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DEPARTMENT OF MANAGEMENT STUDIES

10th INTERNATIONAL STUDENT'S RESEARCH CONFERENCE 2025-26



R-CON

Theme:

Digital Synergy: Transforming Humanity, Sustainability & Innovation Into Futuristic Startups'

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Preface

It is with immense pleasure that we present the Conference Proceedings of the 10th International Students' Research Conference 2026, Theme: **"Digital Synergy: Transforming Humanity, Sustainability, and Innovation into Futuristic Startups.** highlights the critical role of digital transformation in fostering entrepreneurial ecosystems that are not only technologically advanced but also socially responsible and environmentally sustainable. These technological advancements are enabling individuals, researchers, and young entrepreneurs to convert creative ideas into impactful start-up's that contribute to economic development and societal well-being. At the same time, the growing focus on sustainability has encouraged innovators to design solutions that balance profitability with environmental protection and social equity

The inaugural session was graced by Chief Guest Shri. Subodh Dave, Vice-Chairman, Governing Council, BKBCK, BKBPS and BKBNC, His inspiring words and thoughtful reflections on the role of innovation, sustainability, and digital advancement encouraged young minds to explore research, embrace creativity, and transform ideas into meaningful entrepreneurial ventures. His guidance served as a great source of motivation for all participants.

Our sincere gratitude extends to our Shri O. R. Chitlange, Hon'ble Chairman, BKBCK, BKBPS, and BKBNC. Shri Subodh Dave, Hon'ble Vice Chairman, BKBCK, BKBPS, and BKBNC. Dr. Naresh Chandra, Director (Education) BKBCK, Dr. Avinash Patil, Principal, BKBCK, Mrs. Esmita Gupta, Sr. Vice Principal BKBCK, Dr. Suraj Agarwala, Assistant Vice Principal, Dr. Anil Tiwari, Head, Department of Management Studies. There leadership and continued engagement have significantly contributed to building a thriving academic landscape that supports rigorous research.

The integration of humanity, sustainability, and innovation is particularly significant in the start-up's ecosystem. Futuristic start-ups today are not limited to technological disruption alone; they are also committed to addressing real-world problems such as climate change, resource management, healthcare accessibility, financial inclusion, and digital governance. Through digital synergy, innovators can leverage collaborative networks, interdisciplinary research, and emerging technologies to create solutions that are scalable, inclusive, and sustainable.

The Research Cell deserves special recognition for its consistent contributions toward enhancing scholarly awareness and cultivating essential research competencies among students, thus promoting a strong culture of academic inquiry. We further express our gratitude to the faculty members, researchers, and participants whose dedication and collaboration were vital to the success of this event.

Warm Regards,

Dr. Abhijeet Rawal
Convenor

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FROM BREAKS TO BURNOUT: A CROSS-COUNTRY ANALYSIS OF STUDY HABITS AND STUDENT STRESS IN USA AND INDIA

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Abstract:

Academic stress has become a concern among secondary students and higher education students in today's educational environment. Various study habits and patterns like study session length, break frequency, structured study techniques, multitasking behaviours and mainly social media usage during studying time affects the overall well-being as there is massive usage of social media among students. This study investigates the relationship between the study habits and student stress among secondary school and higher education students in India and USA.

Study is descriptive in nature, primary data is collected using a structured questionnaire, data were collected from respondents aged 14–25 years from India and USA. Findings reveal significant cross-country differences in study duration, structured scheduling, and stress levels. Multitasking and poor break management significantly increase stress and burnout risk. The moderating role of country highlights cultural variations in stress pathways.

Keywords: *Study Habits, Academic Stress, Burnout, Multitasking, Cross-Country Comparison, Student Well-being*

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Introduction:

Academic pressure among adolescents and young adults has intensified due to competitive educational systems and digital distractions. While long study hours are traditionally associated with academic success, unstructured study patterns, inadequate break cycles, and excessive multitasking may lead to stress and burnout.

India and the USA present contrasting educational environments. Indian students often face exam-centric pressure, whereas American students balance academics with extracurricular commitments. This study examines how study behaviors transition from productive engagement to burnout and whether these relationships vary across countries.

Problem Statmenet: Although academic stress among students has been widely acknowledged, there is lack of research about topics like study habits, patterns, study breaks, multitasking behviour and effects of social media usage. Due to this research gap, there is insufficient evidence-based guidance to effectively address student

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stress. It is very important to understand how students from different countries perceive and handle regarding academic pressure with multitasking behaviour and about the role of social media in a student's life. By understanding these perspectives, we can examine whether break patterns, study techniques, and social media use significantly affect student well-being in different countries.

Significance of the Study:

1. The study highlights the relationship between study habits and academic stress, helping to identify behaviors that contribute to student burnout.
2. It provides a cross-country comparison between India and the USA, offering insights into cultural and educational differences in study patterns.
3. The research contributes to student mental health and well-being literature by examining the role of multitasking and break management.
4. Findings can help educators design better academic support and stress management strategies for students.
5. The study offers practical guidance for students and parents to adopt healthier and more effective study routines.

Limitations of the Study:

The study uses a small sample size of 97 respondents, which may limit the generalizability of the findings.

1. The research is limited to students from India and the USA, restricting broader global comparisons.
2. Data is collected through self-reported questionnaires, which may lead to response bias or inaccurate reporting.
3. The study focuses only on the age group of 14–25 years, excluding other student populations.
4. Being a cross-sectional study, it captures data at one point in time and does not examine long-term changes in stress and study habits.

Objectives of the Study:

1. To analyse study habits among students in India and the USA.
2. To examine the relationship between break patterns and stress levels.
3. To assess the impact of multitasking and social media usage on academic stress.
4. To compare structured study techniques across both countries.
5. To identify factors leading from productive breaks to academic burnout.

Hypothesis of the Study:

H1: There is a significant difference in study habits between students in India and the USA.

H2: Break patterns have a significant relationship with students' stress levels.

H3: Multitasking and social media usage significantly increase academic stress among students.

H4: Structured study techniques significantly differ between students in India and the USA.

H5: Poor break management significantly contributes to academic burnout among students.

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Review of Literature :

A review of existing literature indicates that academic stress significantly influences students' motivation, study behavior, emotional adjustment, and overall academic performance. Research by Tabassum highlights that high academic stress negatively affects achievement motivation and leads to ineffective study habits among higher secondary students. Similarly, Khan Ayesha reported that excessive academic pressure reduces self-concept, emotional balance, and achievement motivation, thereby impairing students' ability to cope with academic demands. Studies on burnout and psychological well-being further reinforce this relationship. Anuradha G. found that inadequate emotional support and unfavorable classroom environments intensify stress and exhaustion, while Luo et al. (2023) observed high perceived stress and burnout among postgraduate medical trainees exposed to academic and clinical pressures. Rudakova's study on international students also emphasizes that transition-related stress and adjustment challenges significantly affect mental health and academic adaptation. Collectively, these studies establish that academic stress plays a critical role in shaping students' psychological well-being, emotional regulation, and academic engagement.

Student burnout research consistently shows that burnout (emotional exhaustion, cynicism, reduced sense of accomplishment) is strongly linked to both personal (self-control, self-efficacy, anxiety) and contextual factors (family functioning and classroom/school environment). Large empirical studies and mechanistic models indicate that academic stress and anxiety predict higher burnout, and that personal resources such as academic self-efficacy or self-control can moderate or buffer these effects (Satpathy, 2024). Family variables—conflict, cohesion, parental emotional warmth and adaptability—are repeatedly associated with student burnout, often indirectly through peer support, psychological capital or anxiety; classroom-level supports (teacher–student relationships, perceived teacher support) are also important protective or risk factors (Gao, 2023).

Following Variables are identified based on review of literature:

- **Study Hours and Stress:** Excessive study hours without structured breaks increase cortisol levels and academic fatigue.
- **Break Effectiveness:** The Pomodoro technique and distributed learning improve retention and reduce stress.
- **Multitasking Impact:** Research suggests multitasking with social media reduces cognitive efficiency and increases perceived stress.
- **Digital Distraction:** High phone usage during study correlates with lower academic satisfaction.
- **Cross-Cultural Differences:** Asian education systems show higher performance pressure, whereas Western systems show stress due to balancing multiple commitments.

However, limited cross-country comparative studies focus on break behavior and multitasking as mediators of burnout.

Based on variables identified , following model is proposed:

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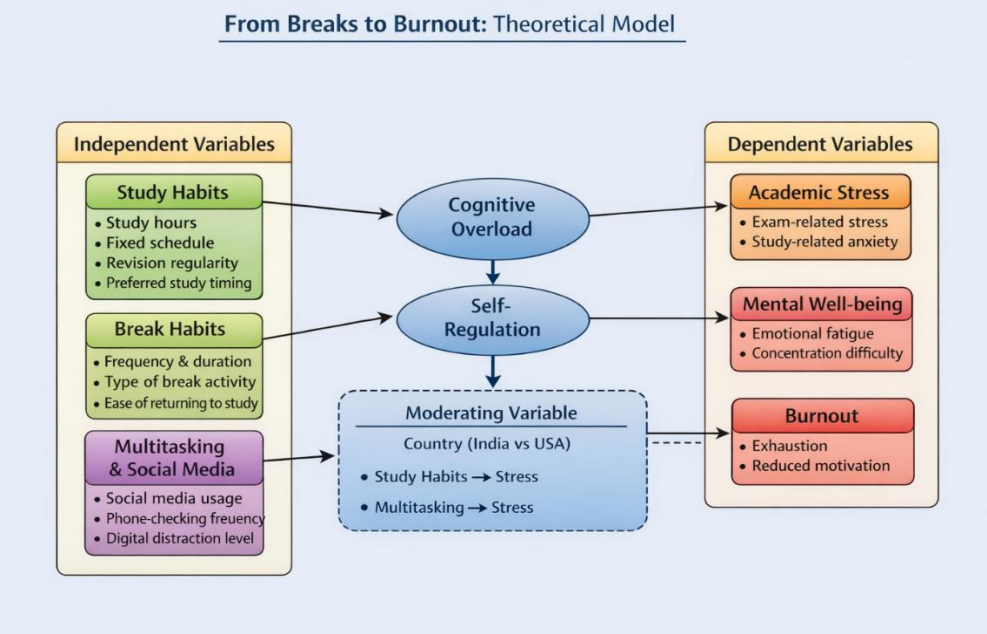
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In this model, study habits, break habits, and multitasking/social media use act as independent variables. These factors influence students' cognitive overload and their ability to practice self-regulation while studying.

Higher cognitive overload and poor self-regulation can lead to academic stress, reduced mental well-being, and eventually burnout (such as exhaustion and reduced motivation).

Additionally, country (India vs. USA) acts as a moderating variable, meaning that the relationship between study habits, multitasking, and stress may differ depending on the educational and cultural context.

Research Methodology:

This study adopts a quantitative, descriptive, and comparative research design using a structured survey method to critically examine the relationship between study habits and students' stress levels among secondary school and higher education students in India and the United States. The research is both descriptive and analytical in nature, as it seeks to identify patterns in study behavior—such as study techniques, multitasking tendencies, study session duration, break habits, and social media usage—and to analyze their impact on students' stress levels and mental well-being. The target population includes 10th grade students and students pursuing higher education from both countries. A total sample of 97 respondents was selected through convenience sampling, comprising 65 students from India and 32 students from the USA, within the age group of 14–25 years.

Primary data was collected through an online structured questionnaire divided into five sections: Study Habits, Break Habits, Multitasking and Social Media, Stress and Mental Well-being, and Study Techniques and Patterns. The questionnaire consisted mainly of multiple-choice questions designed to capture behavioral patterns and perceived stress levels. The collected data was analyzed using percentage analysis, mean score comparison, cross-tabulation, and comparative charts to examine differences between Indian and American students. Additionally, correlation analysis was applied to explore the relationship between study habits and stress levels. Ethical considerations were strictly maintained, ensuring voluntary participation, confidentiality of responses,

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and exclusive use of data for academic research purposes. The scope of the study is limited to students from India and the United States, and other external factors influencing mental health are beyond the purview of this research.

Data Analysis and Interpretation:

Data Analysis 1: Study Habits Comparison

Objective 1: To analyse study habits among students in India and the USA.

Hypothesis 1: H1: There is a significant difference in study habits between students in India and the USA.

Table: Study Hours by Country

Country	Less than 1 hr	1–2 hrs	2–4 hrs	More than 4 hrs	Total
India	4	28	18	15	65
USA	11	9	5	7	32

(Source : Primary Data)

Interpretation:

Indian students mainly study for longer duration as compared with USA. Chi-square value calculated is 4.2 with p value 0.0404. Thus, there is a clear variation in study duration patterns between India and USA students, indicating different study habits. Therefore, H1 is supported.

Data Analysis 2: Break Patterns vs Stress

Objective 2: To examine the relationship between break patterns and stress levels.

Hypothesis 2: H2: Break patterns have a significant relationship with students' stress levels.

Table: Break Frequency vs Mental Health Impact

Stress Level / Break Frequency	No stress experienced	Moderate stress	High level of stress	Very high stress
Every 25–30 minutes	23	13	7	3
Every 45–60 minutes	13	4	3	5
Only when tired	0	4	1	12
No breaks	0	0	3	7

(Source: Primary Data)

Interpretation:

Students who take regular breaks (25–30 minutes) mostly reported low stress. Students who take breaks only when tired reported higher moderate and high stress levels. Students with no breaks show higher very-high stress responses. Chi-Square calculated is 45.79 , p= 0.0001, Thus we accept H2

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Data Analysis 3: Multitasking and Stress

Objective 3: To assess the impact of multitasking and social media usage on academic stress.

Hypothesis 3: H3: Multitasking and social media usage significantly increase academic stress among students.

Table: Social Media Distraction vs Stress

Stress / Multitasking	No Stress	Moderate Stress	High Stress	Very High Stress
Never	2	1	0	0
Rarely	3	4	4	1
Sometimes	4	19	13	6
Very Often	6	14	8	15

(Source: Primary Data)

Interpretation: Among students who very often spend time on social media, 15 reported high stress. Students who sometimes get distracted mostly reported moderate stress. Chi-Square calculated is 9.87 with p value = 0.0017 , it proves higher multitasking and social media distraction is associated with increased academic stress, supporting H3.

Data Analysis 4: Structured Study Techniques

Objective 4: To compare structured study techniques across both countries.

Hypothesis 4: H4: Structured study techniques significantly differ between students in India and the USA.

Table: Structured Study Techniques by Country

Technique Followed	India (65)	USA (32)
No structured technique	36	3
Pomodoro method	13	20
Time-blocking	10	6
Active recall / spaced repetition	6	3
Total	**65**	**32**

(Source: Primary Data)

Interpretation: Indian students do not follow structured techniques much as compared to USA students. There are observable differences in the use of structured study techniques across countries, with Chi-Sqaure14.5 with p = 0.0001, thus confirming H4.

Data Analysis 5: Break Management and Burnout

Objective 5: To identify factors leading from productive breaks to academic burnout.

Hypothesis 5: H5: Poor break management significantly contributes to academic burnout among students.

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Table: Break Frequency vs Study Fatigue

Break Frequency	Low Burnout	Moderate Burnout	High Burnout	Severe Burnout
Every 25–30 minutes	5	1	3	8
Every 45–60 minutes	6	1	7	15
Only when tired	5	3	9	29
No breaks	1	0	1	4

(Source: Primary Data)

Interpretation: Students taking breaks only when tired reported high fatigue levels (29 Sever Burnout). Regular breaks (25–30 minutes) show lower exhaustion levels. Chi-Square calculated is 4.56 at p value 0.0327, justifying poor break management is linked with greater fatigue and burnout symptoms, thus H5 is supported.

Challenges : During the execution, the study has faced several practical and methodological challenges. Major challenges were faced during collection of data from students, as the research is relied on self-reported survey responses, many factors such as personal bias, misunderstanding of questions, or socially desirable answers might have influenced the overall data. The limited sample size and sampling method restrict the generalizability of the findings. Differences in terms of cultural and educational of India and United States might also affect students interpretation of survey questions. Time and coordination constraints during cross-cultural data collection were additional challenges encountered during the study.

Remedies: Educational institutions can introduce effective structured study habits, techniques and study break frameworks for students based on the association between unstructured study patterns and higher stress levels. Since, social media plays a big role in academics and managing stress level hence, evidence-based interventions like notification control, scheduled digital detox periods & focused study environment should inculcated in students daily life. Longitudinal research can further assess whether programs like time management, cognitive coping strategies and academic planning produce sustained reductions in burnout among adolescents. By observing the cultural differences of India and United States with the help of data collected, policymakers and educators should consider contextual academic pressures when designing student well-being initiatives. Mixed method and longitudinal designs must be adopted for future research to explore casual relationship between study habit and stress. Larger representative samples and psychological assessment tools can help in strengthening reliability of findings.

Conclusion: The study examined the relationship between study habits and stress management among secondary and students pursuing higher studies in India and Unites States. After collecting information from both the countries, analysis of factors was done such as session length, break frequency, structured study techniques, multitasking behaviour and social media usage which helped in understanding the that how different study patterns influence student well-being in a cross-cultural context. The findings helped us in understanding different perspectives of students for topics like study routine, frequent multitasking, break habits, attitude towards social media and handling stress from both countries. With the data collected from both the countries, the similarities and differences in how students experience academic pressure are highlighted. This study throws spotlight on adopting structured study techniques and mindful digital engagement as it does show effect on

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academics. Effective study habits and approach towards stress management help in reducing burnout and enhance overall well-being in the world of digitally driven educational environments.

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BRIDGING PERCEPTIONS: QUALITATIVE EXPLORATION OF OPPORTUNITIES, RISKS AND CULTURAL STEREOTYPES IN GERMAN-INDIAN FOREIGN DIRECT INVESTMENT

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Abstract:

This qualitative study explores mutual perceptions of German and Indian business leaders on cross-border foreign direct investment (FDI). Bilateral trade in goods reached USD 29.52 billion in FY 2024-25, with calendar 2024 at USD 33.40 billion and services at USD 17.03 billion, exceeding USD 50 billion combined. Cumulative German FDI in India totaled USD 15.11 billion from April 2000 to March 2025, with FY 2024-25 inflows at USD 469 million. German executives often view India as high-growth but bureaucratic, while Indian leaders see Germany as stable yet rigid. Semi-structured interviews identify opportunities (market scale, innovation synergies), risks (regulatory, cultural mismatches), and stereotypes rooted in Hofstede's cultural dimensions. The India-EU FTA concluded on January 27, 2026—eliminating tariffs on 96.6% of EU exports—projects 41–65% trade surge and 0.12–0.13% GDP gains. Bridging strategies like cross-cultural training enhance FDI. The study offers bidirectional insights for cross-cultural management in emerging-developed partnerships.

