick that built the structures. These monuments also show how architecture isn't just a subject, but a type of beauty that cannot be recreated today.

Monuments are also a pillar of science that people cannot explain. It includes advanced scientific theories regarding sunlight, sound and much more. They used science to build incredible alarm and defense systems, sometimes even water systems. Let us take the example of the Golconda Fort where if we clap from the entrance, the clap can be heard a kilometer away from the fort's top pavilion. This marks the science of sound. We also have the Sun Temple in Modhera, Gujarat in which the temple is aligned in a way that the sun ray falls exactly at the deity. Jaipur's Jantar Mantar has giant stone instruments built to study stars and time with amazing precision. Monuments aren't just plain architectural structures, they are the proof that shows us the complex science. If we lose them, we lose the chance to explore the brilliant minds that brought this complex science to us.

Monuments also have a real value today. They attract tourists and create jobs to help the economy grow. Hotels, guides, transport, all of this for the monuments means a lesser chance of unemployment and a lesser number of people below poverty line. Monuments save people's lives in this way as well. But beyond money, monuments are really priceless. Once gone, nothing can bring back the original history. The broken steps and walls, we cannot build a wall, break it and say it's a part of history. Every scratch, every carving and every cut marks a deep importance of the past, present and the future. Preserving them lets our future generation feel the same wonder, the fights that were fought and much more. Losing them means losing a part of ourselves as well.

Monuments also teach us tradition, our past, culture and the stories of our customs. If they are gone, then all we are left with a history full of guesses, without them, there is no us. We come from there. Monuments are real proof of our past. Preserving them means ensuring our history stays true. Books and pictures explain the past, but monuments are the real evidence of the past. We will not have a proper understanding of history without them. They allow us to see, touch and feel what our past feels like. Losing them signifies losing our chance to learn.

So let us come together. Let us save the buildings that mark a role in our lives, in the past, in the present and the future. In the end, it's not just protecting stones and sand, it's protecting a part of us, our history, our culture and our knowledge. These monuments remind us of where we come from and where we are going. Every stone, every step and every brick there has a story untold. Once we start discovering how it was built, we unfold the stories we were never told, if we didn't see it, doesn't mean we shouldn't know. Therefore, saving monuments isn't a choice, it is our responsibility.

Report on Visit to Wate Sangaggeni Plaza, Zahira

BY: Swarnika Singh

[Report]

Visit to Waste Segregation Plant, Zakhira

On 29th January 2026, our school organized an educational visit to CHINTAN's Waste Segregation Plant in Zakhira, West Delhi. CHINTAN, an organization partnered with Coca-Cola and KPMG, works towards waste management, hyper-segregation, and environmental sustainability. The visit aimed to educate us about waste segregation, recycling, and its role in reducing landfill waste. We left the school at 10:00 AM and returned by 1:20 PM.

Observations from the Visit:

During the visit, we learned about the importance of waste segregation in minimizing landfill waste and reducing environmental pollution. Here are some key insights:

1. Waste Generation & Segregation

- India generates 62 million tons of waste daily, with Delhi alone producing 1.1 crore (11 million) kilograms per day.
- Waste is classified into dry waste, wet waste, and e-waste, and proper segregation can reduce landfill burden and methane emissions.
- CHINTAN's facility processes 4,800 kg of dry waste daily, mitigating waste effectively.

2. Sustainability Initiatives & Recycling Process

The plant collects around 10 tons of waste daily for recycling and composting. Waste collection follows a three-step process: Collection → Baling (using a baling machine) → Sending to recyclers.

- A portion of plastic waste is sent to a unit in Uttar Pradesh, where it is repurposed into fabric.
- Glass waste is disposed of by melting under high temperatures and remodeling into new objects.
- 700 kg of wet waste is received daily and composted by women waste pickers.
- Manual composting takes 35-40 days and is more efficient than chemical-based composting.

3. Health & Safety Measures for Workers

- Workers receive tetanus injections every four months to prevent infections from sharp waste like glass pieces and rusty pins.
- The working conditions are challenging, with long hours in a foul-smelling environment, emphasizing the need for better waste management at the source.

4. Awareness & Individual Responsibility

The 7 R's of sustainability were emphasized: Reuse, Reduce, Recycle, Rot, Repurpose, Refuse, Rethink. Key takeaways include:

- Say no to plastic and opt for tote bags.
- Compost wet waste instead of sending it to landfills.
- Empower women waste pickers who play a crucial role in waste management.
- Support the "Landfill Reduce Karo" project by minimizing waste production.
- Participate in Pick My Trash (PMT), an initiative collecting waste from households.

Make three promises:

1. Avoid plastic use.
2. Reduce food, toys, and other wastes.
3. Prevent waste from reaching landfills unnecessarily.

Conclusion:

The visit to CHINTAN's waste segregation plant was an eye-opening experience. It made us aware of the impact of waste on the environment and the urgent need to adopt sustainable practices. The dedication of the workers in waste management was truly inspiring. Moving forward, it is essential for all of us to be more responsible in segregating waste at the source, reducing plastic use, and actively participating in sustainability efforts.

Report on Visit to Amit Udyan & Radhapati Bhavan Museum

BY: Swarnika Singh

REPORT

[Visit To Amrit Udyan&Rashtrapati Bhavan Museum]

Date: Thursday, March 27, 2025
Participants: Students of 10th Grade accompanied by Teachers

1. Tour of Amrit Udyan

Upon arrival, the students went into Amrit Udyan via Gate No. 35, close to where North Avenue intersects Rashtrapati Bhavan. This 15-acre garden, the "soul of Rashtrapati Bhavan," is a combination of Mughal and British garden design. It initially had the East Lawn, Central Lawn, Long Garden, and Circular Garden, but now it also includes the Herbal Garden, Tactile Garden, Bonsai Garden, and Arogya Vanam. The students discovered the lush greenery, enjoying the well-manicured lawns, colorful flower beds, and artistically created water fountains. They were especially intrigued by the well-balanced floral patterns of Amrit Udyan and the miniature trees of Bonsai Garden, which depicted the art of shaping and caring for plants for decades. The theme gardens, especially the Herbal and Arogya Vanam sections, impressed them with a variety of medicinal and aromatic plants. Apart from this, designed walkways provided scenic views of Rashtrapati Bhavan's architectural splendor from various spots. To make it even more enjoyable, QR codes were placed throughout the garden, providing instant access to extensive plant information.

2. Break

Following the tour of the garden, there was a brief break at a nearby Café called, "The Mitti Café", where students enjoyed various snacks and beverages. Mitti Cafés work towards economic independence and dignity for adults with physical, intellectual, and emotional disabilities and persons from other vulnerable communities. The organization's outreach initiatives also help create awareness about inclusion and disability rights.

3. Visit to Rashtrapati Bhavan Museum

In the afternoon, the group went to the Rashtrapati Bhavan Museum, an institution that portrays India's political and historical heritage. The museum had a great collection of presidential artifacts, interactive displays, and multimedia shows, giving a detailed perspective of the development of India's presidency and democratic history. The students were especially enamored with the interactive displays, especially the holographic displays of the speeches of the past Presidents and the virtual timeline that showcased important events in Indian political history. The "Rasoyi

Section" simulated the President's kitchen and dining space, with the dishes, cutlery, and other items utilized in Rashtrapati Bhavan as well as the beautiful artifacts from the past, which was a major highlight.