Keywords: *Foreign Direct Investment (FDI); India–Germany Trade Relations; Cross-Cultural Management; Bilateral Investment*

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Introduction:

The Indo-German economic partnership represents one of the most stable and strategically important bilateral relationships between a leading European industrial economy and a rapidly emerging Asian market. Diplomatic relations, established in 1951, celebrated their 75th anniversary in 2026, coinciding with more than 25 years of formalized strategic partnership since 2000. This alliance encompasses trade, foreign direct investment, technology transfer, sustainable development, defense cooperation, and people-to-people exchanges, all underpinned by shared democratic values, rule-of-law principles, and mutual interest in a multipolar, rules-based international order.

Bilateral trade has exhibited consistent growth and resilience. In fiscal year 2024-25, merchandise trade totaled USD 29.52 billion, with Indian exports amounting to USD 10.54 billion and imports from Germany reaching USD 18.98 billion. Calendar year 2024 data published by Germany's Federal Statistical Office (Destatis) recorded an all-time high of USD 33.40 billion in goods trade, while services trade rose by 15% year-on-year to USD 17.03 billion. Combined goods and services trade surpassed USD 50 billion in 2024 and continued its upward trajectory into 2025-26, with April–November 2025 provisional figures already at USD 20.25 billion.

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Germany remains India's largest trading partner within the European Union (accounting for over 25% of India's EU trade), while India ranks as Germany's 23rd largest trading partner globally.

Foreign direct investment forms a vital pillar of this relationship. Germany ranks as the 9th largest source of FDI equity inflows into India, with cumulative inflows of USD 15.11 billion from April 2000 to March 2025. Inflows in FY 2024-25 amounted to USD 469 million, concentrated in high-value sectors including transportation, electrical equipment, chemicals, automobiles, and renewable energy. More than 2,000 German companies are active in India, generating significant direct and indirect employment and facilitating substantial technology and knowledge transfer. Notable recent investments include Deutsche Bank's €571 million commitment in November 2024 to expand digital and infrastructure operations, Schneider Electric's €338 million investment in February 2025 for new manufacturing facilities, and Carl Zeiss AG's €334 million project for a Global Capability Center in Bengaluru focused on cloud computing and cybersecurity.

Indian investment in Germany, while smaller in absolute volume, is growing steadily. Over 200 Indian companies are now operating in Germany, primarily in information technology, pharmaceuticals, manufacturing, and research & development. Indian firms are increasingly targeting Germany for access to advanced engineering capabilities, high-quality R&D ecosystems, and the broader European single market. Recent trends show strong focus on digitization (accounting for around 40% of Indian investments), electronics, and green technologies. Examples include Reliance New Energy Solar Limited's €25 million investment in NexWafe GmbH for next-generation solar technology and BorderPlus's €10 million acquisition of a Düsseldorf-based recruitment services company in 2025. A major catalyst for future growth is the landmark India–EU Free Trade Agreement concluded on January 27, 2026. Described by European Commission President Ursula von der Leyen as the "mother of all trade agreements," the FTA eliminates or significantly reduces tariffs on 96.6–99% of goods by value, delivers €4 billion in annual duty savings for EU exporters, and is projected to increase bilateral trade by 41–65% over the coming decade while generating mutual GDP gains of approximately 0.12–0.13%. For Germany specifically, the agreement is expected to accelerate machinery exports by 10–15% in 2026 and strengthen market access in automotive, engineering, and renewable energy sectors. The FTA also supports strategic supply-chain diversification away from over-dependence on China and provides a hedge against potential US tariff escalation or trade-policy volatility.

Despite these positive indicators, investment decisions are heavily influenced by perceptions and cultural stereotypes. German business leaders frequently describe India as a dynamic, high-growth market with vast potential in consumer demand, skilled labor, digital transformation, and green technologies, but they often temper this optimism with concerns over bureaucratic delays, regulatory unpredictability, infrastructure deficiencies, and operational flexibility. Indian executives, by contrast, regard Germany as a global benchmark for precision engineering, quality standards, technological excellence, and economic stability, yet commonly perceive it as constrained by over-regulation, hierarchical decision-making structures, slow approval processes, and cultural rigidity.

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These asymmetric perceptions affect multiple stages of investment: initial risk assessment, partner selection, negotiation dynamics, trust-building, and long-term strategic commitment—especially in a post-COVID world characterized by geopolitical fragmentation, supply-chain resilience priorities, and shifting global trade alignments.

Statement of the Problem:

Robust economic metrics and high-level political commitments often conceal deeper perceptual and cultural barriers that continue to constrain the full realization of German-Indian foreign direct investment potential. German investors frequently adopt cautious or incremental strategies when committing capital to India, largely due to persistent perceptions of regulatory uncertainty, complex and frequently changing bureaucratic procedures, inconsistent legal enforcement, and difficulties in navigating the administrative landscape. These concerns commonly result in under-commitment, prolonged project timelines, or a preference for limited-risk models such as joint ventures rather than large-scale wholly owned subsidiaries or greenfield projects.

Conversely, Indian companies seeking to establish or expand operations in Germany often face challenges adapting to what they perceive as excessive hierarchies, rigid decision-making protocols, lengthy internal approval cycles, and a strong cultural preference for formal processes over speed and flexibility. This mismatch can lead to frustration among Indian managers accustomed to more adaptive and relationship-driven environments, sometimes resulting in slower integration, higher expatriate turnover, or even abandoned expansion plans.

Cultural stereotypes significantly amplify these operational and structural challenges. German business leaders commonly stereotype Indian counterparts and the Indian business environment as lacking punctuality, being overly informal or chaotic in execution, and placing greater emphasis on relationships than on structure—traits that stand in stark contrast to German values of precision, reliability, and rule-based efficiency. Indian executives, in turn, frequently characterize German managers and systems as overly structured, excessively risk-averse, bureaucratic in their own right, and slow to respond to dynamic market changes.

While numerous quantitative studies and economic reports document FDI flows, trade volumes, and macroeconomic trends, there remains a notable scarcity of bidirectional, qualitative research that systematically captures and compares the lived perceptions of senior executives from both countries who are actively engaged in cross-border investment decisions. This research gap is particularly significant in the post-FTA era. The India–EU Free Trade Agreement, finalized on January 27, 2026, promises substantial growth in trade and investment—projecting tariff reductions on 96.6–99% of goods, annual duty savings of €4 billion for EU exporters, and potential bilateral trade increases of 41–65% over the coming decade. However, achieving these gains requires not only legal and tariff alignment but also perceptual and cultural alignment. Without targeted efforts to address entrenched stereotypes and mutual misunderstandings, businesses on both sides may continue to under-invest relative to the new opportunities, thereby leaving considerable economic potential unrealized.

Significance of the Study:

This research carries both theoretical and practical significance. On the theoretical front, it extends the

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application of Hofstede's cultural dimensions framework to the specific domain of foreign direct investment decision-making within an emerging-developed market dyad. By qualitatively examining how high uncertainty avoidance (Germany) and high power distance (India) manifest in real-world perceptions of risk, opportunity, trust, and collaboration, the study enriches cross-cultural management literature and contributes to the evolving scholarship on perceptual and cognitive barriers in international business.

Practically, the findings offer actionable insights for a wide range of stakeholders. Policymakers and investment promotion agencies in both countries can use the identified perceptual pain points to design targeted bilateral initiatives, including joint cultural awareness programs, CEO-level perception-bridging forums, and investment matchmaking events. Corporate leaders and human resource departments can draw on the research to justify greater investment in cross-cultural training, expatriate preparation programs, and the development of hybrid management models that combine German structure and discipline with Indian adaptability and innovation.

The timing of the study is especially pertinent given the recent conclusion of the India–EU Free Trade Agreement. The agreement is projected to generate substantial economic gains: €22 billion in additional trade for the EU and approximately $4.2 billion for India over the medium term, alongside mutual GDP increases of 0.12–0.13%. It also supports strategic supply-chain diversification away from over-reliance on China and serves as a hedge against potential US tariff escalations or broader trade-policy volatility. However, these macroeconomic benefits will only be fully realized if businesses overcome perceptual hurdles and act on the new opportunities with confidence. This study therefore provides a timely and relevant contribution to maximizing the FTA's impact on Indo-German economic cooperation and to fostering deeper, more resilient bilateral investment ties.

Limitations of the Study:

The research relies on a purposive sample of 30–35 senior executives, which, while delivering rich qualitative depth, limits statistical generalizability to the broader population of German and Indian business leaders involved in cross-border investment. Self-reported perceptions may be subject to social desirability bias, with participants potentially emphasizing positive aspects of bilateral ties due to the current favorable political and economic climate. The qualitative methodology, while well-suited for exploring nuanced perceptions and stereotypes, does not permit large-scale quantitative validation or statistical testing of relationships between variables. Finally, responses may have been influenced by external events occurring during the data collection period, including geopolitical developments, economic fluctuations, or FTA-related announcements in late 2025 and early 2026. These limitations are inherent to exploratory qualitative research and can be mitigated in future studies through mixed-methods designs, larger-scale surveys, or longitudinal approaches.

Objectives of the Study:

1. To identify and analyze the key opportunities perceived by German and Indian business leaders when investing in each other's markets.
2. To examine the principal risks and cultural stereotypes that influence FDI decisions and shape mutual perceptions.

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3. To propose practical mechanisms and strategies for bridging perceptual gaps and enhancing bilateral foreign direct investment flows.

Hypothesis of the Study:

H1: Cultural stereotypes significantly influence perceived risks and opportunities in Indo-German FDI, resulting in asymmetric views where German leaders predominantly see India as high-growth but high-risk and Indian leaders predominantly see Germany as stable but bureaucratic and rigid.

Review of Literature:

Cross-cultural business and management research has long relied on Hofstede's six-dimensional cultural framework as a foundational lens. Germany scores high on uncertainty avoidance (65) and individualism, favoring structured environments, rule adherence, planning, and direct, explicit communication. India scores high on power distance (77) and relatively lower on uncertainty avoidance, emphasizing hierarchical relationships, relational networks, adaptability to ambiguity, and indirect, context-sensitive communication. These contrasting orientations manifest clearly in business practices: German managers prioritize task-oriented efficiency, punctuality, and formal processes, while Indian managers place greater value on relationship-building, flexibility, and contextual negotiation.

Trompenaars' cultural dimensions further complement this analysis by highlighting differences in time orientation (sequential and linear in Germany vs. synchronous and flexible in India) and communication styles (explicit and low-context in Germany vs. implicit and high-context in India). These differences often give rise to persistent stereotypes. German business perceptions frequently portray India as "chaotic yet innovative," "exotic," or "relationship-driven to a fault," influenced by both media portrayals and historical interactions. Indian perceptions, in turn, often characterize Germany as "serious," "punctual," "precise," and "reliable," but also "rigid," "overly bureaucratic," and "slow to adapt."

Empirical studies on Indo-German business interactions highlight both complementarities and challenges. German investments in India benefit from cost efficiency, large-scale market access, and a growing skilled workforce, while Indian investments in Germany gain access to advanced engineering capabilities, high-quality R&D ecosystems, and the European single market. Risks arise from mismatches in hierarchy, decision speed, regulatory expectations, and communication styles. Recent analyses (2024–2026) underscore synergies in sectors such as automotive, machinery, and renewables, with German firms creating substantial employment and Indian firms contributing to digitization and green innovation. The India–EU FTA, concluded in January 2026, is expected to significantly boost bilateral trade and investment flows, but perceptual and cultural barriers could limit realization of these gains.

Despite a growing body of work on cultural differences in international business, significant gaps remain. Few studies offer bidirectional, qualitative insights from senior executives actively involved in Indo-German FDI decisions, particularly in the context of recent geopolitical shifts, supply-chain diversification, and the new FTA framework. This study addresses that gap by providing fresh, perception-centered evidence from both sides.

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Research Methodology:

This exploratory qualitative study employs semi-structured interviews with 30–35 senior executives (balanced representation from Germany and India) actively engaged in bilateral FDI, primarily in automotive, information technology, engineering, and renewable energy sectors. Purposive and snowball sampling techniques were used to identify participants with at least five years of relevant cross-border experience, ensuring diversity in firm size, sector, and seniority.

Interviews lasted 45–60 minutes and were conducted virtually via Zoom or in-person, depending on participant preference and location. All interviews were audio-recorded with informed consent. The semi-structured interview guide included open-ended questions on perceived opportunities, risks, cultural stereotypes, and strategies for bridging perceptual gaps. Probes were used to elicit deeper reflections and concrete examples.

Data were transcribed verbatim and analyzed using reflexive thematic analysis following Braun and Clarke (2006, updated 2021). NVivo software supported the coding process, which combined inductive (data-driven) and deductive (theory-informed) approaches.

Initial coding identified emergent patterns, followed by theme development, review, and refinement. Rigor was ensured through inter-coder reliability checks (targeting 80%+ agreement on a 20% subsample), member checking (sharing thematic summaries with select participants for validation), and researcher reflexivity to acknowledge potential biases. Ethical considerations included obtaining informed consent, ensuring participant anonymity through pseudonyms, and complying with GDPR and Indian data protection standards.

Data Analysis and Interpretation

Reflexive thematic analysis revealed three core themes:

Theme 1: Opportunities German executives frequently highlighted India's large and rapidly expanding consumer market, demographic dividend, cost-effective skilled workforce, and growing innovation capacity in digital technologies and renewables. Indian participants emphasized access to German advanced engineering, precision manufacturing, quality standards, and the European single market as a gateway. Many interviewees noted strong complementarities—German structure paired with Indian scale and adaptability—especially in automotive supply chains and renewable energy projects.

Theme 2: Risks Perceived risks differed markedly. German participants cited India's bureaucratic delays, regulatory unpredictability, infrastructure gaps, and occasional policy reversals as major concerns. Indian executives pointed to Germany's hierarchical decision-making, lengthy internal approvals, perceived risk aversion, and cultural inflexibility as barriers to rapid scaling and innovation. Cultural mismatches (e.g., differing expectations around timelines and communication) often amplified operational risks.

Theme 3: Cultural Stereotypes India was frequently stereotyped by German respondents as "flexible and creative but chaotic and non-punctual." Germany was described by Indian respondents as "efficient, precise, and reliable but overly rigid and slow to adapt." These stereotypes influenced initial trust levels and risk assessments, but many interviewees noted that prolonged collaboration and direct experience significantly reduced negative bias and revealed opportunities for hybrid approaches.

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Interpretation: The hypothesis (H1) is strongly supported. Cultural stereotypes significantly shape perceived risks and opportunities, producing asymmetric views consistent with Hofstede's dimensions. However, direct engagement and joint projects often serve as effective mitigators, underscoring the value of perception-bridging interventions.

Challenges:

Key challenges included difficulties scheduling interviews with busy senior executives, subtle cultural communication differences affecting rapport in early interactions, and potential positivity bias in responses given the current favorable bilateral climate and FTA momentum.

Remedies:

These challenges were mitigated through flexible scheduling (offering multiple time slots and virtual/in-person options), pre-interview rapport-building via contextual emails and shared background information, neutral and open-ended probing questions, and strong assurances of anonymity to encourage candid responses. Future studies could complement this qualitative work with anonymous large-scale surveys or longitudinal designs to further reduce bias and enhance generalizability.

Conclusion:

Mutual perceptions significantly shape Indo-German foreign direct investment decisions. While both sides recognize substantial opportunities—market scale and demographic dividend in India, technological excellence and quality standards in Germany—cultural stereotypes and perceived risks continue to influence strategic choices. The India–EU FTA, concluded in January 2026, dramatically improves the economic landscape by reducing tariffs, enhancing market access, and projecting strong trade and GDP growth. However, realizing these benefits requires active efforts to bridge perceptual gaps.

Practical recommendations include: (1) bilateral cross-cultural training programs for executives and managers, (2) joint CEO-level perception-bridging forums organized by the Indo-German Chamber of Commerce and similar bodies, (3) hybrid management models that integrate German discipline with Indian flexibility, and (4) targeted policy advocacy to address regulatory and administrative pain points highlighted by investors. Future research should quantify the impact of stereotypes on investment decisions, track the FTA's actual effects on FDI flows, and explore sector-specific dynamics in greater depth.

By addressing perceptions alongside structural and economic factors, Germany and India can build deeper, more resilient investment ties that capitalize on their complementary strengths in an increasingly multipolar world.

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Original Research Article

A STUDY ON CAREER AWARENESS & PROFESSIONAL RESUME DEVELOPMENT AMONG FIRST YEAR UNDERGRADUATE STUDENTS

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Abstract:

The career awareness and resume development abilities of incoming undergraduate students are the main subjects of the study "A Study on Career Guidance and Resume Building among First Year Undergraduate Students." It draws attention to the fact that many students' academic and professional decisions are impacted by their lack of understanding regarding job options and the importance of professional resumes. 88 first-year students participated in career counseling and resume-building sessions as part of the community-engaged project. A structured questionnaire was used to gather primary data on institutional support and career awareness, and descriptive statistics were used for analysis. The study assesses how well students comprehend career planning, how often they use career counseling services, and how educational institutions support career development initiatives. The majority of pupils have a mediocre awareness of careers, which emphasizes the necessity of planned supervision. 41– 54% think workshops are helpful, and 50–55% acknowledge institutional support. 38–50% of respondents recognize the significance of resume skills, and 47–58% believe that workshops are beneficial for enhancing preparation and expertise. The findings of the ANOVA revealed no significant differences in views of institutional support (p = 0.715) or career awareness (p= 0.901). Participation in guidance programs was positively correlated with enhanced resume skills, according to correlation analysis (0.26–0.74). The results indicate that in order to ensure that students are better equipped for internships, placements, and long-term professional success, universities should implement regular career advising programs and resume workshops.