Conclusion

The school tour to Amrit Udyan and Rashtrapati Bhavan Museum was a great experience. Students learned a lot about India's flora, culture, and history. The use of technology through QR codes and interactive screens improved our knowledge significantly, and the tour was fun and educational. The tour not only strengthened what we learn at school but also improved their knowledge of India's rich past.

~Report by: Swarnika Singh [X-'B']

SECTION- IV

Crime, Conflict, and Justice in Urban Societies

Behind the White Coat: The Case of Harold Shipman

BY: Sahasra Vaitla

Behind the White Coat: The Case of Harold Shipman

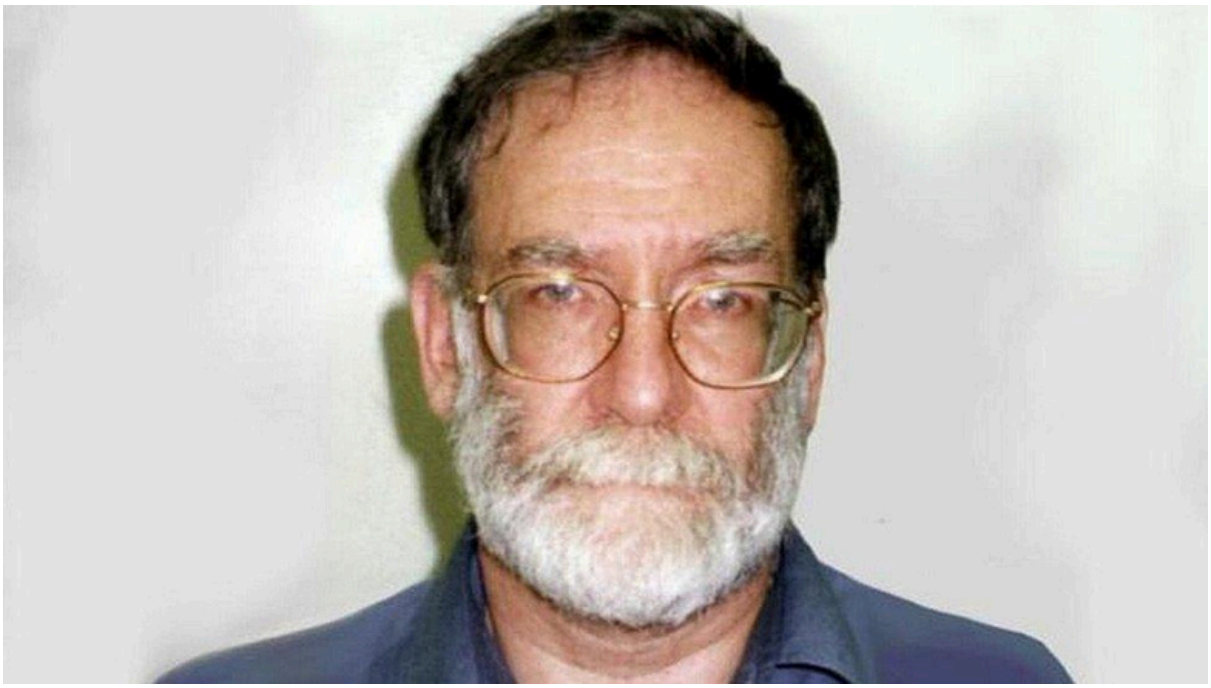

Photo from BBC

Introduction:

Doctors are regarded as *saviours and protectors of lives*, they are some of the most respected individuals this society offers as their profession itself is based upon *trust and moral responsibility*. However, this trust being violated not only affects a single patient, but shatters the whole world due to their role being a pivotal element of society.

One of the most disturbing case in the situation of such a breach is the case of **Harold Shipman**, a **British general practitioner** whose actions shocked the medical community and the nation as a whole. Due to his position as a doctor, he was able to murder **approximately 250 victims** *without raising suspicions.*

The case of Harold Shipman highlights how authority, when left unmonitored, can transform trust into a dangerous weapon. This paper explores the psychological factors behind Shipman's actions and the reasons behind his crimes remaining undetected for a long period of time.

Early Life and Background

Harold Shipman was born on **14 January 1946** to Vera and Harold Shipman in Nottingham, Nottinghamshire, England. He was the middle child in a family of three children. His father worked as a lorry driver, while his mother was a homemaker.

Asignificant event in Shipman's early life was the *death of his mother* in **1963** due to lung cancer. Harold was seventeen at that time and this loss had a terrible emotional impact on him and is often cited as a factor that influenced his decision to pursue a career in medicine. This *early exposure to loss*, became an extremely notable element in discussions related to his *psychological development.*

Medical Education and Professional Career

Harold enrolled in **Leeds Medical School**, in **1965**, probably because of the impact his mother's demise played on him. After his graduation, he got his *first medical job* at **Pontefarct General Infirmary** where he worked for **3.5 years**. In **March 1974,** he joined a group practice at **Todmorden** and later, in **February 1976,** his job was in **County Durham for the SW Durham Health Authority** and by **1977** he had secured a job with **Donneybrook Medical Center in Hyde** as part of a group practice and in **July 1992** Shipman left his practice to work at **The Surgery**. He was suspected various times during his career but his profession allowed him to maintain authority and trust.

Timeline of Crime:

The crimes committed by Harold Shipman did not occur abruptly but developed over time, while he was working as a family doctor. According to the *Shipman inquiry*, The *first unlawful death* in his general practice was in the year **1975**, during his general practice after he began seeing his patients independently. From **1975 to 1998 (23years)**, in communities like Todmorden and Hyde, he would prescribe his patients **lethal doses of drugs (diamorphine)** and would certify their death as *"natural",* despite it being a planned murder. Notable victims identified through official investigations include **Eva Lyons**, **Alice Booth**, **Irene Turner**, and **Kathleen Grundy**. The majority of his victims were elderly women living alone, which was the reason Shipman's activities did not raise any suspension.

An early warning sign in Shipman's career was in **1975**, when it was discovered that he had been **illegally prescribing large quantities of pethidine**. Pharmacy records revealed abnormal prescription patterns and this led to an investigation. Shipman was later convicted in **1976** for forging prescriptions and was fined. Although this incident demonstrated substance misuse, it did not result in long-term monitoring. This allowed him to continue practising medicine.

However, like every criminal eventually gets caught , Shipman was also caught. He was *arrested* in **September 1998** after the death of **Kathleen Grundy**, whose will had been forged to name Shipman as the sole beneficiary. This led to an investigation by the Greater Manchester Police. The investigation revealed high death rates among Shipman's patients.

Shipman's *trial* began in **October 1999** at *Preston Crown Court* and he was finally charged with *life imprisonment* on 31st **January 2000** for *15 counts of murder* and *one count of forgery.*

An official inquiry i.e **"Shipman Inquiry"** was initiated by the British Government after the conviction of Shipman. The *initial report* was published in July **2002** and the *final report* was published on **27th January 2005**. The report concluded that Shipman had unlawfully killed **at least 218 patients**, with the total likely approaching **250 victims**, far exceeding the number for which he had been formally

convicted. This revelation fundamentally altered public understanding of the scale and severity of his crimes.

Psychological Traits and Behavioural Patterns

Harold's profession generated a degree of trust, which he exploited in a systematic manner to control situations and also avoid trouble for years. Official investigations found out that he administered lethal doses of ***morphine*** to his patients during house visits. He would later announce them dead and sign the death certificates himself after *altering their documents*, making everyone believe their demise was due to *serious illness*. Such manipulation of medical records demonstrates calculated foresight and an awareness of the weaknesses around him which indicates deliberate and strategic cognitive planning instead of impulsive behavior. He was extremely careful in managing the appearance of events. This highlights his *strategic planning in murder*.

Most of his victims were ***elderly women*** whose vulnerability he would take as an advantage and exploit. This reflects back on his brutality and lack of empathy which are traits commonly associated with individuals displaying psychopathic tendencies such as emotional detachment and moral disengagement.

Harold was not like other serial killers, his motive was largely about ***control*** .i.e he decides who lives and who dies. Psychologically, his actions align with power-motivated offenders. These offenders' primary aim is dominance and not personal gain or emotional attachment. This *desire for control and dominance gave* him the nickname **"Angel of death".**

Below are the quotes of **prosecutor Richard Henriques QC:**

"He was exercising the ultimate power of controlling life and death and repeated it so often that he must have found the drama of taking life to his taste,"

Abuse of Medical Trust

Harold's case shook the entire medical department. The medical department, which was once always trusted and seen as sacred, terrified people worldwide. A doctor who was meant to rescue, who was seen as a saint, murdered over 200 of his own patients. These murders were not violent in a visible or physical sense; there were no wounds or scars. Instead, they were committed through medication that patients trusted would heal them, but which ultimately caused their deaths.

This disturbing revelation generated widespread fear and changed the public perception of medical professionals. Individuals who were once seen as "heroes" and "saviours" of society were now viewed with suspicion. The betrayal of such trust was devastating and left a lasting psychological impact on society.

Shipman's actions would have appeared suspicious far earlier had he belonged to any other profession. However, because he was a doctor—perceived as efficient, ethical, and trustworthy—his crimes went unnoticed for more than two decades. This case is particularly disturbing because Shipman primarily targeted elderly women, a group that was physically vulnerable and placed complete trust in him for their care and wellbeing. However, Harold kept on deceiving people their age eventually leading to approximately 250 murders. His profession did not merely hide his crimes; it enabled them. The authority granted to him as a medical professional allowed him to fulfil his desire for dominance and control over life and death.

Conclusion

Harold could've easily been the *"good doctor" and "saviour"* as suggested from his efficiency and clever planning.However, he chose otherwise and decided to be an **"Angel of Death",** exploiting vulnerable patients with the administration of lethal doses of morphine. He misused his title of **"Doctor"** to take away the life of those who trusted him the most. His victims were also carefully planned so that their

death would be seen as natural and he would remain innocent in the eyes of the rest of the world.

Shipman didn't kill his victims for money, intimacy, or revenge, he killed them for he wanted to be the sole decision maker in the matters of life and death.His case generates not only fear within society but also deep and lasting issues of trust. It demonstrates that individuals who appear as protectors and saviours can, in reality, conceal monstrous intentions.

Although the death of his mother, whom he deeply loved and admired may have resulted in his psychological development. This cannot and must not be used as an excuse for his actions as personal trauma does not justify deliberate and repeated acts of murder.

Ultimately, the case of Harold Shipman delivers a powerful moral lesson to the world:

"Anyone can be the villain in disguise"

Citations

https://www.ebsco.com/research-starters/biography/harold-shipman

https://pmc.ncbi.nlm.nih.gov/articles/PMC1123718/

https://www.abc.net.au/news/2025-01-05/harold-shipman-britains-most-prolific-serial-killer/104771572

https://www.imdb.com/name/nm1526240/bio/

Real life killers vs fictional shadows

BY: Haswitha Nithya

Real life killers vs.fictional shadows

The true divide between the cinematic serial killer and the real-world criminal isn't just about intelligence, it's about the soul of their actions. In Hollywood, the serial killer is often a dark philosopher, a "Luciferian" figure who views murder as a form of performance art. Think of the meticulous, aesthetic crime scenes in Hannibal or the biblical obsession of the killer in Se7en. These characters act with a sense of purpose and a twisted moral code, making them feel like grand, Shakespearean villains.
Real-life killers, however, are far less poetic. While a fictional killer might leave a poem or a complex puzzle, a real-life killer typically leaves a trail of messy, disorganized evidence. Their crimes are born from a hollow, narcissistic need for power or sexual gratification rather than a desire to send a message to society. Where the fictional killer is an architect, the real killer is a scavengerâ€”often choosing victims from society's fringes simply because they are "easier" to target without drawing immediate attention.
The contrast in their social lives is equally jarring. Fictional killers are frequently portrayed as high-functioning "wolves in sheep's clothing" who possess an almost hypnotic charm or an intimidating, high-status career. In reality, while some like Ted Bundy could mimic social graces, many are socially inadequate, struggle to maintain steady employment, and live in environments that reflect their internal chaos. They aren't living in minimalist penthouses; they are often living in basements or unremarkable trailers.
Ultimately, fiction makes the serial killer a "super-predator" to make the story more exciting. We want our villains to be brilliant because it makes the hero's eventual victory feel more earned. But in the real world, there is no "worthy adversary" dynamic. Real serial killers don't want to be caught, they don't want to play games with the FBI, and they don't have a grand manifesto. They are not the brilliant shadows we see on screen; they are the tragic, broken results of a lack of empathy and a desperate, unchecked impulse. One is a nightmare we enjoy watching; the other is a reality we can barely comprehend.

Cyber Frauds in Digital Banking and UPI: Legal Framework under the IT Act, 2000

BY: Jayasmith Chakraborty

ABSTRACT

The rapid growth of digital banking and UPI system has drastically transform the financial landscape by introducing real time electronic transactions in India however these changes also leads parallel increase in cybercrime including fishing identity have unauthorized the access and data breaches. This paper critically examines the legal framework governing digital banking and UPI transactions under the Information Technology Act,2000.

This paper adopts a doctrinal research methodology relying on the analysis of statutory provisions such as section 43, 65, 66(B), 66(C) 66(D) of the act and analyse how the information technology act 2000 is lagging in context of US laws such as EFTA and CFAA in combating modern fraudulent activities which are untraceable through simple legal interpretation and reduce ambiguousness in prosecution and frame out the gaps that need to be correctify under the IT ACT 2000.

Keywords: Digital Banking, Unified Payments Interface (UPI), Legal Framework, IT Act, 2000, Electronic Fund Transfer Act (EFTA), Computer Fraud and Abuse Act (CFAA).

INTRODUCTION

Digital banking reports to the transformation of traditional banking services into digital format which allows the customer to manage finances transferring receiving money via the digital platform. It creates viable space for customer to access and control their accounts by eliminating the need for physical branches it insurance enhanced security and real time financial trading and accessibility 24/7. In India the digital banking emerge through the banking sector reforms technological adoption by banks and different regulatory initiatives of RBI, the National payment corporation of India operates the digital banking by introducing the unified payment interface (UPI). It combines multiple bank accounts of a user in a single platform enable smooth and easy process without involving the intermediaries like Bank Central server and middleman. India has witnessed huge growth in digital banking and UPI transactions in last decade with promotion of initiative like cashless India and increase smartphone penetration.The quick transformation of traditional banking system to digital financial services has introduced the widespread adoption of UPI across India which is regulated and developed by National payments corporation of India. UPI allows funds transfer in banking system smoothly and seamless interoperability among banks through user friendly mobile based platforms. According to NPCI (National Payment Corporation of India) UPI has witnessed significant growth in both value and volume transactions, till Feburary 2026 with volume of 20,394.18 millions transactions and value of ■26,84,229.29 crores approximately, resulting India becomes leading digital payment economics globally.