Keywords: *Career Awareness, Resume Development.*

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Introduction:

In today's competitive global environment, career awareness is essential for first-year undergraduate students who are beginning their professional journey. Many students lack clarity about career options, required skills, qualifications, and long-term growth opportunities. Early career awareness helps students understand their interests, make informed academic decisions, and set realistic professional goals. It also encourages participation in internships, workshops, and skill development programs, thereby enhancing confidence and decision- making ability.

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Professional resume development is equally important for improving employability. A well- structured resume presents a student's education, skills, and achievements effectively, creating a strong first impression on employers. However, many first-year students lack knowledge about resume format and presentation. Early training in resume writing enhances communication skills, self-presentation, and preparedness for internships and future employment.

Therefore, this study examines the level of career awareness and professional resume development among first-year undergraduate students and highlights the need for structured career guidance programs at the university level.

Significance of the study:

- This study is significant for first-year undergraduate students as it enhances career awareness, develops essential professional skills, and improves their employability from the early stage of higher education.
- The study is valuable for teachers as it enables them to provide structured and industry-relevant career guidance to students.
- It is beneficial for educational institutions in designing and implementing effective career development programs, workshops, and training initiatives.
- The findings of the study are useful for parents as they promote a better understanding of systematic career planning and professional development among students.
- The study is advantageous for employers as it contributes to the availability of career- aware, skilled, and professionally prepared candidates.

Objectives of the Study:

1. To examine the level of Career Awareness and Professional resume development skills among first year undergraduate students
2. To assess student knowledge about the structure, components, & importance of a professional resume.
3. To study the role of educational institution in promoting Career Awareness among first year students
4. To assess students' participation in Career guidance programs, sessions

Hypothesis:

H_1: There is a significant difference in students' responses across the dimensions of career awareness

H_0: There is no significant difference in students' responses across the dimensions of career awareness.

H_1: There is a significant relationship between participation in career guidance programs and resume knowledge/development skills.

H_0: There is no significant relationship between participation in career guidance programs and resume knowledge/development skills.

H_0: There is no significant difference in students' perception regarding the role of the educational institution in providing career awareness and guidance.

H_1: There is a significant difference in students' perception regarding the role of the educational institution in providing career awareness and guidance.

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Limitations of the Study:

1. The study is limited only to first year undergraduate students and does not include other academic years.
2. The research is restricted to a particular college or university, so the findings cannot be generalized to all institutions.
3. Responses are based on students' self-reported information, which may not always be completely accurate.
4. Time constraints may limit in-depth analysis of career awareness and resume development practices.
5. The study may not cover all career fields, industries, or professional resume formats.

Review of Literature: Tabular form of literature review

Author(S)	Focus of Study	Major Findings	Purpose Of Study
Tatsuya T, Yoko N, Takashi T	To examine stable career awareness themes and differences among student types using Structural Topic Model (STM).	Three stable themes were identified: self- strengths and weaknesses, encounters with different values, and toward life fulfillment.	To analyze how first-year career education courses influence students' career awareness.
Chithra K G, Saranya P, Rithika V, Yuvasri S	To compare performance metrics and self- reported burnout levels between hybrid and fully remote staff using quantitative surveys.	Hybrid models showed the highest job satisfaction, while fully remote work correlated with increased task focus but higher social isolation.	To investigate the long-term impact of remote work policies on employee productivity and mental well-being.
Michael A, Duca Perara, Prekerthi P, Trinette F	To evaluate the usefulness of an Employability Skills Development module in enhancing fresh graduates' abilities in self-assessment, job search techniques, and self-marketing tools.	The results showed strong effectiveness of the module, with 89.55% of graduates expressing confidence in facing career challenges and 81% reporting increased career readiness through employability skills training.	To determine how effective learning employability skills at the university level is in developing fresh graduates' knowledge, self- marketing skills, and career readiness.

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C Eseadi - Konselor	To analyze students' free- writing reports using Structural Topic Model (STM) to compare themes across different student types.	Three stable themes emerged: self- assessment of strengths/weaknesses, exposure to diverse values, and pursuit of life fulfillment.	To identify consistent career awareness themes developed by students during first-year career education courses.
Nik Rafidah Nik Yusoff, Mastura Mahfar, Muhammad Saud, Aslam Senin	To evaluate changes in career self-efficacy (including self-appraisal, occupational information, goal selection,	The study found significant improvements in overall career self- efficacy and all its subscales in the experimental group following the Career	To determine the effect of a Career Readiness Module on university students' career self-efficacy and its key subcomponents.
	planning, and problem-solving) before and after intervention using the Career Readiness Module.	Readiness Module intervention	
Joshua LeBlanc	To measure and compare specific dimensions of vocational maturity—including career planning, exploration, and knowledge—between students who participated in career courses and those who did not.	Students completing career education showed significantly higher vocational maturity scores, specifically in self-knowledge and the ability to integrate personal interests with career information.	To investigate the influence of career education on the vocational maturity and career decision-making of college students.
Yibin Wang	To analyze how career planning education is implemented in universities and how it helps students' career development.	The study found that while career planning education positively supports students' career awareness and decision-making, its effectiveness is limited by insufficient guidance, lack of systematic curriculum, and inadequate integration with students' actual needs.	To explore the current situation and problems of career planning education for college students and propose improvement strategies.

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Original Research Article

Hend Alnajjar, Ebtsam Aly Abou Hashish	To analyze qualitative changes in students' perceptions and reflections using the Structural Topic Model (STM) to identify shifts in thematic interests.	Students shifted from passive concerns about academic life to active professional goals, specifically emphasizing self- understanding and the importance of connecting with diverse perspectives.	To investigate the changes in career awareness among first-year university students before and after completing a career education course.
Sofia Elias, Dayang Rusimah, Mohd Sofi Ali, Mohd AL Mahdi Hussain	To assess the level of career guidance awareness among students and its influence on	The study found that enhanced career guidance significantly improves students' understanding of	To examine students' awareness of career guidance and how it affects their decisions in
	educational and career choices.	career options, supports informed course selection, and strengthens career planning confidence.	course selection and career planning.
Wael Yousef	To analyze the relationship between students' preparedness for college and their career decision-making and future planning.	The study found that stronger college readiness skills significantly enhance students' career awareness, confidence, and preparedness for post-secondary and career pathways.	To investigate how college readiness programs influence career development among high school students.
Askar A, Ainash K, Nataliia F, Gulmira T.	To conduct a 15- week intervention comparing an experimental group taking the online career course with a control group using the Career Decision-making Difficulties Questionnaire (CDMDQ).	The career course significantly reduced students' difficulties across three key areas: lack of readiness, lack of information, and inconsistent information.	To evaluate the impact of a "Career Development" course on the career decision-making readiness and difficulties of undergraduate students.

Research gap:

- Prior research has mostly concentrated on career educational courses and the growth of students' career awareness.
- Through organized programs, numerous researchers investigated career self-efficacy, vocational maturity,

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and career decision-making abilities.

- In order to improve career preparedness, certain research stressed the significance of employability skills and career coaching courses.
- Additionally, research showed that while career planning education is available, it frequently lacks appropriate structure and real-world application.
- Nonetheless, few studies concentrate on first-year undergraduate students' career knowledge and resume development skills in tandem.
- Additionally, there is a dearth of research on career awareness workshops that students participate in as community-engaged activities.
- Thus, the current study looks at first-year students' career awareness and resume development skills and assesses the effectiveness of these awareness sessions.

Research Methodology:

The study uses a descriptive research design to assess career awareness and resume development among first-year students of FYBBI, FYB.Com, FYBMS, FYBSCIT, and FYBBA at PRAGATI College. A quantitative approach was employed, with simple random sampling of participants in career guidance and resume-building sessions. Primary data were collected via a structured Likert scale questionnaire with a sample size of 88 students form Pragati college, while secondary data were sourced from journals, books, and credible online resources.

Data Analysis :

1. **Demographic analysis:**

Demographic table	Category	Frequency	Percentage
Age	17-18	53	60.2%
	19-20	33	37.5%
	21+	2	2.3
Gender	Male	29	33%
	Female	59	67
Course /stream	BMS	49	55.7%
	BBA	1	1.1%
	BBI	2	2.3%
	B.com	7	8%
	BSc IT	29	33%

Interpretation:

The majority of participants were female (67%) and between the ages of 17 and 18 (60%). The BMS stream accounted for the majority of students (56%), followed by the BSc IT stream (33%), with lower representation from the B.Com., BBI, and BBA programs.

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2. Career Awareness among Students

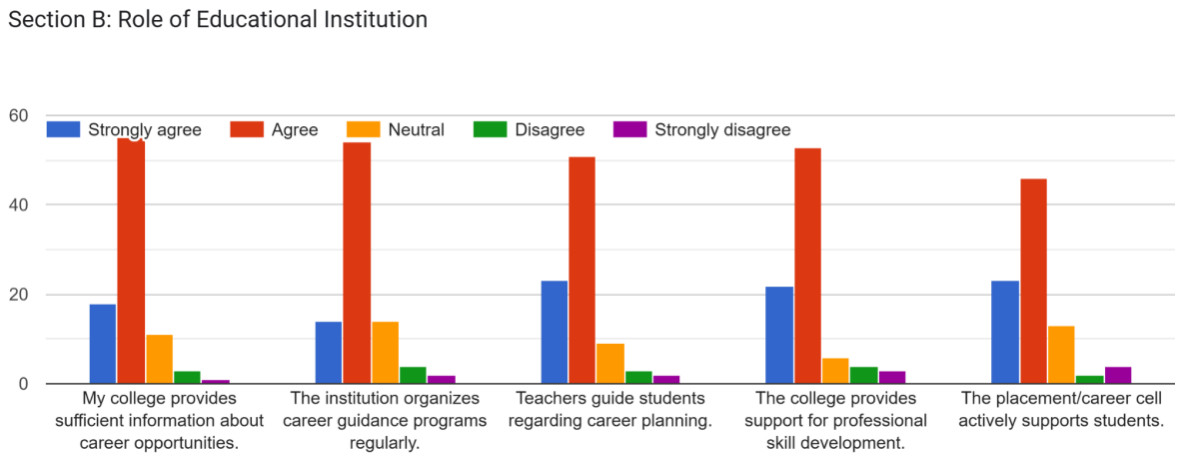


Interpretation:

According to the research, the majority of students have a moderate awareness about career prospects, aspirations, and necessary skills (29–40%), while 26–37% have a slight

awareness and 12–21% have a strong awareness. 4–6% are unaware, and only 3–10% show severe awareness. The results point to the need for improved career counseling programs to help students better grasp career options.

3. Role of Educational Institution



Interpretation:

According to the findings, 50–55% of students think that career information and guidance programs should be provided, and a sizable majority of students acknowledge the critical role that educational institutions play in professional development. Furthermore, 22– 24% strongly believe that teachers help with skill development and career planning, whereas only 9–14% are neutral or disagree (2-4%). Overall, the results indicate that educational institutions are providing students with career guidance, skill development, and placement services in an effective manner.

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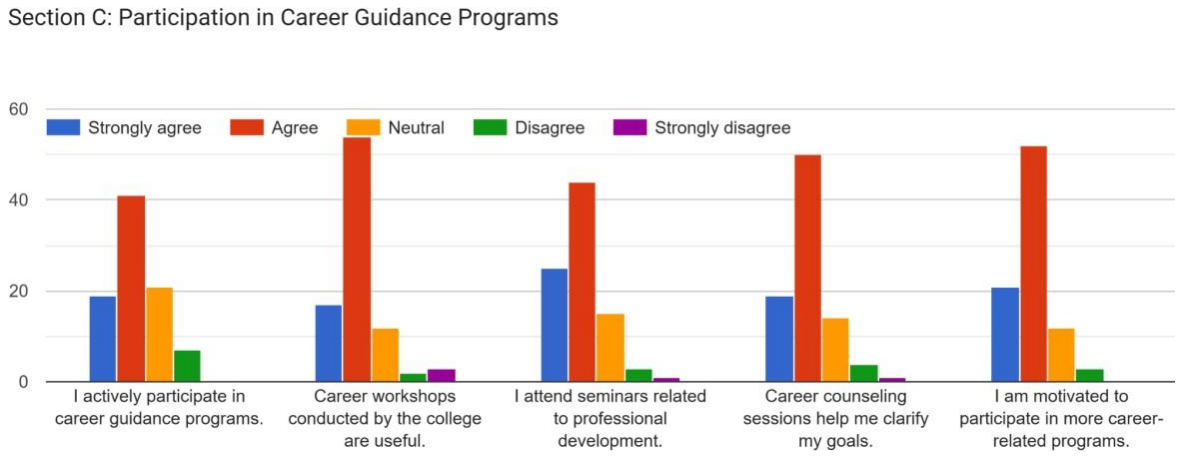
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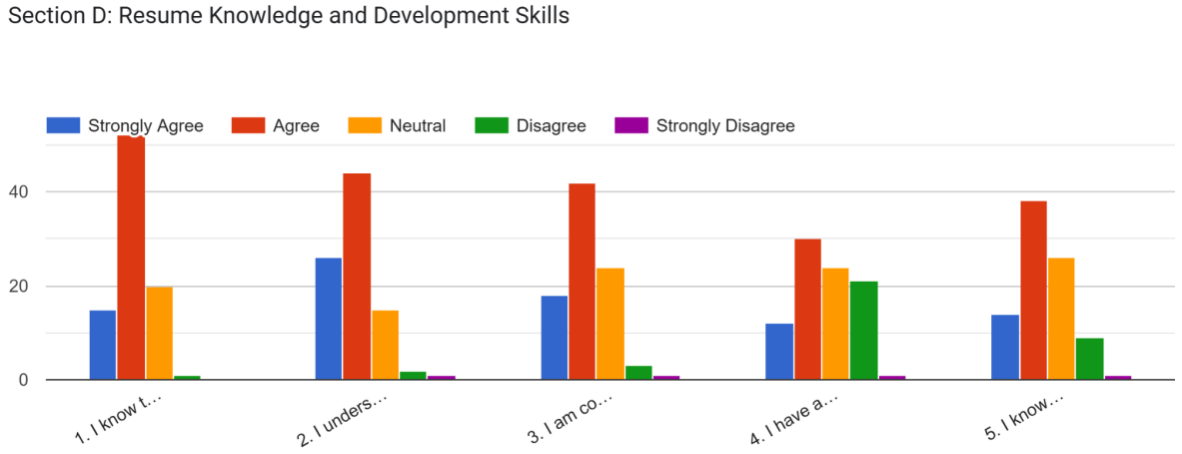
4. Participation in Career Guidance Programs



Interpretation:

According to the study, most students (41–54%) see career guidance programs favorable, find workshops helpful, and attend seminars for professional growth. Furthermore, 18–25% strongly concur that these programs inspire continued involvement and make career goals clear. Just 1–7% disagree, and 12–21% are neutral, indicating that students actively gain from the college's career counseling programs.

5. Resume Knowledge and Development Skills



Interpretation:

According to the research, the majority of students have a fundamental knowledge of resume preparation, and between 38 and 50 percent of them recognize its significance. Nonetheless, 15–26% are neutral, indicating partial awareness, and a noteworthy 12–26% strongly agree. A few percent (2–21%) disagree, suggesting a lack of confidence in their resume-writing competence. Students' overall understanding is mediocre, indicating that more training and seminars might improve their skills.

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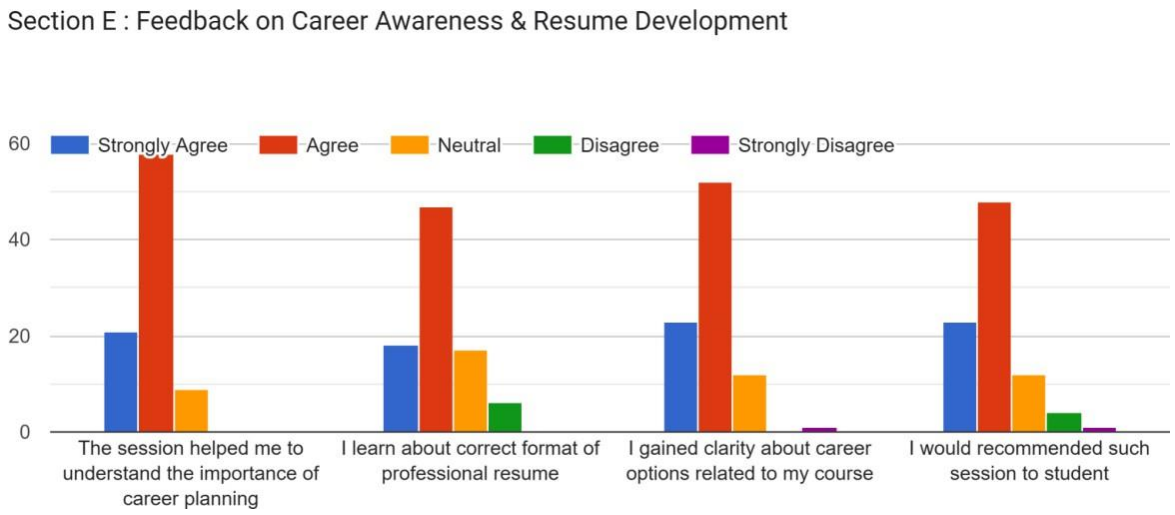
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6. Feedback on Career Awareness & Resume Development



Interpretation:

According to the results, 47–58% of students said that the career awareness and resume preparation workshop helped them grasp resume formatting and career planning, with 18–23% strongly agreeing. 1–6% disagreed, and a minority (9–17%) felt neutral. In general, the session was perceived to be helpful to enhance résumé skills and career awareness.

7. Anova: Single Factor level of awareness across all career-related aspects

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
I am aware of different career opportunities related to my course.	88	242	2.75	1.178161		
I have a clear idea about my future career goals	88	254	2.886364	0.791536		
I understand the skills required for my desired career.	88	253	2.875	1.122126		
I regularly search for information about career opportunities	88	248	2.818182	0.978056		
I am aware of higher education options related to my field.	88	251	2.852273	0.931949		

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ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.059091	4	0.264773	0.264676	0.90059	2.392445
Within Groups	435.1591	435	1.000366			
Total	436.2182	439				

A one-way ANOVA was conducted to determine whether there is a statistically significant difference in students' responses across five statements measuring **career awareness**. the one- way ANOVA results indicate that there is no significant difference among the five dimensions of career awareness The calculated **F value (0.265)** is **less than** the critical value (2.392). The **p-value (0.901)** is **greater than 0.05**.

Therefore, the **null hypothesis (H_0)** is accepted. This suggests that students possess a relatively consistent level of awareness across all career-related aspects measured. However, the mean values indicate only moderate awareness levels, highlighting the need for enhanced career guidance initiatives to strengthen students' understanding of career opportunities, required skills, and higher education pathways.

8. The correlation analysis to study participation in career guidance programs and resume knowledge/development skills**.**

	I know the correct format of a professional resume	I understand the important sections of a resume (education, skills, experience, etc.).	I am confident in preparing my own resume	I have already prepared a professional resume	I know how to tailor my resume according to job requirement s
I actively participate in career guidance programs.	1				
Career workshops conducted by the college are useful.	0.367307344	1			

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I attend seminars related to professional development	0.590127689	0.263866209	1		
Career counselling sessions help me clarify my goals.	0.488501697	0.636856541	0.40610829	1	
I am motivated to participate in more career-related programs.	0.69452042	0.424630483	0.744643105	0.534998209	1

The correlation analysis shows a positive relationship between students' participation in career guidance programs and their resume knowledge and development skills. The correlation values range from **0.26 to 0.74**, indicating moderate to strong associations. This suggests that students who actively participate in workshops, seminars, and counselling sessions tend to have better resume knowledge, greater confidence, and higher motivation. Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted, confirming a significant relationship between participation in career guidance programs and resume development skills.

9. Anova: Single Factor: students' perceptions of the role of the educational institution in promoting career awareness

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
My college provides sufficient information about career opportunities	21	43	2.047619	0.647619		
The institution organizes career guidance programs regularly.	21	44	2.095238	1.090476		
Teachers guide students regarding career planning	21	39	1.857143	0.528571		
The college provides support for professional skill development	21	40	1.904762	0.790476		
The placement/career cell actively supports students	21	37	1.761905	0.690476		

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ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.580952	4	0.395238	0.527319	0.71589	2.462615
Within Groups	74.95238	100	0.749524			
Total	76.53333	104				

The ANOVA test was conducted to examine students' perceptions of the role of the educational institution in promoting career awareness. Since the p-value (0.715) is greater than 0.05 and the F-value (0.527) is less than the F-critical value (2.463), the null hypothesis is accepted. This indicates that there is no statistically significant difference in students' perceptions regarding the institutional role in career awareness and guidance**.** Overall, the findings suggest that while institutions provide some level of support, further improvement in structured career guidance and skill development initiatives is required.

Findings :

- Approximately 79.5% of students report being satisfied with the career awareness session, which was deemed beneficial. Although just a small proportion of students remained neutral or slightly dissatisfied, indicating that there is ample opportunity for growth, this shows that the session proved beneficial and successful.
- The majority have moderate awareness of career opportunities (29–40%), with slight awareness seen in 26–37%, and only 12–21% show strong awareness.
- Roughly 50–55% believe colleges should offer career guidance, while around 22–24% acknowledge teachers' assistance in career planning.
- Most students (41–54%) view career guidance programs favorably, and 18–25% feel they clarify career goals.
- Understanding of resume preparation is moderate (38–50%), highlighting a need for more training (15–26% neutral; 2–21% disagree).
- The career awareness session was effective, with 47–58% agreeing it enhanced understanding.
- Students have a steady but moderate level of career awareness, according to the ANOVA test, which reveals no significant differences across various components of career awareness
- The correlation analysis (0.26–0.74) indicates a moderately to strongly favorable association between resume development skills and involvement in career assistance programs.
- Students' opinions about the role of educational institutions in career advising do not significantly differ, according to the second ANOVA result.

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Suggestion:

Category	Key Suggestions & Recommendations
Career & Professional Development	Strengthen placement support and internship opportunities. Enhance career counseling to help students identify and secure ideal job opportunities.
Practical & Industrial Exposure	Increase the frequency of workshops & industrial visit. Shift teaching methods include more practical work
Technological Advancement	Incorporate specialist training and curriculum focus on Artificial Intelligence (AI) and Machine Learning (ML) to meet modern industry demands
Academic Support & Pedagogy	Conduct regular doubt solving sessions and provide leaner more detailed instructions focus and Holistic skills developed and career specialist guidance
Engagement & Outreach	Continue organizing physical activities related to course and encourage awareness about different career filled and professional Pathways

Conclusion:

According to the study, many first-year undergraduate students still lack clarity and confidence in these areas, even though some of them exhibit awareness of career planning and resume preparation. The knowledge of learners of professional expectations and readiness for future employment were improved through career coaching sessions and resume-building workshops. In order to provide students with the knowledge and skills necessary for successful career

planning and professional development, the study emphasizes the necessity of organized, continuous career support and skill development programs.

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Original Research Article

BUILDING TRANSDISCIPLINARY TEAMS FOR COMPLEX PROBLEM SOLVING IN THE MUMBAI METROPOLITAN REGION

**** Radhadevi Shailendra Singh, ** Swara Milind Palkar,*** Ishika Praveen Jain, **** Dhanashree Nandkumar Jadhav & ***** Dr. Chandra Hariharan Iyer***

** Undergraduate Students*

Abstract:

This study examines sustainability governance in the Mumbai Metropolitan Region (MMR), where institutional fragmentation and sectorial silos constrain integrated climate planning and cross-sector coordination. Using a convergent parallel mixed-methods design, thematic analysis of twelve academic and policy documents was combined with survey data from 120 stakeholders to assess climate planning integration, governance effectiveness, and collaborative capacity. The finding shows that there is uneven sustainability implementation, limited collaboration and resource misalignment. Statistical analysis indicates significant interrelationships among governance indicators, highlighting the importance of institutional coordination. The study proposes the FISA Framework to strengthen collaborative governance and metropolitan resilience.

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Introduction:

Urban metropolitan regions support economic growth and advancement's but face rising environmental damage, climate-related threats, pressure on infrastructure, geographic disparities. These interconnected challenges restrict traditional department-based planning and require governance systems that combine environmental, economic, infrastructural, and social dimensions within organized systems. The Mumbai Metropolitan Region (MMR)— including Mumbai, Thane, Navi Mumbai, Vasai-Virar, and nearby urban centers—faces rapid population growth, need for infrastructure, flooding risks, air pollution, coastal exposure to risk, and land-use disputes. However, governance remains divided among multiple agencies with shared duties, limiting, joint sustainability planning. This study analyzes climate planning integration, cross-sector sustainability alignment, and collaborative governance efficiency in MMR. Using views of stakeholder and thematic policy analysis, it assesses how governance integration affects long-term metropolitan resilience and sustainable development

Statement of the Research Problem:

In spite of policy commitments to sustainable urban development Governance in the Mumbai Metropolitan Region still remains divided. Overlapping responsibilities in MMR cause of multiple agencies, restricting cross-sector coordination across transport, infrastructure, environment, and social development. Even though

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sustainability initiatives exist, they are often integrated in isolated formats rather than through integrated metropolitan-level planning.

Existing literature documents identifies coordination challenges in Mumbai metropolitan region, yet stakeholder perceptions is evaluated by limited empirical research of governance integration and trans disciplinary collaboration in MMR. The main problem identified in this study is the absence of structured mechanisms that support coordinated sustainability implementation across institutional boundaries.

This study examines the degree of sustainability integration and institutional coordination within the Mumbai Metropolitan Region by combining conceptual analysis with empirical survey-based assessment This study examines the degree of sustainability integration and institutional coordination within the Mumbai Metropolitan Region by combining quantitative stakeholder perception data with qualitative thematic analysis of academic and contemporary policy discourse. Using a convergent parallel mixed-methods design, the research evaluates climate planning integration, cross-sector sustainability alignment, and collaborative governance capacity simultaneously. The findings are integrated at the interpretative stage to assess structural coordination gaps and institutional coherence within the metropolitan governance framework. This study seeks to address the following research questions: 1) To what level are sustainability objectives implemented across major sectors such as transport, infrastructure, environment, and social development in the Mumbai Metropolitan Region? 2) What institutional and governance gaps restricts effective cross- sector coordination in agencies operating in the MMR? 3) What practical collaboration challenges do stakeholders face in implementing transdisciplinary sustainability initiatives, and how can these be addressed?

Significance of the Study:

The study analyses how working together structures long-term development cooperation which enhances the metropolitan management studies. Stakeholder views and thematic policy review together improves the understanding of governance collaboration within complicated city systems. At the regional level, MMR represent an important case for sustainable governance in developing economies. Improving institutional coordination in MMR provide lessons relevant to other metropolitan regions facing similar division related challenges. At the policy level, the research identifies coordination weaknesses and suggests strategies to improve Trans disciplinary collaboration, supporting more unified, strong and adaptable metropolitan development.

Limitations of the Study:

The study is based on survey data from 120 participants, mainly students and private sector professionals, which may not fully represent policy decision-makers or government officials. The research depends on self-reported views, possibly causing personal bias. Also, the qualitative study is limited to public documents, not including internal organizational records that may provide more detailed understanding into coordination practices.

Objectives of the Study:

1. To evaluate the degree of integration of sustainability objectives across major sectors such as transport, infrastructure, environment, and social development within the Mumbai Metropolitan Region.

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2. To identify gaps in existing collaborative governance mechanisms and assess the extent of institutional coordination among metropolitan agencies in MMR.
3. To examine stakeholder perceptions regarding the effectiveness of transdisciplinary collaboration in strengthening sustainable metropolitan development within the region.

Hypothesis of the Study:

Null Hypothesis (H_{01}): There is no significant continuity across the collaborative governance indicators.

Alternative Hypothesis (H_{11}): There is significant continuity across the collaborative governance indicators.

Null Hypothesis (H_02): There is no significant relationship across the collaborative governance indicators.

Alternative Hypothesis (H_12): There is a significant relationship across the collaborative governance indicators

Review of Literature:

Existing scholarship on sustainable metropolitan governance in the Mumbai Metropolitan Region (MMR) consistently identifies substantial weaknesses in climate change planning integration and cross-sector sustainability alignment. According to Sonam Sahu MMR's regional development framework shows that there is extremely low incorporation of climate mitigation and adaptation objectives, which shows that climate considerations are not perfectly rooted across planning sectors (Sahu, 2018). Same for, Amit Chatterjee he observed that sustainability objectives within metropolitan development policies remain divided, with limited institutional mechanisms which supports coordinated inter-sectoral implementation (Chatterjee, 2020). These findings are supported by modern developments. The Metro Line 12A extension indicates the coordination problems that arise when transport expansion intersects with environmental and land-use authorities operating under overlapping decrees. same as, recent climate finance policies aimed at positioning Mumbai as a sustainability investment hub indicating attempts at aligning governance, finance, and environmental priorities, yet reveal not even integration across departments, which suggests that cross-sector sustainability integration remains selective rather than systemic.

The inter-sectoral policy structural weaknesses are highlighted by analysis institutional in integration and sectoral sustainability alignment within MMR. The identification of Ishant Sharma and his colleagues show weak coordination in environmental, transport, infrastructure, and land-use agencies, which reflects persistent policy silos (Ishant Sharma, 2023). Raghav Chawla's research shows low strategic coordination across planning and infrastructure sectors, which is underscoring misalignment in metropolitan sustainability execution (Chawla, 2025). The indication by fiscal assessments segments allocation of regional development funds, which points towards weak inter-agency funding cohesion and limited financial integration of sustainability priorities (MMRDA, n.d.). These institutional gaps are mirrored by real world cases: regulatory conflicts between environmental authorities and infrastructure agencies indicates delay in overlapping jurisdictions coordinated decision-making, while integrated transport initiatives show that structured alignment mechanisms can increase sectoral sustainability coherence when deliberately implemented. These patterns suggest that institutional fragmentation, rather than absence of sustainability intent, constrains effective governance integration.

Recent scholarship increasingly divert focus towards transdisciplinary collaboration and stakeholder-level

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coordination in complex urban systems. Network analysis of infrastructure megaproject governance by Aritra halder, including the Delhi–Mumbai Industrial Corridor, finds minimal stakeholder network density and precise influence patterns, which indicates in coordination complexity and asymmetrical decision-making power within multi-actor governance structures (Halder, 2024). this perspective is complimented by Carsten Butsch in his research the team argue that megacities such as Mumbai must be understood as complex adaptive systems, where multi-actor institutional interactions shape climate and risk governance results and need integrative, adaptive approaches rather than isolated technical solutions (Carsten Butsch, n.d.). Further Contemporary research indicates that integrating quantitative complexity analysis with transdisciplinary stakeholder engagement make system's strong understanding and supports actionable sustainability pathways. News-based evidence highlights the same that stakeholder involvement mediates the relationship between risk mitigation practices and improved social project performance, which helps in reinforcing the centrality of perceived transdisciplinary collaboration effectiveness in achieving sustainable results. in spite of these insights, existing scholarship largely depends on qualitative policy analysis and institutional case studies, with limited empirical measurement of perceived integrative governance capacity or stakeholder perceptions of collaboration effectiveness within the MMR context.

Together, the reveal of literature persistent challenges in climate change planning integration, cross-sector sustainability alignment, inter-sectoral policy coherence, and collaborative governance capacity in the Mumbai Metropolitan Region. Whereas emerging policies indicate growing awareness of integrative approaches, structural fragmentation and uneven coordination continue to constrain systemic sustainability transformation. therefore, A clear research gap exists in the empirical assessment of stakeholder perceptions related to climate planning integration, policy alignment, funding cohesion, and transdisciplinary collaboration effectiveness. By compiling academic scholarship, contemporary developments, and primary survey data, the present study found this gap and advances structured evaluation of sustainability governance changes within MMR.

Research Methodology:



Figure 1: Alan Brymans research design model

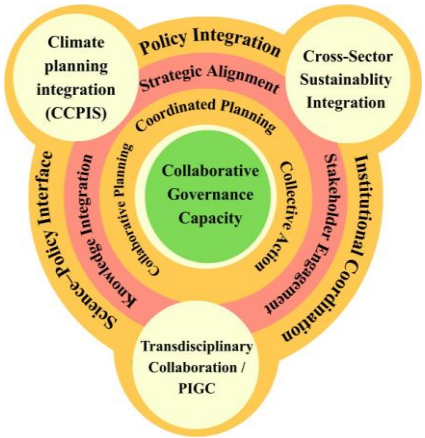


Figure 2: Collaborative governance underpinning theory

The study examines sustainability governance of Mumbai metropolitan region by looking at integrity of climate planning, cross sector coordination, and governance capacity of collaboration by a mixed method way. It is found

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that sustainability objectives are highly understood by all metropolitan sectors but still their application are poorly handled because of separation of institution, mandates overlapping, and lesser coordination mechanism between multiple disciplines.

Governance effectivity, policy application and resource infrastructure expansion but rather on strong integrity of governance structures and formal collaboration methods. Structuring trans disciplinary governance should he addressed for better metropolitan resilience, policy constituency, and long-term urban development.

Data Analysis:

1. **Thematic analysis based on review of literature and News articles**

   This table represents the regular governance challenges, institutional patterns, and coordination gaps identified through thematic analysis of academic literature and news articles relevant to sustainability integration in MMR.

Table 1: Thematic analysis governance patterns in Mumbai metropolitan regions

Category / Theme	Findings (Thematic Analysis)	Implications
Institutional Fragmentation	• Different agencies manage in MMR. • Overlapping compulsion exist across institutions. • coordination is limited of Inter- agency.	Fragmented governance leads to • procrastination • Inefficient work • Inconsistent integration of sustainability policies.
Cross-Sector Sustainability Integration	• Objectives of Sustainability vary across sectors. • Sectoral silos persist. • Integration of Cross-sector remains limited.	• Climate resilience weakens because of Lack of integrated planning. • Optimization of resources is affected. • The challenged is Long-term urban sustainability.
Transdisciplinary Collaboration Gaps	• Limitation of structured collaborations. . • Weak Cross-sector coordination • At the time of joint decision- making Stakeholders face challenges.	• Formal coordination is required by Sustainable development. • Transdisciplinary collaboration is essential. • Institutional coordination is supported by sustainability.
Stakeholder Perception of Governance Capacity	• Governance effectiveness is perceived as moderate to weak. • Stakeholder trust remains limited. • Coordination challenges are evident.	• Collaborative governance remains weak. • Stakeholder engagement is affected. • Policy implementation is undermined.
Resource & Policy Alignment Issues	• Funding initiatives remain sector-specific. • Infrastructure and economic priorities dominate. • Environmental and social concerns receive less focus.	• Resource allocation remains misaligned. • Sustainability adoption is restricted. • Climate and social program impacts are reduced.

(Source: Sources: Study of variables derived from the reviewed literature, as cited in the reference list)

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Findings and discussion on findings:

The thematic analysis of twelve documents (six academic papers and six contemporary news articles) shows several serious patterns in sustainability governance within MMR:

Climate Change Planning Integration – Climate objectives are often secondary to infrastructure and transport priorities. This weak integration indicates a gap between policy intent and sectoral practice. **Cross-Sector Coordination Gaps** – Multiple agencies manages in silos, creating divided decision-making. And coordination limits the ability to implement sustainability policies in a fixed manner. **Collaborative Governance & Stakeholder Engagement** –the note of lack of structured collaboration, trust deficiency, and mixed responsibilities by stakeholder, indicating the importance for trans disciplinary governance frameworks. **Policy-Implementation Misalignment** –for sustainable development policies exist, which unevenness the implementation due to divided resources and managing gaps undermines effectiveness. **Resource & Capacity** e assessment of institutional effectiveness.

2. Factor wise classification table for further analysis

To analyse the multidimensional perspectives of climate change governance and planning integration, the survey questionnaire items were grouped into particular analytical way based on conceptual relevance. Each factor shows a different dimension influencing climate planning effectiveness, coordination mechanisms, governance collaboration, implementation alignment, and institutional capacity. The following table represents the classification of factors with their corresponding questionnaire items used for analysis.