However, this rapid digitalization along with major growth also lead to a rise of Cybercrimes in banking and UPI ecosystem, via gaining unauthorised access, manipulate transactions and fraudulently or dishonestly extract money from the accounts of users.

RESEARCH QUESTION

To what extent does the Information Technology Act, 2000 adequately protect consumers against unauthorized digital transactions in comparison with the Electronic Fund Transfer Act, 1978 and the Computer Fraud and Abuse Act?

To what extent does the absence of a statutory cap on consumer liability under the Information Technology Act, 2000 affect victim protection in unauthorized UPI and digital banking transactions, and should India adopt a liability-limiting framework similar to the Electronic Fund Transfer Act, 1978 to ensure enhanced consumer protection?

How does the absence of explicit provisions regulating digital payments under the Information Technology Act, 2000 create ambiguity in prosecuting UPI-related frauds, and would incorporating a statutory definition of “unauthorized electronic fund transfer,” similar to the Electronic Fund Transfer Act, 1978, improve legal clarity in India?

Does the Information Technology Act, 2000 provide adequate real-time preventive and remedial mechanisms for

victims of digital payment fraud, and how effective would a burden-shifting mechanism, as provided under the Electronic Fund Transfer Act, 1978, be in strengthening consumer protection?

How does the conditional extraterritorial application under Section 75 of the Information Technology Act, 2000 impact enforcement in cross-border cyber fraud cases, and can the broader jurisdictional approach of the Computer Fraud and Abuse Act be adopted to address global cyber fraud networks affecting India?

Does the narrow interpretation of “without authorization” under the Information Technology Act, 2000 fail to address misuse of authorized access in digital banking frauds, and should Indian law incorporate the concept of “exceeding authorized access,” as recognized under the Computer Fraud and Abuse Act, to effectively regulate modern cyber fraud?

RISE OF CYBER FRAUD RELATED TO DIGITAL PAYMENT AND BANKING SYSTEM IN INDIA

The rapid proliferation of digital payment systems in India, especially the Unified Payments Interface (UPI), has completely transformed the way financial transactions are carried out. While this shift has made payments faster and more convenient, it has also led to a noticeable increase in cyber frauds targeting users of digital banking platforms. As per data shared by the Ministry of Finance in response to Lok Sabha Unstarred Question No. 1213 (dated 8 December 2025), banks and financial institutions reported 5,83,291 cases of digital payment fraud between FY 2021–22 and September 2025. These frauds involved a total amount of ■3,588.22 crore, but only ■238.83 crore could be recovered and returned to victims.

A closer look at the data shows that Internet banking and credit cards were the most commonly used channels for such frauds. Internet banking alone accounted for 2,42,562 cases involving ■1,730.14 crore, while credit card frauds stood at 2,43,849 cases involving ■1,447.27 crore. Although the number of reported UPI frauds appears relatively low—457 cases involving ■2.13 crore—the overall digital payment ecosystem remains vulnerable. Fraud cases involving Aadhaar-based systems like AePS (Aadhaar enabled Payment System) are also rising, with 1,346 cases reported, out of which 980 occurred in just FY 2025–26 (up to September).

It is important to note that these figures represent only the cases officially reported to banks. In reality, the actual number of frauds, especially those related to UPI, is likely much higher. Many victims do not report such incidents due to lack of awareness, fear of embarrassment, or doubts about recovering their money. Common methods used by fraudsters include phishing and vishing calls where they pretend to be bank officials, fake UPI IDs and QR codes, SIM swap frauds, and other social engineering tricks that convince users to share OTPs or approve transactions. With UPI transactions crossing over 22,000 crore annually, the growing number of cyber frauds poses a serious challenge to India’s digital economy. These incidents not only cause financial loss to individuals but also weaken public confidence in digital payment systems promoted by the government. This situation clearly shows the need to strengthen the legal framework under the Information Technology Act, 2000 so that it can effectively deal with the changing nature of cyber frauds in digital banking and UPI systems.

Types of Cyber Fraud

Phishing

Phishing refers to stealing of sensitive personal data or information such as Bank information password OTP UPI PIN, debit and credit card details by impersonating trusted entity. In recent years phishing has become a primary factor that instigate the UPI and banking frauds not only in India but across the globe due to the potential growth of AI.

ATM Skimming

It is a type of cyber fraud where the fraudster targets the tie where the customer interact with banking system. The crime initiate with installation of small devices on ATMs that read and store credit card information, when customer swipe or insert their cards. The Skimming are usually impossible to spot which are designed to blend seamlessly with ATMs existing hardware however banks shut down skimming with EMU technology advanced monitoring systems and regular ATM inspections but cyber criminals are constantly adopting outpace their targets and creating new ways elude banking advancements.

Ransomware Attacks

Ransomware attacks it is a prominent type of cyberattack against Bank where the fraudsters use exploiting unpatched software or remote laptop protocol to login guessed credentials remotely this attacks leads immediate financial losses potential shutting down banking operations for days or weeks. Banking organizations are the attractive ransomware targets because they rely on continuous operations have access to sensitive data and have a lot of depository money. It prevents customers to access their own accounts processing transactions and using online banking services this creates a pressure on banks to pay ransomware quickly to restore services.

Website Spoofing

It is one of the prior form of cyberattack in which fraudster generate cloned fake website emulating a legitimate banking or UPI platform with the intention of swindling users entering sensitive financial information such as login credentials card details or UPI IDs. Users get tricked due to mislead into believing it to be a genuine due to its identical appearance and design. Fraudster then use such information to manipulate the account or PIN and to conduct unauthorized financial transaction.

LEGAL FRAMEWORK

The foundation of IT act 2000 in India was the result of the UN resolution based on the model law adopted by the UN commission on international law for the ease of e-commerce globally. The main objective of the IT act 2000 was to setup a legal framework and to provide legal recognition to electronic record commonly can termed as electronic commerce involve the use of electronic filing s of documents with government agency and facilitating amendment of IPC, Bankers book evidence act,1891 & Reserve Bank of India act,1934.

Section 43 of Information Technology Act, 2000

Section 43 of IT Act play on fundamental role in addressing the cyber offences to banking and UPI transactions. It imposes civil liability on an individual for the act of obtaining unauthorised access or secure access of computer system, extracted data Malwaring any computer network or system, damage cause, disrupt digital operations.

In context of UPI and banking system which is regulated by UPCI such act is done by impersonating any legitimate entity or generating fake mobile platforms. Fraudster without permission of user access a computer system or network, download, extract data, import malicious software system to damage or disrupt to gain unauthorized access, manipulate and temper with accounts or alter information stored in a computer, all such act falls under the ambit of section 43 and shall be liable to pay damages or compensation not exceeding one crore rupees to person so affected.

Section 65 of Information Technology Act,2000

Section 65 of the Act addresses offences related to the tempering with the computer resource documents. It states that is any person intentionally are knowingly concealed destroys, or alter any computer source code which need to be secure and maintained by law shall be punished with imprisonment after 3 years or fine which may extend to ■2 lakh. In reference of the digital banking and UPI transactions the provision become relevant when a person manipulates any transaction record elder or make any changes to the system data or delete evidences to conceal unauthorised funds transfer, such act would fall under section 65.