Table 2 : Factor-wise Classification of Study Variables and Questionnaire Items

Factors	**Associated Questionnaire Items**
Institutional Fragmentation	Q1, Q2, Q3
Cross-Sector Sustainability Integration	Q2, Q3
Transdisciplinary Collaboration Gaps	Q4, Q5, Q6
Stakeholder Perception of Governance Capacity	Q7, Q8
Resource & Policy Alignment Issues	Q9

(Source: primary data questionnaire)

The above classification shows formatted statistical analysis by grouping related questionnaire items into measurable dimensions.Q1–Q9 denotes items from the Google Forms survey questionnaire. This allowed us to calculate Descriptive Statistics of Collaborative Governance Indicators.

3. Descriptive statistics of Collaborative Governance Indicators.

To analyse the central pattern and variability of key collaborative governance indicators we have used descriptive analysis, particular for Climate Change Planning Integration Score (CCPIS), Cross-Sector Governance Strength and Effectiveness (CGSE), Policy Implementation Mechanism (PIM), and Resource Coordination Level (RCL). Overall understanding of institutional performance and consistency among the selected governance components within the study area is provided by the analysis.

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Table 3: Descriptive Statistics of Collaborative Governance Indicators

CCPIS	*CCPIS*	*CGSE*	*PIM*	*RCL*
Mean	3.166666667	3.505555556	2.979166667	3.466666667
CCPIS	CCPIS	CGSE	PIM	RCL
Standard Error	0.070346614	0.071876642	0.075869339	0.090077257
Median	3.166666667	3.666666667	3	4
Mode	3	4	3	4
Standard Deviation	0.770608548	0.787369165	0.83110697	0.986746912
Sample Variance	0.593837535	0.619950202	0.690738796	0.973669468
Kurtosis	0.416230158	1.110883615	0.429126524	-0.172837674
Skewness	-0.246919428	-0.785684189	-0.234256093	-0.412796609
Sum	380	420.6666667	357.5	416
Count	120	120	120	120

(Source: primary data collected through questionnaire)

Indicator's mean value range between **2.97 and 3.50**, indicates a **moderate to good level of governance performance**. And **low standard deviation values** show confined variation in responses, which is suggesting consistency among governance components. Therefore, the results indicate **certain institutional perception**, supporting the presence of consistency across indicators

We accepted the **H_{11} alternate hypothesis** based on the descriptive results, indicating consistency among collaborative governance indicators.

4. Correlation matrix of Collaborative Governance Indicators.

After descriptive statistical analysis, correlation analysis was calculated to evaluate the relationship and degree of relationship among the collaborative governance indicators. Pearson correlation analysis was used to decide the strength and direction of relationships among Climate Change Planning Integration Score (CCPIS), Cross-Sector Governance Strength and Effectiveness (CGSE), Policy Implementation Mechanism (PIM), and Resource Coordination Level (RCL). This analysis helps in understanding the degree of interrelationship across governance dimensions influencing collaborative metropolitan governance.

Table 4 : Correlation Matrix of Collaborative Governance Indicators

	CCPIS	*CGSE*	*PIM*	*RCL*
CCPIS	1			
CGSE	0.47858457	1		
PIM	0.366290667	0.395056258	1	
RCL	0.04052144	0.411250421	0.191274516	1

(Source: Primary data collected Correlation Matrix Calculated using Excel Data Analysis Tool Pack)

A moderate positive correlation exists between CCPIS and CGSE (r = 0.478), This indicating that improved climate planning integration is related with stronger cross-sector governance. PIM shows positive relationships with CCPIS (r = 0.366) and CGSE (r = 0.395), which is suggesting the effective policy implementation is supporting coordinated governance mechanisms.RCL demonstrates weaker but positive correlations, mainly with CGSE (r = 0.411), which is indicating partial linkage with governance effectiveness. Since most variables

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demonstrate positive interrelationships, collaborative governance components are interconnected.

Based on the positive correlations among key indicators we rejected the **H_{02} null Hypothesis** and accepted the **H12** Alternative Hypothesis. This is confirming the significant relationship among collaborative governance indicators.

Summary of Findings Based on Research Questions:

This study discovered sustainability governance in the Mumbai Metropolitan Region through thematic analysis and particular governance indicators. The findings disclose patterns of partial integration, determined fragmentation, and emerging collaborative potential.

RQ1: Sustainability Integration Across Sectors

Even though sustainability goals are visible across major sectors integration is still uneven. Planning efforts of course shows signs of coordination but sectoral silos influence implementation. A good relationship between planning integration and governance effectiveness implies that stronger inter agency alignment results in improvement of sustainability coherence.

RQ2: Institutional and Governance gaps.

Institutional fragmentations are the central constraints. Overlapping mandates, poor coordination mechanism, and lack of resources management results in weak cross sector collaboration. These gaps are the reasons for delays and inconsistent nature of sustainability outcomes

RQ3: Collaboration challenges and Pathways

Stakeholders noticed a gap between transdisciplinary engagement and execution of policy. However, it's found that improved coordination and institutional collaboration are directly influencing governance performance to be better, this highlights collaboration as a practical path forward

Overall interpretation

Overall, according to the evidences, Policy intent has less of an impact on sustainability challenges in MMR and is rather a problem of misalignment of various institutions.

Coordination governance mechanism strength holds more credibility in the advancing of resilient metropolitan development

Innovative suggestion for problem solving The FISA Framework:

(Fragmentation–Integration Sustainability Alignment Framework)

The **FISA Framework** is a theoretical management model developed to address institutional division and sustainability coordination challenges in the Mumbai Metropolitan Region. The model is structured into four step-by-step stages that move from identifying governance barriers to achieving sustainable metropolitan outcomes.

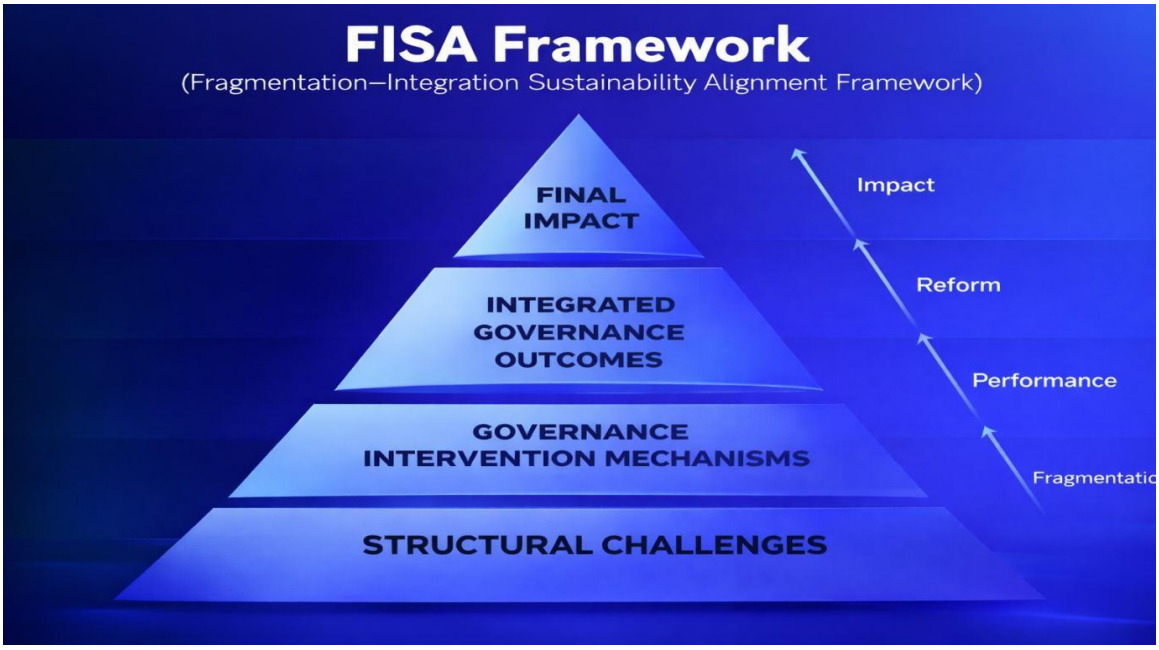
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Model designed by team using canva

- ***Structure of the Model (Four-Tier Architecture) Layer 1: Structural Challenges (Foundational Layer)***

  These represent autonomous structural barriers derived through thematic examination:

  Institutional Fragmentation, Sectoral compartmentalization, Deficient Transdisciplinary Architecture, Limited Governance Capacity Perception, Resource & Policy Mismatch

  These factors obstruct institutional coordination, prolong execution processes, and Undermine sustainability consolidation.

  Layer 2: Governance Intervention Mechanisms (Core Reform Layer)

  These act as mediating instruments to address institutional framework:

  Enhancing Metropolitan Coordinating Authority, Format Inter-Agency Sustainability committees, Integrated Budgeting Framework, Cross-Sector Information Exchange Mechanism, Participatory Governance Platforms

  These mechanisms Institutionalize collaboration and enhance inter-sectoral coherence

  Layer 3: Integrated Governance Outcomes (Intermediate Results)

  This layer captures the immediate managerial and organizational improvements that emerge once governance reform action measures are systematically operationalized.

  Better policy coordination, reduced overlapping of responsibilities, quicker decision- making, increased stakeholder trust, and better use of resources.

  This stage reflects administrative efficiency enhancement in metropolitan governance.

  Layer 4: Final Impact (Sustainability Outcomes)

  Climate flexibility, Sustainable urban systems expansion, Social equity in Urban Planning, Long-Term Metropolitan Sustainability Represents long-term transformation through integrated governance architecture.

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Conclusion:

The study examines sustainability governance of Mumbai metropolitan region by looking at integrity of climate planning, cross sector coordination, and governance capacity of collaboration by a mixed method way. It is found that sustainability objectives are highly understood by all metropolitan sectors but still their application is poorly handled because of separation of institution, mandates overlapping, and lesser coordination mechanism between multiple disciplines Governance effectivity, policy application and resource coordination are related to each other. Therefore, stronger institutional collaboration improves sustainability outcomes. Sectoral silos, improper resource alignment, and poor stakeholder participation are still major source of constraint for unified metropolitan planning. Overall, in conclusion, sustainable metropolitan development in MMR is not dependant on formation of policy or infrastructure expansion but rather on strong integrity of governance structures and formal collaboration methods. Structuring trans disciplinary governance should he addressed for better metropolitan resilience, policy constituency, and long-term urban development.

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A STUDY ON THE IMPACT OF SOCIAL MEDIA MARKETING ON CUSTOMER PURCHASE INTENTION WITH REFERENCE TO START-UPS

** Hrittika Krishna Yadav, ** Ainesh Balaji Iyer,*** Dip Nirmal Dutta, **** Aniket Mayuresh Teli & ***** Dr. Lakshita Bhagwan Soni*

* *Students*

Abstract:

In the digital era, social media marketing has emerged as a powerful promotional tool for start-ups seeking rapid growth and customer engagement. Indian start-ups increasingly rely on platforms such as Instagram, Facebook, and LinkedIn to build brand awareness and influence consumer behaviour. But in this oversaturated environment it is difficult to recognize what works and what is of utmost importance when starting with a new start-up's marketing. Through this study we try to navigate the best practices for the social media marketing of Indian start-ups. The data analysed using methods and parameters like ANOVA, correlation and Chi square. At the conclusion of the study suggestions include a standard basic model for assessment of the effectiveness of a social media campaign.

Keywords: *social media marketing, purchase intention, Indian start-ups, content quality, influencer marketing, brand engagement, consumer trust.*

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Introduction:

Marketing has always been essential for business success as it bridges products/services with customer needs, driving revenue, awareness, and loyalty across eras. Just a few years ago marketing a product meant spending a hefty amount ranging from thousands to lakhs on T.V commercials, billboards, radio, print media, etc. to launch a product, rebrand it or simply reach out to new audiences. Be it big brands like Pepsi signing megastars like Michael Jackson or AMUL running their adorable, animated campaigns it was levels impossible for a start-up to touch in their early stage. But influencing people into buying your products or services has always been the topmost priority of every enterprise, be it an established business or a fresh start-up and continues to be so. But the methods of marketing have now changed. India's total advertising expenditure crossed over 1,11,000 crores in FY2025, with digital channels now the dominant share at around 46% of total ad spend ((IBEF), 2025). A product launch that gets you visibility took lakhs and months and now it happens over a single post, that too for free. Being discovered by new audiences took years of hard work and consistency and now it comes for 3 relatable posts a day for 12 weeks in a row.

Social media contributes 40-45% of digital marketing's ROI boost in India by enabling hyper- targeted ads, viral short-form videos, and influencer partnerships. Marketing may not be easier today but is for sure more affordable

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now. But with billions of internet-connected devices worldwide, 1.5% of the world population being an influencer, and a single user coming across more than 5000 ads per day, what is to be done to sustain? With 200000+ start-ups in India with a social media account does a customer actually purchase over a post? Does the algorithm actually reward good content with the right audience? are a few important questions to ask. Through this research we try to find the answers to these questions and look for a solution that is a one stop guide to a start-up's dream to be discovered.

Statement of the Problem:

In the era of digitization, there is a visible increase in the dependency of start-ups on social media for marketing but there is a lack of a structured framework and certainty around the audience reaction to the efforts initiated. Almost all platforms for social media marketing are over saturated with content. Humongous number of users and tough competition makes visibility difficult.

Significance of the Study:

Through this study we attempt to fill the gap of lack of insights about the relationship between social media marketing and customer purchase intention. This study is of utmost importance with respect to start-ups especially in the Indian diaspora and contributes academically and practically as it presents an assessment model based on the findings in the later half of the paper.

Limitations of the Study:

- Most of what we know about social media marketing comes from studies rooted in the USA and Europe, while the Indian start-up ecosystem operates in a completely different rhythm and different consumers, with different price sensitivities, different digital behaviours, and a scale that shifts overnight.
- The sample size of the study is limited to 109 individuals because of the convenience sampling. It also leads to convenience sampling bias.
- There is a lack of cross-sectional data limitation, and the sample is student heavy.

Objectives oftThe Study:

1. To measure the impact of social media content quality on customer purchase intention among Indian start-up consumers within the study period.
2. To evaluate the influence of influencer marketing on consumer purchase intention in Indian start-ups.
3. To analyse the effect of online customer engagement on purchase intention.
4. To develop a data-driven social media marketing framework for Indian start-ups based on empirical findings.

Hypothesis oftThe Study:

H_0: Social media content quality has no significant impact on customer purchase intention

H_1: Social media content quality has a significant positive impact on customer purchase intention. H_0: Influencer marketing has no significant positive impact on customer purchase intention

H_2: Influencer marketing has a significant positive impact on customer purchase intention. H_0: Online customer engagement has no significant impact on customer purchase intention

H_3: Online customer engagement has a significant positive impact on customer purchase intention.

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Review of Literature:

1. As per author Omar Mohmmad Ali Al-Qudah's study on the effect of brands' social network content quality and interactivity on purchase intention it is clearly visible that content quality has a significant positive impact on purchase intention, meaning that better and more informative, interactive social media content helps in improving brand awareness and eventually increasing the customer purchase intention, directly and indirectly both. (Al-Qudah, 2020)
2. In the power of social media by Wenjia Huang it is made clear that a strong storytelling through your social media is necessary to strengthen connections with your customers along with user interactions. It also stresses on the importance of ethical issues in social media marketing to ensure respect and safety of consumer autonomy. It supports the assertion that quality content improves a brands relationship with its consumers. (Huang, 2024)
3. High quality social media content characterized by informativeness, visual appeal, authenticity and entertainment value enhances perceived value and trust, thereby positively influencing consumers' buying decisions. Short form video content, influencer collaborations, user generated content, live streaming are strong digital engagement strategies. It is important to maintain consumer confidence and sustainability. Together, these factors contribute to a data driven framework in which content quality, influencer partnerships and engagement activities enhance trust and brand attitude, ultimately increasing customer purchase intention. (Sheng, Ali, Ali, Razali, & Nordin, 2025)
4. In Dr. Dipika Bharti's paper on the Effect of Social Media Marketing on Consumer Purchase Intention we learn how in order to stay relevant in the age of social media it is extremely important for brands to keep adapting to changes and make improvements in their strategies to stay connected with the audiences and maintain their brand presence. It is important to take negative feedback and make necessary improvements in this constantly evolving environment (Bharti, 2024)
5. AL Hadeed, A. Y. in his study stated that due the numerous options, humongous number of users and large competition due to easy entry in marketing through social media it becomes difficult for corporates to figure out the right way to promote through social media to optimise performance instead of blindly following existing patterns. Suggesting how there is a need of a standard initial model for start-ups as wells as corporates just starting with their socials (Alhadeed & Y., 2017)
6. Digitals platforms facilitate information seeking through communities, groups, posts etc. and information seeking develops product and brand familiarity which eventually develops customer purchase intention. The more brand or vendor is trusted by their customers the more is their engagement with the product related content and interaction with the brand. Thus, trust is an important factor in taking customer purchase intention to actual buying.Continuous information seeking enhances the feeling of social presence and this sense of social presence with active participation and brand familiarity inspires purchases. (Hajli, Zadeh, Sims, & Richard, 2017)

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7. Consumer trust plays a very important part in the process of choosing which product to buy, i.e. it is an important factor in determining customer purchase intentions. It helps with gaining an edge in the market and further opportunities to grow, and this makes the product/service a sustainable deliverable. (] X. Palin Jeromina, 2024)
8. Social media positively impacts customer purchase intention by attractive media and simplified purchase patterns. Creativity and respectfulness towards consumer preferences are important factors for the same. (Mu, 2023)
9. Engagement is higher when influencers post about specific topics that match the audience's interests, rather than just broadcasting to a generic mass. For an Indian startup to drive purchase intention, it is often more effective to use a moderate-sized influencer who is seen as an expert, rather than a "mega-celebrity" who might inadvertently signal that the product is "too common." (Marijke De Veirman, 2017)

Research Methodology:

1. **Research Design**

   This study follows a Descriptive Research Design. This approach is used because our goal here is to describe the current habits, opinions, and purchase intentions of a specific group concerning social media marketing. It focuses on "what" is happening in the start-up market rather than "why."