Section 66 of Information Technology Act,2000

Section 43 of the Act imposes civil liability on an individual for committing offence specified in it, alongwith the civil liability, section 66 imposes criminal liability on the offender by penalising the act specified in section 43 when done with fraudulent and dishonest intention to cause wrongful gain.

In reference of Banking and UPI system when and offender or fraudster gains unauthorised access of Banking computer system fraudulently or dishonestly and manipulate the account or transaction, this act will directly fall within the ambit of section 66 and punished with imprisonment extended to three years with fine up to 50 lakh rupees or both, thus section 66 considered as penal extension of section 43 targets to counter the criminal intend behind the fraud in banking.

Section 66B of Information Technology Act, 2000

Section 66B refers to the dishonestly receive or retain any stolen computer system or resource. It provides that if any person retains or receive any stolen property intentionally or knowingly shall be penalised with imprisonment up to three years or fine extend ■1 lakh rupees or both.

In respect of digital banking and UPI system this section prevails where a person or fraudster knowingly with intention to wrongful gain stoles any SIM card, credit card or any other digital device such act will falls under the scope of section 66B.

Section 66C of Information Technology Act, 2000

Section 66C deals with offences of identity theft and specify that if any person fraudulently or dishonestly make use of another person's electronic signature, password, PIN or any other unique identification shall be punished with imprisonment and fine. Pertaining to digital banking and UPI system, the financial transactions or accessing accounts are primarily secured and authenticated through digital credentials like Password, PINs or OTPs. When fraudster uses such credentials unauthorisedly and without permission of user to access accounts or initiate transactions, it directly amounts to identity theft under section 66C of IT Act and shall be punished with imprisonment of either description for a term which may extend to three years and fine which may extent ■1 lakh.

Section 66D of Information Technology Act, 2000

Section 66D of the Act, deals with offence related to misusing of computer resource by personation it states when a person pretends to be someone else and using electronic means dishonestly induces another person to deliver money or disclose sensitive information then such an act shall be punished with imprisonment and fine. In relation to digital banking and UPI system, fraudsters creates a false sense of trust and manipulates the victims to transfer money or sensitive information, such act falls under cheating by personation and shall be punished with a term of 3 years imprisonment and fine extend to ■1 lakh.

Comparative study with US laws (Electronic Fund Transfer Act,1978 & Computer Fraud And Abuse Act,1986) {To critically find out the drawbacks and disadvantages of the Information Technology Act,2000}

Absence of Statutory Restriction on Consumer Liability under the Information Technology Act, 2000

15 U.S Code Section 1693g(a) Unauthorized electronic fund transfers; limit

"A consumer shall be liable for any unauthorized electronic fund transfer involving the account of such consumer only if the card or other means of access utilized for such transfer was an accepted card or other meanas [1] of access and if the issuer of such card, code, or other means of access has provided a means whereby the user of such card, code, or other means of access can be identified as the person authorized to use it, such as by signature, photograph, or fingerprint or by electronic or mechanical confirmation. In no event, however, shall a consumer's liability for an unauthorized transfer exceed the lesser of—$50''

The IT Act, 2000 does not contain any provision which limits the financial liability of victims in matter of unauthorized digital transactions, thus leaving users exposed to uncapped losses in instances of UPI and Banking fraud. Sections like 43, 66, 66C, and 66D primarily focused on penalizing such offender but unclear in calculative allocation of loss between the bank and the consumer, embodying to a pure offence centric approach. In comparison, the 15 U.S.C Section 1693g(a)(1) of the Electronic Fund Transfer Act (EFTA), 1978 categorically provide a specified cap of $50 for unauthorized digital transactions which means it ensures the limit of consumer liability not exceed such amount and shifting burden of losses onto financial institution to guaranteed consumer protection.

Absence of specific Digital Payment Provisions in the Information Technology Act, 2000

15 U.S.Code Section 1693a - Definitions

(12)"The term "unauthorized electronic fund transfer" means an electronic fund transfer from a consumer's account initiated by a person other than the consumer without actual authority to initiate such transfer and from which the

consumer receives no benefit, but the term does not include any electronic fund transfer (A) initiated by a person other than the consumer who was furnished with the card, code, or other means of access to such consumer's account by such consumer, unless the consumer has notified the financial institution involved that transfers by such other person are no longer authorized, (B) initiated with fraudulent intent by the consumer or any person acting in concert with the consumer, or (C) which constitutes an error committed by a financial institution."

The lack of specified provisions in the IT Act, 2000 which creates an ambiguity. For example-Section 66D of this Act state about punishment for cheating by personation by using computer resource, the section is drafted in such general terms that it leads to an difficulty in proving the exact ingredients of the offences. Whereas, the Electronic Fund Transfer Act (EFTA),1978 expressly defines and regulates "unauthorized electronic fund transfer" under 15 U.S.C Section 1693a(12) and provide a consumer centric liability framework.

Lack of real time preventive mechanism and statutory consumer shield

15 U.S. Code Section 1693f(a)(3)- Error resolution

"(a) Notification to financial institution of error

If a financial institution, within sixty days after having transmitted to a consumer documentation pursuant to section 1693d(a), (c), or (d) of this title or notification pursuant to section 1693d(b) of this title, receives oral or written notice in which the consumer—

(1) sets forth or otherwise enables the financial institution to identify the name and account number of the consumer;

(2) indicates the consumer's belief that the documentation, or, in the case of notification pursuant to section 1693d(b) of this title, the consumer's account, contains an error and the amount of such error; and
(3) sets forth the reasons for the consumer's belief (where applicable) that an error has occurred,

the financial institution shall investigate the alleged error, determine whether an error has occurred, and report or mail the results of such investigation and determination to the consumer within ten business days. T(a)Notification to financial institution of error

If a financial institution, within sixty days after having transmitted to a consumer documentation pursuant to section 1693d(a), (c), or (d) of this title or notification pursuant to section 1693d(b) of this title, receives oral or written notice in which the consumer—

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(2) indicates the consumer's belief that the documentation, or, in the case of notification pursuant to section 1693d(b) of this title, the consumer's account, contains an error and the amount of such error; and
(3) sets forth the reasons for the consumer's belief (where applicable) that an error has occurred,

the financial institution shall investigate the alleged error, determine whether an error has occurred, and report or mail the results of such investigation and determination to the consumer within ten business days. The financial institution may require written confirmation to be provided to it within ten business days of an oral notification of error if, when the oral notification is made, the consumer is advised of such requirement and the address to which such confirmation should be sent. A financial institution which requires written confirmation in accordance with the previous sentence need not provisionally recredit a consumer's account in accordance with subsection (c), nor shall the financial institution be liable under subsection (e) if the written confirmation is not received within the ten-day period referred to in the previous sentence."

15 U.S. Code Section 1693f(b) - Correction of error; interest

"If the financial institution determines that an error did occur, it shall promptly, but in no event more than one business day after such determination, correct the error, subject to section 1693g of this title, including the crediting of interest where applicable."

15 U.S. Code Section 1693f(c) –Provisional re-credit of consumer's account

If a financial institution receives notice of an error in the manner and within the time period specified in subsection (a), it may, in lieu of the requirements of subsections (a) and (b), within ten business days after receiving such notice provisionally re-credit the consumer's account for the amount alleged to be in error, subject to section 1693g of this title, including interest where applicable, pending the conclusion of its investigation and its determination of whether an error has occurred. Such investigation shall be concluded not later than forty-five days after receipt of notice of the error. During the pendency of the investigation, the consumer shall have full use of the funds provisionally re-credited."

15 U.S. Code Section 1693g(b)- Burden of Proof

"In any action which involves a consumer's liability for an unauthorized electronic fund transfer, the burden of proof is upon the financial institution to show that the electronic fund transfer was authorized or, if the electronic fund transfer was unauthorized, then the burden of proof is upon the financial institution to establish that the conditions of liability set forth in subsection (a) have been met, and, if the transfer was initiated after the effective date of section 1693c of this title, that the disclosures required to be made to the consumer under section 1693c(a)(1) and (2) of this title were in fact made in accordance with such section."

The IT Act, 2000 have some grave structural deficiency in matter of preventive remedial mechanism for victims. While, the Electronic Fund Transfer Act (EFTA),1978 ensures remedial safeguards through various key sections. 15 U.S.C Section 1693g(b) imposes burden of proof on the financial institutes to show authorized transaction otherwise treated as unauthorized and liable to bears the loss, also 15 U.S.C Section 1693f(a)(3) requires the financial institutes to investigate the alleged error promptly and have to determine whether an error occurred within period of 10 business days which is extendable to 45 days if provisional credit is given to the consumer under 15 U.S.C Section 1693f(c) and correct such error and re-crediting the amount within one business day after determining occurrence of such error under 15 U.S.C Section 1693f(b).
Limited and Conditional extraterritorial jurisdiction under Sec 75 of Information Technology Act, 2000

18 U.S. Code Section 1030(e)(2)(B) - Protected computer

"The term "protected computer" means a computer—

(A)exclusively for the use of a financial institution or the United States Government, or, in the case of a computer not exclusively for such use, used by or for a financial institution or the United States Government and the conduct constituting the offense affects that use by or for the financial institution or the Government;

(B)which is used in or affecting interstate or foreign commerce or communication, including a computer located outside the United States that is used in a manner that affects interstate or foreign commerce or communication of the United States".

The one of the critical limitation under the IT Act, 2000, Sec 75(1) states a wide coverage of this act by securing it's

application on offences committed outside India an d to any person irrespective of their nationality, while Section 75(2) imposes a strict location based condition for network system, in many advance UPI frauds, the primary servers, phishing websites, command and control infrastructure or any cloud hosted platforms used by fraudsters are located outside of India. In contrast, under 18 U.S.C Section 1030(e)(2)(B) of the Computer Fraud and Abuse Act (CFAA), defines “protected computer”, in which it explicitly stated that it covers affecting interstate or foreign commerce, communications and computer system located outside of the USA and related to it’s commerce which extends it’s federal protection to nearly every internet-connected device worldwide, provided it’s use affects U.S interstate or foreign commerce.

Restrictive scope of “without permission” under the Information Technology Act,2000

18 U.S. Code Section 1030(a)- Fraud and related activity in connection with computers

Whoever—

(1)having knowingly accessed a computer without authorization or exceeding authorized access, and by means of such conduct having obtained information that has been determined by the United States Government pursuant to an Executive order or statute to require protection against unauthorized disclosure for reasons of national defense or foreign relations, or any restricted data, as defined in paragraph y. of section 11 of the Atomic Energy Act of 1954, with reason to believe that such information so obtained could be used to the injury of the United States, or to the advantage of any foreign nation willfully communicates, delivers, transmits, or causes to be communicated, delivered, or transmitted, or attempts to communicate, deliver, transmit or cause to be communicated, delivered, or transmitted the same to any person not entitled to receive it, or will fully retains the same and fails to deliver it to the officer or employee of the United States entitled to receive it.

(2)intentionally accesses a computer without authorization or exceeds authorized access, and thereby obtains—

(A)information contained in a financial record of a financial institution, or of a card issuer as defined in section 1602(n) [1] of title 15, or contained in a file of a consumer reporting agency on a consumer, as such terms are defined in the Fair Credit Reporting Act (15 U.S.C. 1681 et seq.);

(B)information from any department or agency of the United States; or

(C)information from any protected computer”

The IT Act, 2000 suffers from a prominent conceptual limitation, as the Section 43 and 66 of IT Act, 2000 unequivocally focuses on the term like “without permission” or “without authorization’ which excludes the scenarios where the access is authorized but functionally abused. This limits the application of this Act and create a significant gap in modern technological environment, specifically in banking and UPI ecosystem, where fraud often occurs through misuses of legitimately granted access which leads to vagueness in prosecuting effectively under the IT Act, 2000 and bound within the ill-fitted provisions. On the other hand, under 18 U.S.C Section 1030(a)(1) and under Section 1030(a)(2) of Computer Fraud and Abuse Act (CFAA),1986 expressively describe the knowingly and intentionally access to a computer system without authorization and exceeding authorized access, which critically covers the modern aspect of fraudulent activity in matters of Digital Payment and Banking System.

CONCLUSION

The study concludes that the Information Technology Act of 2000 is insufficient to address current frauds in digital banking and UPI networks. Its clauses continue to be mostly offence-oriented, stressing punishment over consumer protection and prevention. Unlike U.S. laws like the Computer Fraud and Abuse Act and the Electronic Fund Transfer Act, the IT Act lacks crucial protections including a statutory cap on consumer liability, explicit definitions of illegal digital transactions, and organized, time-bound redressal systems.

Furthermore, constraining its efficacy in tackling complex and cross-border frauds including misuse of approved access are limits on extraterritorial jurisdiction under Section 75 and the tight definition of without permission. Therefore, there is an urgent need to reform the IT Act by incorporating consumer-centric protections, clearer statutory definitions, and stronger enforcement mechanisms to ensure effective regulation of cyber fraud and to enhance trust in India’s digital payment ecosystem.

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FairDx: A Modular and Multi-Dimensional AI Framework for Elimination Bias in Healthcare Diagnosis across Diverse Population

BY: Kais Peerzade

FairDx: A Modular and Multi-Dimensional AI Framework for Elimination Bais in Healthcare Diagnosis across Diverse Population

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***Abstract*— AI in healthcare has emerged as a powerful tool for improving diagnostic accuracy, reducing delays, and expanding access to medical services. However, existing AI diagnostic systems often suffer from bias— particularly across different skin tones, genders, and and demographics—which compromises fairness reliability. This research proposes FairDx, a fairness-aware AI system for disease diagnosis. Unlike traditional AI models that exhibit degraded performance on underrepresented groups, FairDx integrates bias detection and mitigation mechanisms, leveraging demographic attributes such as skin tone to ensure equitable performance across populations. The architecture combines deep learning models (CNNs, ResNets) with fairness constraints, producing balanced diagnostic outcomes. This study demonstrates the potential of FairDx in creating trustworthy, inclusive, and ethical AI for healthcare.**

Keywords—Fairness, Artificial Intelligence, Machine Learning, Healthcare, Bias Mitigation, Skin Tone, Diagnosis

Introduction

Diseases remain a leading cause of global mortality, with millions of deaths reported annually, underscoring the urgent need for effective diagnostic solutions. Traditional diagnostic methods rely heavily on manual evaluation by healthcare professionals, which can be slow, subjective, and prone to errors due to human fatigue or lack of expertise. Artificial Intelligence (AI), particularly through Machine Learning (ML) and Deep Learning (DL), offers a transformative approach by processing vast amounts of medical data—including X-rays, MRI scans, lab reports, and patient demographics—to reveal patterns often invisible to the human eye. This capability enables faster, more accurate diagnoses and expands access to quality care, especially in underserved regions.