2. **Sources of Data**

   The research relies on two types of information:

   a. Primary Data: This is the core of the study. It was collected directly from people using a structured Google Form questionnaire consisting of 20 specific marketing-related questions.

   b. Secondary Data: This includes background information gathered from academic journals, digital marketing articles, and previous studies on start-up growth to build a strong theoretical foundation.

3. **Sampling Method**

   - Target Population: The study focuses on young consumers, specifically students, who are the most active users of social media.
   - Sampling Technique: Convenience Sampling was used. This means participants were selected based on their availability and willingness to respond, allowing for a quick and efficient collection of 109 responses.
   - Sample Size: The final analysis is based on 109 valid responses.

4. **Data Collection Tool**

   The primary tool used was a Structured Questionnaire.

   Format: The survey used a 5-point Likert Scale, where 1 represents "Strongly a. Disagree" and 5 represents "Strongly Agree."

   Categories: The questions were divided into three main areas: Content Quality, Influencer Credibility, and Brand Engagement.

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1. **Data Analysis Techniques:**

To make sense of the 109 responses, the following statistical tests were applied:

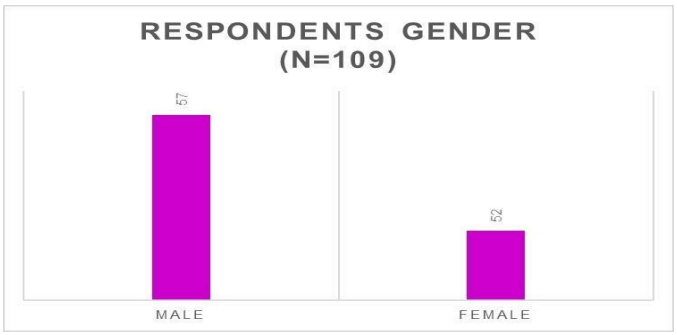
- ANOVA: Used to determine whether significant differences exist between different marketing factors.
- Correlation Analysis: Used to measure the strength and direction of relationships between variables and test their significance.
- Chi-Square Test: Used to examine whether demographic factors (e.g., gender, occupation) influence responses to marketing.
- Descriptive Statistics: Used to summarize data and identify which marketing tactics received the highest average scores.

2. **Data Processing**

The raw data from Google Forms was exported to Microsoft Excel and SPSS (Statistical Package for the Social Sciences). These programs were used to calculate the F-values, P-values, and Crosstabs necessary to prove or disprove the research hypotheses.

Data AnalysisaAnd Interpretation:

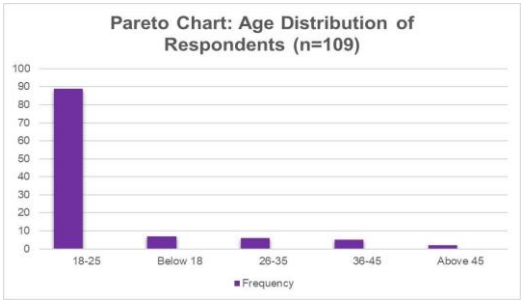
1. **GENDER DISTRIBUTION**



(Source – Primary Data)

Out of 109 respondents, 57 are male and 52 are female, showing nearly equal representation. This balanced gender distribution ensures reliable insights into how social media marketing influences customer purchase intention toward start-ups.

2. **AGE GROUP**



(Source- Primary Data)

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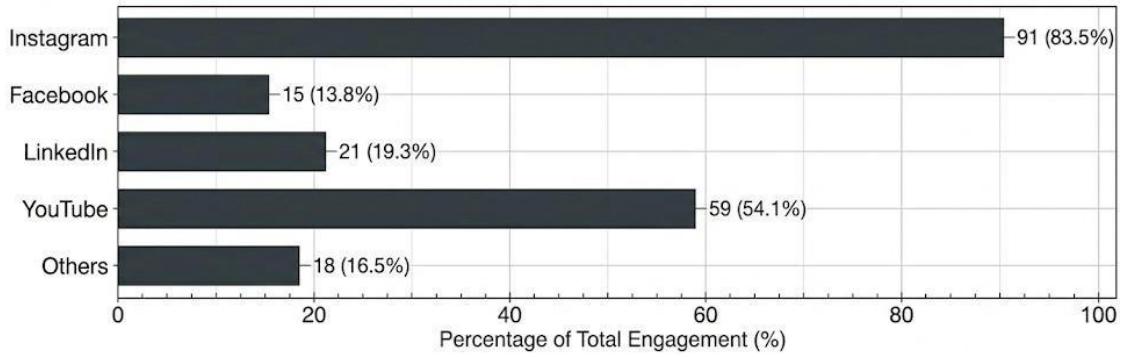
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The chart indicates that most respondents are aged 18–25, with minimal representation from other age groups. This suggests social media marketing primarily influences young consumers' purchase intention toward start-ups in the study.

3. **APPLICATION USAGE**



(Source – Primary Data)

The data shows Instagram has the highest engagement (83.5%), followed by YouTube (54.1%). LinkedIn (19.3%), Others (16.5%), and Facebook (13.8%) have significantly lower engagement among respondents overall.

4. **Content and Trust (Hypothesis 1)**

DENOTATION:

V1: Do you think the content clearly explains product benefits?

V2: Do you feel the content appears professional and well-designed?

Do you think the product information shared is transparent and detailed? V4: Do you find the content relevant to your needs?

V5: Do you feel that quality content increases your trust in the start-up? V6: Do you think the content differentiates the brand from competitors?

V7: Do you feel high-quality content increases your intention to purchase?

ANOVA

SUMMARY

Groups	Count	Sum	Average	Variance
V1	109	395	3.623853211	0.699796126
V2	109	400	3.669724771	0.575093442
V3	109	324	2.972477064	0.564050289
V4	109	405	3.71559633	0.631328576
V5	109	420	3.853211009	0.570846075
V6	109	426	3.908256881	0.732246007
V7	109	428	3.926605505	0.679748556

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	70.508519	6	11.75141983	18.47247339	4.244E-20	2.1105546
Within Groups	480.93578	756	0.636158439			
Total	551.444299	762				

(Source – Primary Data)

Variables V1-V7: The F-statistic (18.47) is much higher than the F crit (2.11), and the P-value (4.24×10^{-20}) is near zero. This indicates a highly significant difference between group means that is not due to chance.

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CORRELATION

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
V1	109	395	3.6238532	0.6997961
V2	109	400	3.6697248	0.5750934
V3	109	324	2.9724771	0.5640503
V4	109	405	3.7155963	0.6313286
V5	109	420	3.853211	0.5708461
V6	109	426	3.9082569	0.732246
V7	109	428	3.9266055	0.6797486

CORRELATION							
	Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*	*Column 7*
V1	1						
V2	0.4007758	1					
V3	0.4844533	0.390324	1				
V4	0.3808487	0.303668	0.3126047	1			
V5	0.1315792	0.302448	-0.039821	0.2845605	1		
V6	0.1583038	0.195439	0.0104421	0.0429786	0.107871	1	
V7	0.1475525	0.242247	-0.0332	0.1374528	0.473065	0.357846	1

(Source – Primary Data)

With a sample size of 109, coefficients of 0.484, 0.473, and 0.401 ($p < 0.001$) and around 0.30 ($p < 0.01$) are significant at the 5% level ($p < 0.05$); therefore, the null hypothesis is rejected. However, coefficients of 0.15 and −0.039 have $p > 0.05$ and are not significant; therefore, the null hypothesis is not rejected.

5. Influencer Impact (Hypothesis 2)

DENOTATION:

V8: Do you trust recommendations made by influencers?

V9: Do you feel influencers make startup brands appear credible? V10: Do influencer reviews influence your buying decisions?

V11: Do you feel more likely to try a product endorsed by influencers? V12: Do influencer discount codes encourage you to purchase?

V13: Do influencer promotions increase your awareness of startups?

V14: Do you feel influencer marketing increases your purchase intention?

ANOVA

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
V8	109	346	3.174311927	0.811926606
V9	109	383	3.513761468	0.659531091
V10	109	373	3.422018349	0.894325518
V11	109	363	3.330275229	0.926945294
V12	109	345	3.165137615	1.083588175
V13	109	416	3.816513761	0.540095141
V14	109	371	3.403669725	0.817023445

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	32.4587156	6	5.409785933	6.604853765	8.1E-07	2.110555
Within Groups	619.2110092	756	0.819062181			
Total	651.6697248	762				

(Source – Primary Data)

Variables V8-V14: With an F-statistic of 6.60 exceeding the F crit of 2.11 and a P-value (8.1×10^{-7}) well below 0.05, the results are statistically significant.

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CORRELATION

SUMMARY							
Groups	*Count*	*Sum*	*Average*	*Variance*			
V8	109	346	3.174312	0.811927			
V9	109	383	3.513761	0.659531			
V10	109	373	3.422018	0.894326			
V11	109	363	3.330275	0.926945			
V12	109	345	3.165138	1.083588			
V13	109	416	3.816514	0.540095			
V14	109	371	3.40367	0.817023			
CORRELATION							
	Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*	*Column 7*
V8	1						
V9	0.342048	1					
V10	0.477627	0.374856	1				
V11	0.380033	0.235587	0.438784	1			
V12	0.324403	0.204325	0.585083	0.322742	1		
V13	0.146623	0.200287	0.357647	0.472743	0.427285	1	
V14	0.333439	0.383088	0.507372	0.399662	0.341807	0.377369	1

(Source – Primary Data)

With a sample size of 109 (V8–V14), coefficients of 0.586, 0.507, 0.478, 0.473, and 0.439 ($p < 0.001$) and 0.32–0.38 ($p < 0.01$) are significant at the 5% level; therefore, the null hypothesis is rejected. However, coefficients of 0.146 and 0.200 have $p > 0.05$ and are not significant; therefore, the null hypothesis is not rejected.

6. Engagement and Loyalty (Hypothesis 3)

DENOTATION:

V15: Do you trust brands with high engagement (likes/shares)? V16: Do positive comments influence your buying decision?

V17: Do quick responses by brands improve your perception? V18: Do you find actively engaging brands more trustworthy? V19: Do live sessions or webinars increase your interest?

V20: Do you feel engagement improves your loyalty to the brand?

ANOVA

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
V15	109	400	3.669724771	0.72324159
V16	109	423	3.880733945	0.828236493
V17	109	423	3.880733945	0.698606864
V18	109	406	3.724770642	0.664288141
V19	109	366	3.357798165	0.917091403
V20	109	417	3.825688073	0.719334013

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	21.4204893	5	4.284097859	5.648368551	4.1519E-05	2.227931286
Within Groups	491.4862385	648	0.758466417			
Total	512.9067278	653				

(Source – Primary Data)

Variables V15-V20: The F-statistics (5.65) is greater than the F crit (2.23) with a P-value of 0.00004, confirming that the differences between these group means are statistically significant.

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CORRELATION

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
V15	109	400	3.66972	0.72324
V16	109	423	3.88073	0.82824
V17	109	423	3.88073	0.69861
V18	109	406	3.72477	0.66429
V19	109	366	3.3578	0.91709
V20	109	417	3.82569	0.71933

CORRELATION						
	Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*
V15	1					
V16	0.35539	1				
V17	0.3088	0.45586	1			
V18	0.29511	0.47962	0.34553	1		
V19	0.44204	0.09191	0.06537	0.11547	1	
V20	0.39442	0.29671	0.19245	0.34519	0.3397	1

(Source – Primary Data)

With a sample size of 109 (V15–V20), coefficients of 0.480, 0.456, 0.442, and 0.394 ($p < 0.001$) and 0.30–0.35 ($p < 0.01$) are significant at the 5% level; therefore, the null hypothesis is rejected. However, coefficients of 0.091 and 0.065 have $p > 0.05$ and are not significant; therefore, the null hypothesis is not rejected.

7. Demographic Insights (Chi-Square)

The Chi-Square tests reveal how different groups interact with your variables.

Testing across multiple variables generally shows P-values above 0.05. This indicates that male and female students perceive these marketing efforts in a similar way. The tests suggest that being a student vs. working does not significantly change the reaction to startup marketing in this specific sample.

Age Chi-Square Test

Table No. 4.2.2.4 Age Chi-Square Test

Variable		Pearson Chi-Square	Likelihood Ratio	Linear-by-Linear Association	N of Valid Cases
	DF	15 / 20	15 / 20	1	
Variable 001	Value	11.775•	14.238	.272	109
	Asymp. Sig. (2-sided)	.696	.508	.602	109
Variable 002	Value	10.468•	13.633	.648	109
	Asymp. Sig. (2-sided)	.789	.554	.421	109
Variable 003	Value	8.344•	11.080	.303	109
	Asymp. Sig. (2-sided)	.909	.747	.582	109
Variable 004	Value	8.027•	12.068	.000	109
	Asymp. Sig. (2-sided)	.923	.674	.996	109
Variable 005	Value	11.293•	13.843	.140	109
	Asymp. Sig. (2-sided)	.938	.838	.709	109
Variable 006	Value	11.715•	13.315	.027	109
	Asymp. Sig. (2-sided)	.700	.578	.870	109
Variable 007	Value	34.920•	18.895	4.576	109
	Asymp. Sig. (2-sided)	.021	.529	.032	109
Variable 008	Value	11.616•	13.920	1.203	109
	Asymp. Sig. (2-sided)	.929	.835	.273	109
Variable 009	Value	24.279•	28.734	3.544	109
	Asymp. Sig. (2-sided)	.061	.017	.060	109
Variable 010	Value	15.825•	17.401	.470	109
	Asymp. Sig. (2-sided)	.727	.627	.493	109
Variable 011	Value	14.292•	14.495	.497	109
	Asymp. Sig. (2-sided)	.815	.805	.481	109
Variable 012	Value	12.013•	13.689	.017	109
	Asymp. Sig. (2-sided)	.916	.846	.897	109
Variable 013	Value	22.033•	14.756	1.475	109
	Asymp. Sig. (2-sided)	.107	.469	.225	109
Variable 014	Value	16.587•	18.041	1.098	109
	Asymp. Sig. (2-sided)	.680	.585	.295	109
Variable 015	Value	11.756•	13.570	.515	109
	Asymp. Sig. (2-sided)	.924	.852	.473	109
Variable 016	Value	26.237•	20.029	2.050	109
	Asymp. Sig. (2-sided)	.158	.456	.152	109
Variable 017	Value	25.943•	20.979	1.460	109
	Asymp. Sig. (2-sided)	.168	.398	.227	109
Variable 018	Value	14.788•	18.735	.042	109
	Asymp. Sig. (2-sided)	.788	.539	.838	109
Variable 019	Value	14.037•	16.559	2.335	109
	Asymp. Sig. (2-sided)	.829	.681	.126	109
Variable 020	Value	13.356•	14.970	.000	109
	Asymp. Sig. (2-sided)	.862	.778	.989	109

(Source- Primary Data)

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Occupation Chi-Square Test

Table No. 4.2.2.5 Occupation Chi-Square Test

Variable		Pearson Chi-Square	Likelihood Ratio	Linear-by-Linear Association	N of Valid Cases
	DF	9 / 12	9 / 12	1	
Variable 001	Value	7.683•	10.947	.318	109
	Asymp. Sig. (2-sided)	.566	.279	.573	109
Variable 002	Value	7.978•	10.058	.000	109
	Asymp. Sig. (2-sided)	.536	.346	.986	109
Variable 003	Value	9.627•	10.628	2.571	109
	Asymp. Sig. (2-sided)	.382	.302	.109	109
Variable 004	Value	6.928•	5.726	.235	109
	Asymp. Sig. (2-sided)	.645	.767	.628	109
Variable 005	Value	6.908•	8.027	.424	109
	Asymp. Sig. (2-sided)	.864	.783	.515	109
Variable 006	Value	6.950•	8.310	.009	109
	Asymp. Sig. (2-sided)	.642	.503	.926	109
Variable 007	Value	3.984•	5.769	1.450	109
	Asymp. Sig. (2-sided)	.984	.927	.229	109
Variable 008	Value	6.704•	8.882	.057	109
	Asymp. Sig. (2-sided)	.877	.713	.812	109
Variable 009	Value	10.288•	9.842	2.209	109
	Asymp. Sig. (2-sided)	.328	.363	.137	109
Variable 010	Value	6.581•	8.901	.024	109
	Asymp. Sig. (2-sided)	.884	.711	.876	109
Variable 011	Value	11.075•	14.399	.159	109
	Asymp. Sig. (2-sided)	.523	.276	.690	109
Variable 012	Value	11.556•	11.627	1.818	109
	Asymp. Sig. (2-sided)	.482	.476	.178	109
Variable 013	Value	5.988•	5.790	.445	109
	Asymp. Sig. (2-sided)	.741	.761	.505	109
Variable 014	Value	5.392•	8.050	.877	109
	Asymp. Sig. (2-sided)	.944	.781	.349	109
Variable 015	Value	9.145•	11.343	.584	109
	Asymp. Sig. (2-sided)	.690	.500	.445	109
Variable 016	Value	7.102•	9.211	.592	109
	Asymp. Sig. (2-sided)	.851	.685	.442	109
Variable 017	Value	6.060•	7.667	.409	109
	Asymp. Sig. (2-sided)	.913	.811	.523	109
Variable 018	Value	6.498•	8.255	.814	109
	Asymp. Sig. (2-sided)	.889	.765	.367	109
Variable 019	Value	33.238•	14.011	1.207	109
	Asymp. Sig. (2-sided)	<.001	.300	.272	109
Variable 020	Value	4.133•	5.548	.111	109
	Asymp. Sig. (2-sided)	.981	.937	.738	109

(Source- Primary Data)

Gender Chi-Square Test

Table No. 4.2.2.3 Gender Chi-Square Test – Social Media Marketing Variables

Variable		Pearson Chi-Square	Likelihood Ratio	Linear-by-Linear Association	N of Valid Cases
`	DF	3 / 4	3 / 4	1	
Variable 001	Value	2.782•	2.873	1.555	109
	Asymp. Sig. (2-sided)	.426	.412	.212	109
Variable 002	Value	5.948•	6.357	4.981	109
	Asymp. Sig. (2-sided)	.114	.095	.026	109
Variable 003	Value	2.514•	2.544	2.022	109
	Asymp. Sig. (2-sided)	.473	.467	.155	109
Variable 004	Value	5.592•	5.830	.036	109
	Asymp. Sig. (2-sided)	.133	.120	.849	109
Variable 005	Value	1.152•	1.536	.447	109
	Asymp. Sig. (2-sided)	.886	.820	.504	109
Variable 006	Value	2.190•	2.232	.714	109
	Asymp. Sig. (2-sided)	.534	.526	.398	109
Variable 007	Value	4.480•	4.524	.036	109
	Asymp. Sig. (2-sided)	.345	.340	.849	109
Variable 008	Value	5.015•	5.118	1.666	109
	Asymp. Sig. (2-sided)	.286	.275	.197	109
Variable 009	Value	2.602•	2.761	.569	109
	Asymp. Sig. (2-sided)	.457	.430	.451	109
Variable 010	Value	3.448•	3.469	.644	109
	Asymp. Sig. (2-sided)	.486	.483	.422	109
Variable 011	Value	2.416•	2.460	.284	109
	Asymp. Sig. (2-sided)	.660	.652	.594	109
Variable 012	Value	8.144•	8.414	4.557	109
	Asymp. Sig. (2-sided)	.086	.078	.033	109
Variable 013	Value	9.203•	9.694	8.940	109
	Asymp. Sig. (2-sided)	.027	.021	.003	109
Variable 014	Value	2.077•	2.093	.178	109
	Asymp. Sig. (2-sided)	.722	.719	.673	109
Variable 015	Value	2.483•	2.880	.744	109
	Asymp. Sig. (2-sided)	.648	.578	.388	109
Variable 016	Value	3.157•	3.583	.028	109
	Asymp. Sig. (2-sided)	.532	.465	.866	109
Variable 017	Value	5.904•	6.556	5.054	109
	Asymp. Sig. (2-sided)	.206	.161	.025	109
Variable 018	Value	1.260•	1.644	.005	109
	Asymp. Sig. (2-sided)	.868	.801	.941	109
Variable 019	Value	5.378•	5.856	1.260	109
	Asymp. Sig. (2-sided)	.251	.210	.262	109
Variable 020	Value	6.928•	7.860	.792	109
	Asymp. Sig. (2-sided)	.140	.097	.374	109

(Source- Primary Data)

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Summary:

It is clear that visual professionalism catches the eye, but active engagement and social proof keep the customer. The above data shows that while influencers are excellent for reaching new audiences and getting your potential customers to visit your store profile, but they are not the primary reason they choose to trust or stick with a startup brand. Though they significantly contribute to making a customer want to buy your product/services they solely cannot get them to click buy. But this gap is bridged through the next step, that is customer engagement and active social media presence, this is where we see true customer trust and connection build, which is the most essential part of any brand's final sales. It is visible that most of the social media strategies have the same impact on both the genders almost similarly and same goes for the working and student population.

Suggestions:

Startups can assess and evaluate the effectiveness of their social media campaign through the "C.O.N.N.E.C.T." model created based on the findings of this study.

C: Creative

It is observed that creativity and uniqueness are important when it comes to turning the content engaging and forming a connection with the audience while making the product standout.

O: Omni-channel

Omni-channel representation of the product is important to reach a wider pool of audience and also making the distribution of the product easier as it is convenient to seek information and make a purchase.

N: Niche

Choosing a niche when designing the product campaign is important to narrow down the prospective customer base thus making it easier to relate to the campaign's story while also making the product feel exclusive, which has been proven to improve the customer purchase intention.

N: Narrative

Setting the right narrative for the product is important to reach the right audience. This can be done by choosing relevant influencer collaborations and creating right copy of marketing.

E: Engaging

The social media campaigns must be engaging i.e. interactive with the audience not just in terms of the creatives posted but also with respect to other parameters like lives, stories, likes, comments, shares, reposts etc. And community building. Using smart strategies for audience engagement is an essential part of any good social media marketing campaign.

C: Conversion

The process of designing a campaign is incomplete without strategically placed call-to-action (CTA).

T: Trustworthy

Trust is the most important factor among the ones acting as a bridge between customer purchase intention and actual buying behavior. Authentic content, ethical marketing and transparency are few important factors for building trust among your customers.

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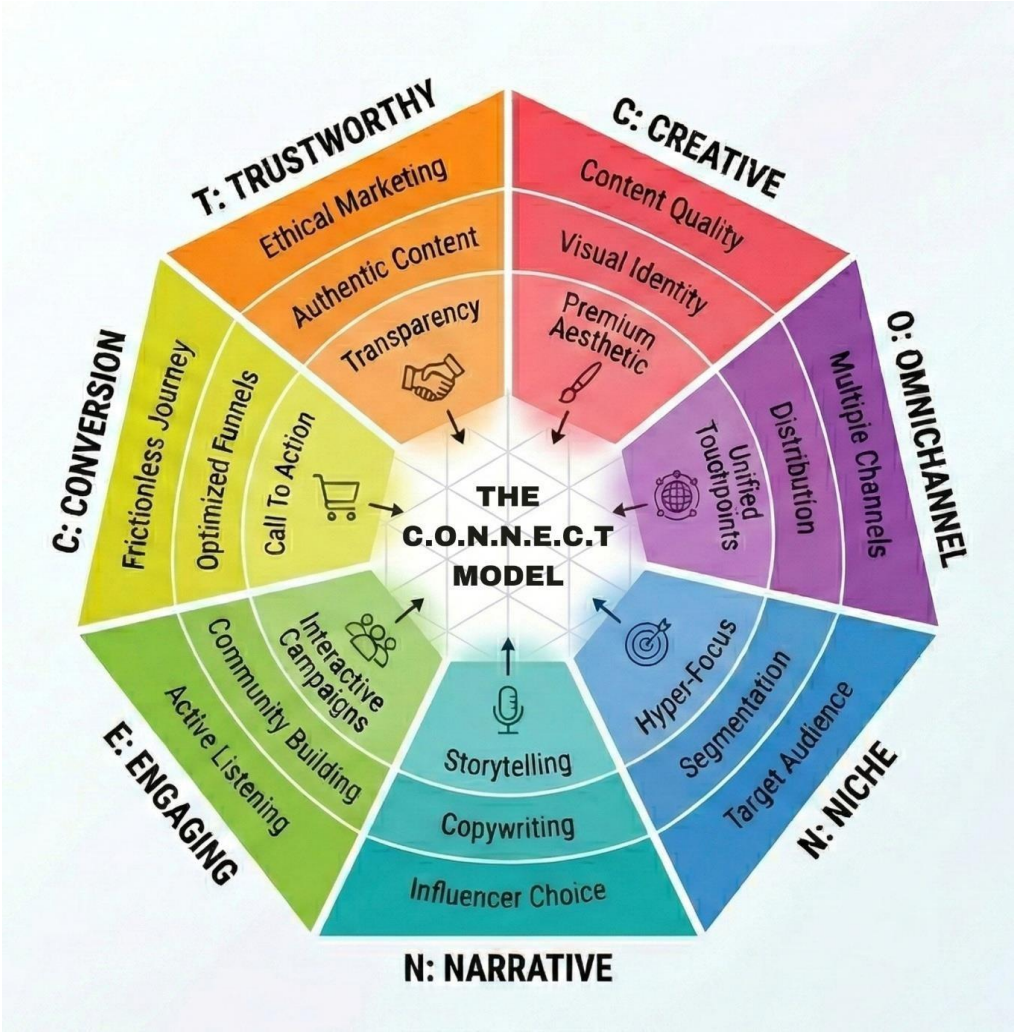
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It is represented by the following chart :-



THE C.O.N.N.E.C.T MODEL

(Source- Self-made from the findings of the Research)

Conclusion:

The research confirms that social media marketing significantly dictates the purchase intentions of the across different demographics especially the student group. Quality of the content posted positive impacts a customer's perception about a brand. Influencer marketing serves as a successful tool for brand differentiation and initial attraction. Influencers effectively expand brand reach and awareness, yet they do not independently secure consumer trust. The statistical evidence proves that the strongest link to customer loyalty lies in active brand engagement and the presence of positive social proof. For a startup to achieve consistent sales performance, it must move beyond mere visibility and focus on building a responsive, interactive, and transparent digital presence.

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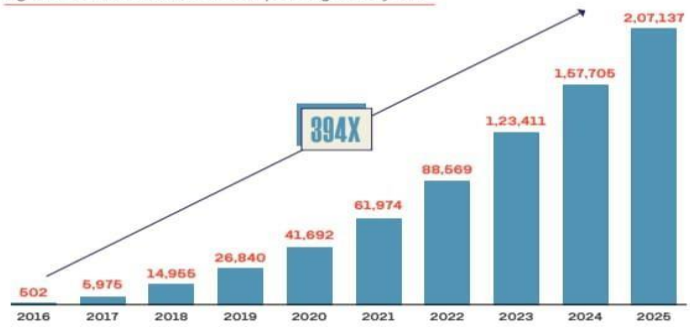
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Figure 1: Year-wise number of Startups recognized by DPIIT



(Source: DPIIT)

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EMOTION-TO-ACTION IN THE AGE OF DIGITAL TRANSFORMATION: A NEURO-EMOTIONAL FRAMEWORK TO IMPROVE GEN Z PERFORMANCE

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******* Jay Prakash Prajapati & ***** Dr. Sadhana Kapote***

* *Students*

Abstract:

This study examines how emotional patterns and cognitive processes influence learning efficiency among Generation Z students and teachers within modern educational institutions. It proposes a Structured Equation framework integrating core emotional-cognitive learning constructs to understand their collective impact on academic outcomes. A descriptive and applied research design with a mixed-method approach was adopted using purposive sampling techniques. Data were collected from 130 management students and 20 teachers in the KDMC region through structured questionnaires and interviews. Statistical tools including correlation, paired t-test and Single ANOVA were applied for analysis. The study further introduces the conceptual ECF-WR model and proposes an AI-based application to enhance emotional regulation, engagement and overall academic performance.

Keywords: *Gen-Z, Emotional Supply Chain, Neuro Behavioural, Thinking Patterns, Educational Institution.*

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Introduction:

This study examines the growing generational gap between teachers and students, particularly in understanding emotional experiences in academic settings. Differences in communication styles, expectations and emotional expression often hinder engagement and learning outcomes. The research identifies students' concerns and maps their emotional flow through systematic data collection and analysis. By treating emotions as measurable units, patterns were identified to assess their impact on academic performance. Based on these findings, an AI-based application is proposed to bridge the gap and promote healthier teacher–student interactions.

Problem Statement:

Due to a prevailing generational gap between Gen Z learners and teachers from earlier generations, there is often a lack of understanding and responsiveness towards students' psychological and emotional needs.This disconnect not only leads to the use of traditional teaching methods but also affects behavioural approaches in academic settings.These approaches do not align with contemporary learning styles, resulting in reduced engagement, ineffective communication, and limited academic growth.

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Significance of Study:

This research is significant as it moves beyond traditional academic metrics by recognizing emotions as measurable drivers of learning efficiency. By examining emotional triggers, cognitive appraisal, regulation mechanisms and engagement patterns, the study provides evidence that emotional energy directly influences academic performance in structured ways. The ECF-WR conceptual model offers a framework to identify emotional waste, optimize emotional capital and improve learning consistency. Additionally, the proposed AI-based application converts these insights into practical solutions, enabling data-driven emotional management, stronger engagement and a more efficient and sustainable academic ecosystems.

Limitations:

Though our study provides valuable key insights it has some limitations that can be considered.

- The proposed research was conducted on a sample size of 150 people in Management domain from KDMC region. However, it can be done on larger sample size from a greater sample space to provide deeper insights.
- The application was tested within a specific academic context and age group, which may limit immediate generalizability. However, this focused scope allowed for deeper contextual insights and stronger internal validity.

Objectives:

- To study the impact of emotional dynamics on academic productivity and classroom behaviour among Generation Z students.
- To evaluate the role of emotional intelligence and psychological awareness training in improving teachers' ability to manage students' emotional transitions.
- To understand whether Stress processing varies as a function of neuro-emotional behavior across individuals.
- To examine the influence of integrated emotional-cognitive regulatory factors on students' learning efficiency and to suggest an AI-based application to monitor and regulate these factors for improved academic outcomes.

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Review of Literature:

Author(s)	Year	Title of the Study	Key Findings	Research Gap Identified	Gap Filled by Present Study
Bandari, M. & Zheng, X.	2024	Academic Stress & Mental Well-Being in College Students	Higher academic stress significantly reduces engagement and overall mental well-being. Emphasizes coping strategies and institutional mental health support.	Does not conceptualize stress as a dynamic neuro-emotional process or examine long-term classroom efficiency impact.	Our Models stress within a Neuro- Emotional Flow framework, identifies burnout zones, and integrates stress processing into the Emotional Supply Chain and SEQ model to explain learning efficiency among Gen Z students.
Einav, M., Confino, D., Margalit , M., & Geva, N.	2024	Teachers' Burnout – The Role of Social Support, Gratitude, Hope, Entitlement and Loneliness	Social support, gratitude, and hope reduce burnout; loneliness and entitlement increase emotional exhaustion. Teacher burnout affects classroom climate and effectiveness.	Treats burnout as an individual outcome rather than a systemic factor influencing student emotional energy and engagement.	The Study teacher emotional states within an Emotional Supply Chain framework, examines emotional spillover effects, and structurally links teacher burnout to student engagement and academic efficiency in the SEQ model.
Gaikwad , A.	2023	Neurological Basis of Emotion, Learning & Memory	Emotional arousal enhances neuroplasticity, reward circuit activation, and memory.	Remains theoretical; does not apply neuro-emotional principles within Classrooms	Embeds neuro- emotional mechanisms into measurable constructs within a structured Emotional Supply Chain and SEQ framework to enhance classroom efficiency and well- being.
Zhang, H., Liu, Y., Jiang, M., Chen, J., Wang, M., & Paas, F.	**2025**	Emotional Artificial Intelligence in Education: A Systematic Review and Meta-Analysis	AI systems detecting emotional states and providing cognitive guidance significantly improve knowledge acquisition, motivation, and affective outcomes.	Does not integrate AI monitoring within a broader classroom emotional ecosystem including teacher-student interactions.	Proposes an AI- enabled monitoring application grounded in the Emotional Supply Chain model to regulate emotional-cognitive factors and improve academic performance.
Zheng, Y. & Xiao, A.	**2024**	A Structural Equation Model of Online Learning: Investigating Self-Efficacy, Informal Digital Learning, Self- Regulated Learning, and Course Satisfaction	Demonstrates how interconnected psychological constructs influence learning outcomes using SEM and validated model fit indices.	Focuses mainly on cognitive and motivational constructs; does not integrate emotional flow, stress processing, or teacher- student dynamics.	Extends SEM approach to develop a comprehensive SEQ model integrating emotional energy, stress processing, teacher emotional spillover, and digital regulation to predict learning efficiency.

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Research Methodology:

A) Structure:

The study adopts a multidisciplinary framework by integrating concepts from psychology, behavioural science and sociology. It also incorporates technology by proposing an AI-driven application.

B) Design:

The study follows an applied research design as all the findings related to students' emotional triggers, recovery duration, behavioural habits, burnout tendencies are utilised and transformed into practical actionable solutions aimed at improving overall well-being.

C) Nature:

The proposed research is descriptive in nature as it collects and presents first hand insights into how students perceive and manage their emotional energy within the academic environment.

D) Approach:

The study employs a mixed method approach. Both qualitative and quantitative research techniques have been used.The qualitative approach focuses on understanding students' emotional journey within the academic environment. Data from teachers have also been considered to understand whether adequate training to cope up with students not just academically but also in addressing students' psychological needs is provided within institutions or not.While the quantitative approach focuses on collecting data through structured questionnaires, analysing and intrepreting it.

E) Data Collection:

1. **Primary Data**:

A) *Online Survey and Questionaire:*

Primary data was collected through a structured online questionnaire circulated via Google Forms. The survey received an impressive response of 150 respondents from the KDMC region, including 30 teachers and 120 students.Separate sets of questions were designed for students and teachers to ensure accuracy of responses.The questionnaire included both closed-ended questions (Likert scale and multiple-choice) and open-ended questions.A pre- training session was also conducted with teachers to gain primary inputs which helped in refining the questionnaire.

Questionnaire Development:

To test the validity of the instrument, Cronbach's Alpha , Split Half and Spearman Brown's tests were calculated. The values of which were 0.84,0.71 and 0.83 respectively making the questionnaire correlated and reliable.

Sampling Technique:

A purposive sampling method was adopted for the study as only management students and teachers were taken into consideration to obtain subject-specific insights.

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B) ***Interview Method:***

The interview method was also used to collect qualitative insights from professional psychologist, Mrs. Namrata Chandwadkar associated with Mpower (Aditya Birla Education Trust). The discussion focused on common psychological concerns faced by college students and frequency of student visits along with recurring cases. The interviews also explored whether teachers seek psychological guidance for handling student-related concerns and whether an AI-based emotional tracking application could contribute positively.



(Source: Primary Data –Expert Inrterview)

Data Analysis Tools and Statistical Tests:

Data was analysed using statistical techniques like correlation analysis, paired t-test and single-factor ANOVA across MS EXCEL and Structured Equation Modelling was performed using AMOS.

2. Secondary Data:

Secondary data was collected from research papers available on DELNET, INFLIBNET and Google search. Relevant articles, journals, books and reports along with YouTube videos and blogs, were also reviewed to support the research.

Hypothesis:

H0: There is no significant correlation between classroom behavior and academic productivity.

H1: There is a significant correlation between classroom behavior and academic productivity.

H0: Emotional intelligence and psychological awareness training does not significantly improve teachers' ability to manage students' emotions.

H2: Emotional intelligence and psychological awareness training significantly improves teachers' ability to manage students' emotions.

H0: Stress processing does not vary as a function of neuro-emotional behavior across individuals.

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H3: Stress processing varies as a function of neuro-emotional behavior across individuals.

Data Analysis:

Hypothesis 1

Objective - *To study the co-relation between academic productivity and classroom behaviour among Generation Z students.*

Question - When emotionally exhausted, are your study habits affected the most?

CO-RELATION TEST	ACADEMIC PRODUCTIVITY	CLASSROOM BEHAVIOUR
ACADEMIC PRODUCTIVITY	01	0.647
CLASSROOM BEHAVIOUR	0.647	01

(Source: Primary Data -Online Questionnaire)

Interpretation: Since the co-relation value achieved was 0.647, we conclude that the classroom behaviour and academic productivity are moderately correlated.