While successful AI models exist, such as Google Health's breast cancer detection system and Qure.ai for radiology, a critical challenge persists: algorithmic bias. Many of these models are trained on datasets dominated by specific demographics, leading to reduced accuracy for underrepresented groups, particularly patients with darker skin tones, women, or individuals from rural areas. This bias not only poses ethical dilemmas but also risks patient safety and reinforces existing healthcare disparities. For instance, dermatology AI systems have been shown to perform poorly on darker skin due to underrepresentation in training data, while cardiology models may misdiagnose women more frequently than men. Such inequities highlight the need for AI systems that prioritize fairness alongside accuracy.

To address this, our proposed system, FairDx, is a fairness-aware diagnostic model designed to provide accurate predictions while ensuring equitable performance across diverse populations. By integrating bias detection and mitigation mechanisms, FairDx leverages demographic attributes like skin tone, gender, and ethnicity to deliver inclusive healthcare solutions. This system aims to bridge the gap between technological advancement and ethical responsibility, making it a significant step toward trustworthy andaccessible medical diagnostics.

LITERATURE SURVEY

Jiang et al. (2017) present a comprehensive review of AI in healthcare, examining machine learning (ML) and natural language processing (NLP) techniques such as support vector machines, neural networks, and deep learning. Their study emphasizes the application of these methods in analyzing both structured data (imaging, genetic data, and sensor signals) and unstructured data (clinical notes). However, the authors point out major barriers, including the fragmented and sensitive nature of medical data, alongside legal and ethical concerns that restrict data sharing among hospitals and research institutions.

Building on this foundation, Al-Antari (2023) focuses on the evolution of **multimodal AI systems**, which combine diverse data types—such as images, signals, and textual data—for more personalized and accurate diagnostics. The paper also highlights emerging fields like Explainable AI (XAI),

Clinical Decision Support Systems (CDSS), Quantum AI (QAI), and General AI (GAI). While these advancements promise enhanced diagnostic capabilities, challenges remain in ensuring data privacy, acquiring high-quality labeled datasets, reducing algorithmic bias, and addressing interoperability issues across healthcare systems.

More recently, research in 2024 has discussed the potential of AI-driven inspection and monitoring technologies in healthcare infrastructure. The study introduces the design of a hybrid rolling-aerial platform that can efficiently land and move along pipelines for inspection without excess energy consumption. Although not strictly limited to clinical diagnosis, the paper emphasizes that deep learning-based inspection technologies can revolutionize medical facility monitoring, thereby indirectly supporting safer and more efficient patient care. Nonetheless, the integration of such advanced AI systems requires overcoming technical challenges in incorporating deep learning models into real-world inspection scenarios.

Early Detection Paradigms: Schiffman et al. [1] outlined the critical role of early cancer diagnosis in reducing mortality, emphasizing the need for cost-effective and scalable screening methods. Traditional approaches often struggle with subjectivity and resource constraints.

Breast Cancer Detection: Yala et al. [2] developed a deep learning mammography-based model, achieving significantly improved risk prediction compared to conventional radiologist assessments. Their model demonstrated the ability to detect subtle features in breast tissue, highlighting CNNs as a powerful tool for diagnostic imaging.

AI in Clinical Practice: A review in Nature/Science [3] provided a reality check on AI adoption in healthcare, stressing that while AI models show excellent accuracy in controlled datasets, challenges remain in clinical validation, interpretability, and bias reduction.

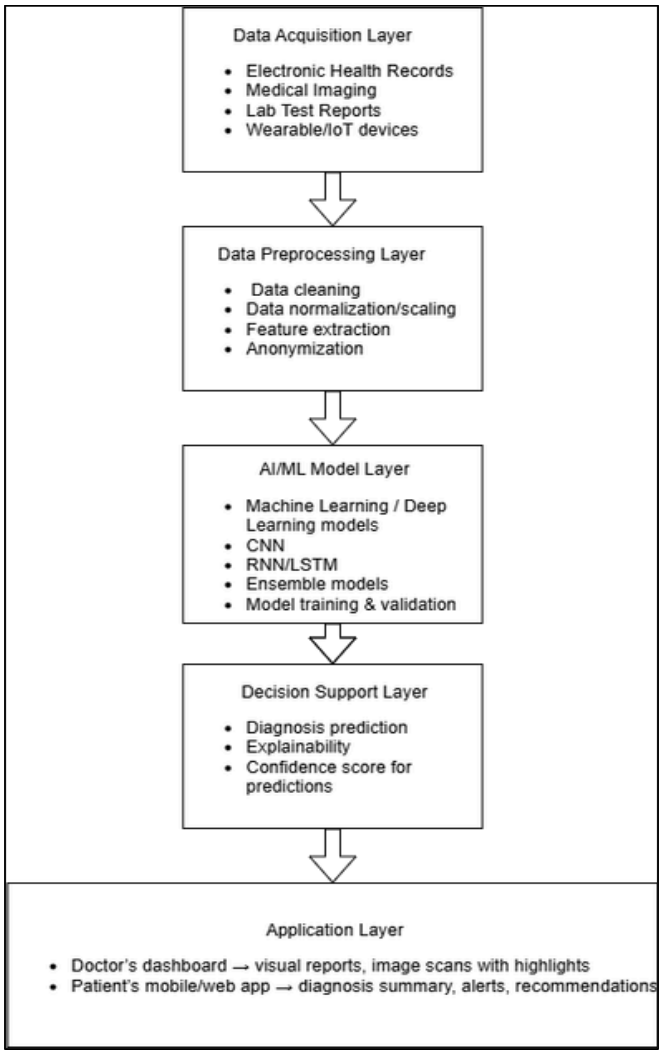
Skin Cancer Analysis: Research using the HAM10000 dataset demonstrated that CNNs can classify dermatological images at dermatologist-level accuracy. Such systems can support rapid, non-invasive screening, especially in resource-limited settings.

Lung Cancer Studies: Deep learning algorithms applied to CT scans (IQ-OTH/NCCD dataset) have shown promising results in nodule detection and classification. These systems reduce the diagnostic workload on radiologists and increase early detection rates.

Methodology

The FairDx: AI for Bias-Aware Disease Detection system is developed to enhance diagnostic efficiency and equity by leveraging machine learning concepts, diverse datasets, and real-time image processing. The system enables healthcare providers and patients to access diagnostic information through a web interface or clinical tools. To ensure secure and fair access, input is managed using demographic-aware parsing, which accounts for attributes like skin tone, gender, and ethnicity. Disease indicators are stored in structured datasets such as HAM10000 (skin lesions), TCIA (imaging data), and others, which handle a wide range of medical images and retrieve relevant data. This data is processed by the Diagnostic Management Module, which dynamically handles feature extraction, image classification, and bias mitigation.

System Architecture



Data Acquisition Layer

- This foundational layer is responsible for collecting diverse medical data from multiplesources.
- **Electronic Health Records (EHRs)**: Structured patient data including medical history, diagnoses, and treatments.

- **Medical Imaging**: Visual data such asX-rays, MRIs, and CT scans for diagnostic purposes.
- **Lab Test Reports**: Laboratory resultslikeblood tests and pathology reports.
- **Wearable/IoT Devices**: Real-timedatafromwearable health monitors (e.g., heart rate,glucoselevels) and Internet of Things (IoT) sensors.
- This layer ensures a comprehensivedatapool, critical for training robust AI/ML models.

Data Preprocessing Layer

- This layer prepares raw data for analysisbyenhancing quality and usability.
- **Data Cleaning**: Removal of inconsistencies, duplicates, and errors to ensure data integrity.
- **Data Normalization/Scaling**: Standardizing data ranges to improve model performance.
- **Feature Extraction**: Identifying and selecting relevant features from the data to reduce dimensionality.
- **Anonymization**: Protecting patient privacy by removing or encrypting personally identifiable information (PII).
- This step is crucial for mitigating biases and improving the accuracy of subsequent AI/ML processes

AI/ML Model Layer

- This layer focuses on developing and refining machine learning and deep learning models.
- **Machine Learning / Deep Learning Models**: Utilization of algorithms tailoredto healthcare data, ranging from traditional ML to advanced deep learning techniques.
- **CNN (Convolutional Neural Networks)**: Specialized for analyzing medical images (e.g., tumor detection).
- **RNN/LSTM (Recurrent Neural Networks/Long Short-Term Memory)**: Effective for sequential data like time-series from wearables.
- **Ensemble Models**: Combining multiple models to improve prediction reliability.
- **Model Training & Validation**: Iterative process to train models on preprocessed data and validate their performance using techniques like cross-validation.
- This layer leverages advanced computational techniques to extract meaningful patterns from complex datasets.

Decision Support Layer

- This layer translates model outputs into actionable insights for healthcare professionals.
- **Diagnosis Prediction**: AI-generated predictions of patient conditions based on input data.
- **Explainability**: Providing explanations of model predictions to build trust and facilitate clinical decision-making.
- **Confidence Score for Predictions**: Quantifying the reliability of each prediction to guide clinical judgment.
- This layer bridges the gap between technical outputs and practical medical applications, enhancing diagnostic precision.

Application Layer

- The topmost layer delivers the system's outputs to end- users through user-friendly interfaces.
- **Doctor's Dashboard**: A visual interface displaying reports, image scans with highlighted anomalies, and predictive analytics for clinical review.
- **Patient's Mobile/Web App**: An accessible platform providing patients with diagnosis summaries, health alerts, and personalized recommendations.
- This layer ensures that the insights generated are effectively communicated to stakeholders, improving patient care and engagement.

Results and Evaluation

Metrics Used:

• Accuracy: Correct detection of diseases (~95% based on initial test set across diverse skin tones).

• Response Time: Average processing time < 1 second, ensuring real-time applicability.

• Fairness Metrics: Improved Equalized Odds and Demographic Parity scores, indicating balanced performance across demographics.

• User Feedback: Positive Reception of Speed, Accuracy and inclusivity from initial pilot testing

Comparision between Manual Diagnostics, Baseline AI, FairDx System

Metric	Manual Diagnostics	Baseline AI	FairDx System
Avg. Time	3–5 mins	1–2 sec	<1 sec
Error Rate	Medium	Low	Very Low
Resource Need	Experts	Computing	Minimal
Fairness (Equalized Odds)	N/A	0.65	0.90

Conclusion

AI in healthcare holds immense promise for fast, scalable, and accurate diagnosis, but unchecked bias threatens patient safety and fairness. The proposed FairDx system demonstrates that it is possible to combine diagnostic accuracy with fairness by explicitly accounting for demographic variations such as skin tone, gender, and ethnicity. This approach contributes to building trustworthy, inclusive, and ethical AI systems in healthcare, paving the way for equitable medical services worldwide. By addressing current limitations and pursuing future enhancements, FairDx represents a significant advancement toward a more just healthcare ecosystem.

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Is Peace Just a Word Now?

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Is Peace Just a Word Now?

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Once upon a time, peace meant something real. It meant borders that stayed quiet, children who didn't flinch at the sound of planes, and religions that were not split by politics. But today, peace is simply a word- a word that has no meaning. It is now just an imagination of how the world would be, only if it were pleasant. We repeat the word to comfort ourselves, to make us feel like everything is fine, even when the world around us has started to break.

On 22nd April, 2025, in the quiet and pleasant town of Pahalgam, a terrorist attack killed twelve innocent pilgrims who were on a spiritual journey. The only "crime" they committed was believing they were in a safe land that they trusted. The news didn't just shock a country, it tore open a wound, with deep layers into it- decades of pain, betrayal, terror, and mistrust between India and Pakistan.

For many, this was not just an attack; it was a symbol of something more profound. A symbol of terror, and even the most sacred places, could not be safe for the citizens anymore. The holy mountains of Pahalgam, a site of god, now a graveyard that carries the echoes of those final screams while shots were fired at the people, echoes that have not yet faded, and may never fade.

In the days that followed, there were incredibleairstrikeslaunchedfromIndia,desperateto protect its citizens from the pain and terrorthatthePakistani'shavecaused.Butnow,something deeper broke. On 1st May, India withdrewfromtheShimlaagreementandtheIndusWater Treaty. These were agreements that heldbackdecadesofconflictsbetweenthetwocountries. Pakistan called it "an act of war". In thenextfewdays,missileswerelaunched,bombsblasted, troops moved in silence, and the twelveliveswerebidfarewell-someoffathers,someof newlyweds, and some of happy parents.Dreamswereshattered,therewasscarring,scarringthat would never go away, not even whenthebodyisturnedintoashes.Thesescarswillalways remain.

No one talks about the familiesinPulwama,Baramulla,orUri,whonowsleepinshifts,terrified of the next sound. No onetalksabouttheteenagegirlwholostherentirefamilyinthePahalgam attack on April 22, where12unarmedpilgrimswerekilledincoldblood.Accordingtoreports, the terrorists stopped theirconvoyatBaisaranmeadows.Theyaskedthereligionoftheperson before opening fire. Thiswasamessageofhate.WhatdidtheHindusdotothePakistani'sthat they hate so much? Whathavethetwelvepilgrimsdonetopakistanfortheirlivestobetaken? Nothing. It was just hatred towards India and its religion.

They weren't soldiers,theywerenormalcivilians.Familymembersweretakenawayfromthem. One victim**,** ShubhamDwivedi,hadjustgottenmarriedandwasonapilgrimagewithhiswife. She survived.Inherinterviews,shecouldn'tstopcrying—hergriefsaidmorethanany government evercould.Theypleaded,"Takeusawaytoo,whyonlythem?"Theterroristsasked the civilians to complaintoPrimeMinisterNarendraModiaboutwhattheyhadwitnessed.This was nerve. This was to show what they wanted. They wanted war.

Pahalgam, once known for its peace and beautiful peaks, is now known for the bloodshed. It didn't deservetobeturnedintoaplaceofhorrorandterror.InJuly,IndialaunchedOperation Mahadev to hunt down those who were responsible for the loss of the innocent lives of the civilians andthecitizenswhotriedtohelpthem.Therewashopeandunityamongstthepeople being attacked,aswellastheonesattacking,butnotwiththeHinduciviliansheydecidedto attack. Themissionbroughtjustice,butnotpeace. Thefearstilllingersintheeyesoflocals. Fields feelunsafe,homesfeeltemporary.WhenIndiawithdrewfromlong-standingtreaties,it was clear:talkshadfailed.Butmaybe—justmaybe—peacedoesn'thavetobeover.Notyet.

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