Thus, we accept the alternate Hypothesis (H1) that is, There is a significant relationship between students' emotional state and their academic productivity and classroom behaviour

Hypothesis 2

Objective - *To evaluate the role of emotional intelligence and psychological awareness training in improving teachers' ability to manage students' emotional transitions.*

Question - 1. How much difficulty do you face while handling the Gen Z students in your class? (PRE-TRAINING)

How much difficulty do you face while handling the Gen Z students in your class? (POST-TRAINING)

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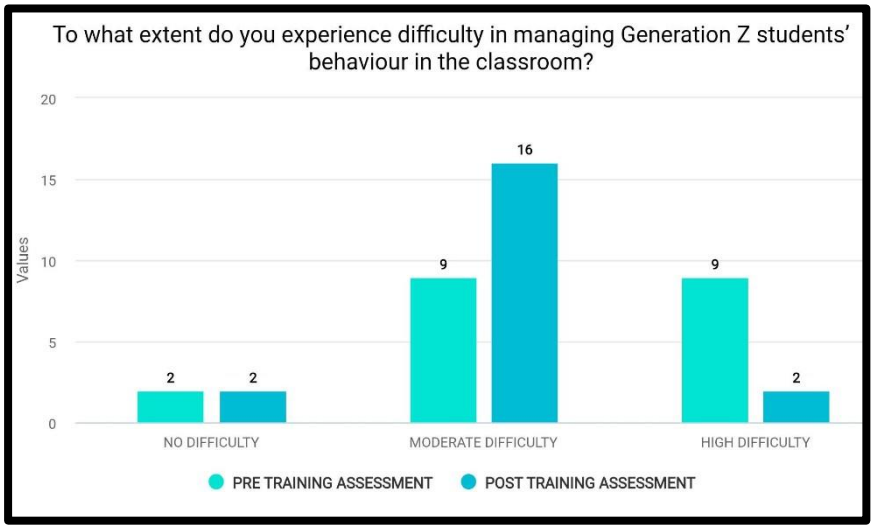
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(Source: Primary Data -Online Questionnaire)

t-Test: Paired Two Sample for Means

	Pre- Training	*Post - Training*
Mean	1.65	2
Variance	0.45	0.2105263158
Observations	20	20
Pearson Correlation	0.6839855681	
Hypothesized Mean Difference	0	
df	19	
t Stat	-3.198557367	
P(T<=t) one-tail	0.0023647293	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.0047294587	
t Critical two-tail	2.093024054	

As P valus is less than 0.05 we accept H1

Interpretation: From the Data collected 9 Teachers faced High Difficulty before the training whereas only 2 teachers faced High Difficulty after the training was provided. This shows that there is a significant increase in understanding the behaviour of GenZ Students when the teachers are provided with emotional intelligence and psychological awareness training. On performing The PAIRED T-TEST we get the P-value less than 0.05.Thus, we accept the alternate Hypothesis (H2) that is, Emotional intelligence and psychological awareness training significantly improves teachers' ability to manage students' emotions.

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Hypothesis 3

Objective - *To understand whether Stress processing varies as a function of neuro-emotional behaviour across individuals.*

Question -

(Cognitive Distortions based on Situations)

If I fail at one task, I feel like a complete failure.

I often anticipate the worst-case scenario in situations.

I assume I know what others are thinking about me without proof. I overgeneralize based on a single negative experience.

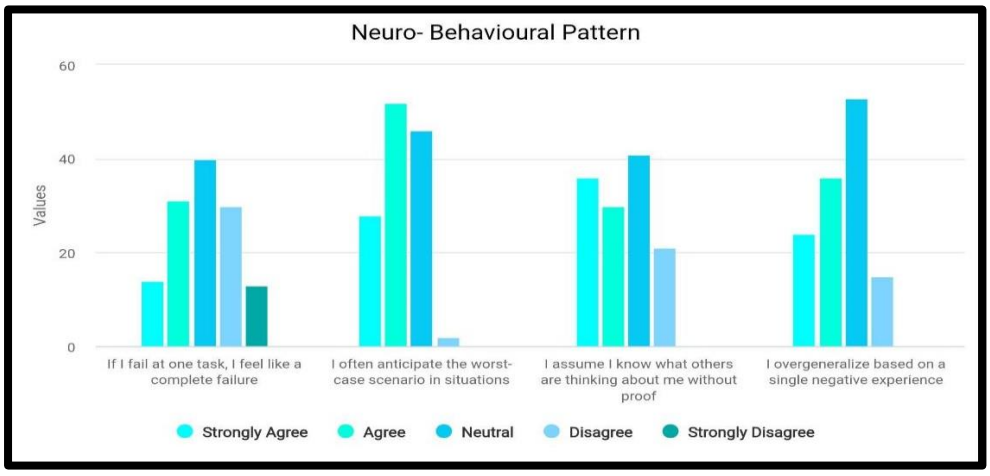
Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
complete failure	128	387	3.023437	1.330155
I often anticipate the wor	128	490	3.828125	0.615895
I assume I know what otl	128	465	3.632812	1.131828
I overgeneralize based o	128	453	3.539062	0.864603

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	45.28710	3	15.09570	15.31593	0.0023	2.622452
Within Groups	500.6953	508	0.985620			
Total	545.9824	511				



(Source: Primary Data -Online Questionnaire)

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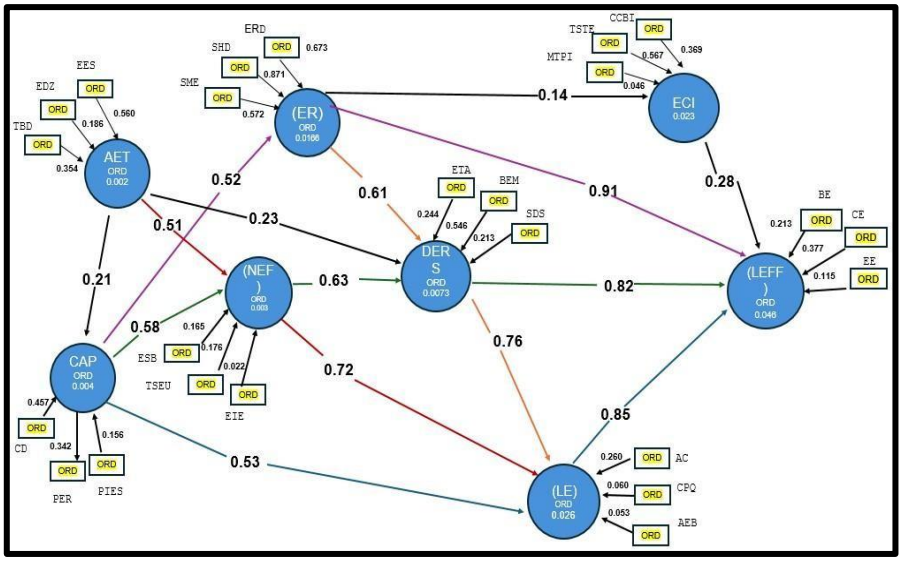
Interpretation: Here we have given different situations to different people, where different people processed stress differently. For instance, a person who over-generalize based on a single experience might not often anticipate the worst and a person anticipating the worst might not over-generalize things.

After running the ANOVA TEST on the collected data the P-value was 0.0023 which is less than 0.05. Thus, we conclude with our alternate Hypothesis(H3)

i.e Stress processing varies as a function of neuro-emotional behavior across individuals.

Structured Equation Modelling:

Objective - *To examine the influence of integrated emotional-cognitive regulatory factors on students' learning efficiency and to suggest an AI-based application to monitor and regulate these factors for improved academic outcomes.*



MAIN VARIABLE	SUB VARIABLES
AET	EES-EMOTIONAL ENERGY SOURCES EDZ-EMOTIONAL DRAIN ZONE TBD-TIME BASED EMOTIONAL DRAIN
CAP	CAP-COGNINITIVE DISORTIONS PER-PERCEIGED EMOTIONAL RECOVERY PIES-PERCEIVED INSTITUTIONAL EMOTIONAL SUPPORT
NEF	ESB-EMOTIONAL SPILLOVER BEHAVIOUR TSEU-TEACHER STUDENT EMOTIONAL UNDERSTANDING EIE-EMOTIONAL IMPACT ON ENGAGEMENT
ER	ERB- EMOTIONAL RECOVERY DURATION SHD-STUDY HABIT DISRUPTION SME-SELF MOTIVATION ENERGY
ECI	CCBI- CROSS CONTEXT BEHAVIOURAL IMPACT TSTE- TEACHER STUDENT TRUST AND EXPRESSION MTPI- MOTIVATION THEORUGH POSITIVE INTERACTION
DERS	ETA-EMOTIONAL TRACKING EXPERIENCE BEM-BELIEF IN EMOTIONAL ENERGY SDS-SUGGESTED DIGITAL SOLUTIONS
LEFF	AC- ACADEMIC CONSISTENCY CAP-COGNINITIVE PERFORMANCE QUALITY AEB-ACADEMIC ENGAGEMENT BEHAVIOUR
LE	BE- BEHAVIOURAL ACADEMIC ENGAGEMENT CE-COGNITIVE ACADEMIC ENGAGEMENT EE-EMOTIONAL ACADEMIC ENGAGEMENT

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PATHWAY	VALUE FOR PATHWAY	HYPOTESIS	INTERPRETATION
CAP → ER → LEFF (Pink)	0.5 , 0.91	H4: Emotional Regulation mediates the relationship between Cognitive Appraisal Process and Learning Efficiency among Gen-Z students.	Supported
CAP →NEF → DERS → LEFF (Green)	0.58 , 0.63, 0.82	H5: Neuro-Emotional Flow (NEF) and Digital Regulatory System (DERS) sequentially mediate the relationship between Cognitive Appraisal Process (CAP) and Learning Efficiency	Supported
CAP → LE → LEFF (Blue)	0.53, 0.85	H6:Learning Engagement (LE) significantly mediates the relationship between Cognitive Appraisal Process (CAP) and Learning Efficiency (LEFF).	Supported
ER → DERS → LE → LEFF	0.61, 0.63, 0.85	H7: Digital Regulatory System (DERS) and Learning Engagement (LE) sequentially mediate the	Supported
(Orange)		relationship between Emotional Regulation (ER) and Learning Efficiency (LEFF).	
AET → NEF → LE → LEFF (Red)	0.51, 0.72, 0.85	H8: Neuro-Emotional Flow (NEF) and Learning Engagement (LE) sequentially mediate the relationship between Academic Emotional Triggers (AET) and Learning Efficiency (LEFF).	Supported

Interpretation of Hypothesis Result:

H4: CAP → ER → LEFF (pink)

The path Co-efficient (0.50) and (0.91) suggests that there is a very strong positive relationship between Cognitive Appraisal Process (CAP) and Learning Efficiency (LEFF) mediated by Emotional Regulation (ER). This suggests that thinking patterns shape how people regulate their emotions, and emotional regulation ultimately determines learning efficiency.

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H5: CAP → NEF → DERS → LEFF (green)

The path Co-efficient (0.58) , (0.63) & (0.82) suggests that there is a strong positive relationship between Cognitive Appraisal Process (CAP) and Learning Efficiency (LEFF) mediated by Neuro-Emotional Flow(NEF) and Digital Regulatory System (DERS). This suggests that a digital system that monitors the neuro-emotional flow improves the learning efficiency of GENZ students.

H6: CAP → LE → LEFF (blue)

The path Co-efficient (0.53) & (0.85) suggests that there is a strong positive relationship between Cognitive Appraisal Process (CAP) and Learning Efficiency (LEFF) mediated by Learning Engagement (LE) . This implies that students' thinking patterns influence their academic engagement, and higher engagement significantly enhances learning efficiency .

H7: ER → DERS → LE → LEFF (orange)

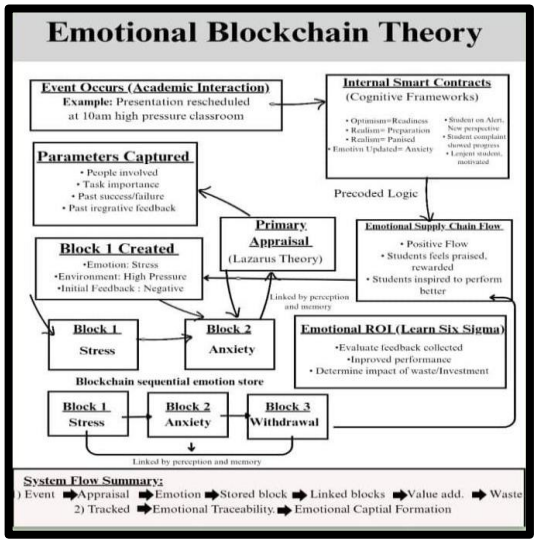
The path Co-efficient (0.61) , (0.63) & (0.85) suggests that there is a strong positive relationship between Emotional Regulation(ER) and Learning Efficiency (LEFF) mediated by Digital Regulatory System (DERS) and Learning Engagement (LE). This indicates that students who are able to regulate their emotions utilize Digital Regulatory Systems as a supportive tool which strengthens their learning engagement and theory by increase learning efficiency

H8: AET → NEF → LE → LEFF (red)

The path Co-efficient (0.51) , (0.72) & (0.85) suggests that there is a strong positive relationship between Academic Emotional Triggers (AET) and Learning Efficiency (LEFF) mediated by Neuro-Emotional Flow(NEF) and Learning Engagement (LE). This means that academic emotional incidents affect the emotional flow of students , which influences their engagement in class and thereby affect the learning efficiency.

EMOTIONAL CAPITAL FLOW WASTE:

REDUCTION MODEL



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Based on the structured questionnaire, several recurring emotional patterns were observed:
Emotional responses were not triggered merely by events but by interpretations of those events.
The following three Theories lay the foundation of the The ECFWR Model

1. **Cognitive Appraisal Theory:**
   It states that emotions rise from an individual's interpretation of events rather than from the events themselves.Within the Emotional Blockchain Model, this theory defines how emotional "blocks" are created.
2. **Circadian Rhythm Theory:**
   It explains the biological timing factor behind emotional reactions i.e., how the same event can create different emotional intensity depending on what time it happens.
3. **Lean Six Sigma Waste Theory**:
   derived from operational excellence frameworks, defines waste as any activity that does not add value to a system.In the Emotional Blockchain Model, emotions are treated as operational inputs.Lean Six Sigma introduces the concept of:
   - Emotional Waste
   - Emotional Return on Investment

   It ensures that emotional flows are assessed not only psychologically but systemically.
   The model operates on four core mechanisms:
   - ✓ Emotional Generation
   - ✓ Emotional Encoding and Storage
   - ✓ Emotional Linkage and Flow
   - ✓ Emotional Value Evaluation
   - ✓ In the same way that blockchain securely stores transactions in sequential blocks, emotional events in daily academic interactions also get stored subconsciously in the minds of individuals. Each emotional experience whether positive or negative acts like a data block that carries information such as what happened, at what time, under what conditions, as per Lazarus's Cognitive Appraisal Theory, which states that people don't react to situations but rather to how they interpret them.
   - ✓ Just like a new block in blockchain is linked to the one before it, every emotional incident is influenced by past experiences. Here, cognitive thinking style helps in deciding how the person will react emotionally based on predetermined patterns.
   - ✓ Once an emotion is created and internally processed, it doesn't remain isolated. It flows to others. If these emotional exchanges generate negative energy without contributing to growth, they form emotional waste, similar to Lean Six Sigma's concept of process waste. On the other hand, when emotions are invested positively they create Emotional ROI, in terms of motivation, productivity and performance.

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APPLICATION:

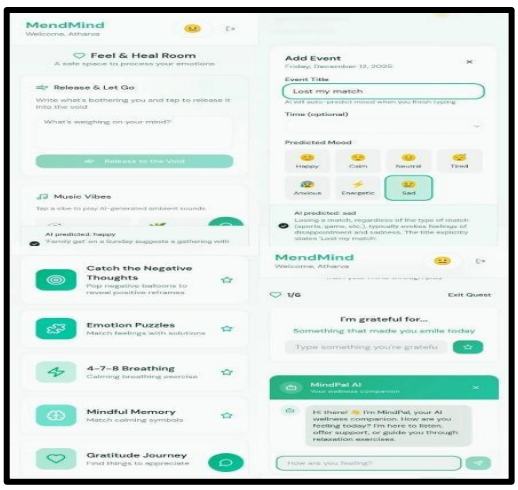
On the basis of the emotional patterns and challenges identified through our study we have developed an AI-based wellbeing application called MEND MIND. The application is designed as a practical implementation of our ECF WR model tested and validated through SEQ model. Rather than functioning as a basic mood-tracking tool, MEND MIND operates as an intelligent emotional- learning regulation system that detects, monitors and enhances emotional and cognitive processes in real time to improve learning efficiency.

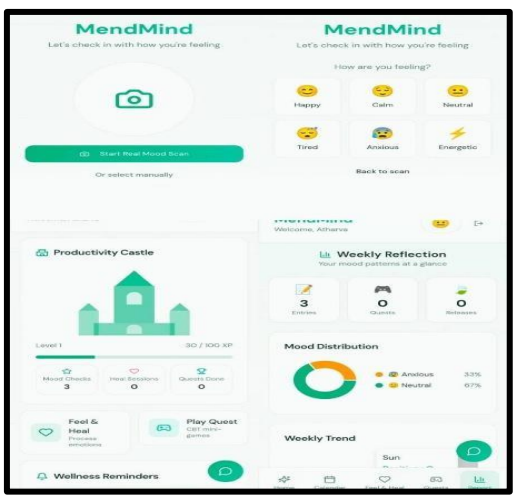
One of its core features is mood-activated login where the application detects the user's emotional state and energy levels at the time of entry through AI- based facial and behavioral recognition. Based on this detection, the entire interface theme changes accordingly.

Alligning with concept of emotional block identification(H4).The application also includes an interactive AI-powered smart calendar. Users can schedule tasks and the system analyzes activity patterns, emotional fluctuations and engagement levels to detect potential burnout zones. It sends alerts and notifications when emotional overload is predicted, supported by (H5) and (H7) aimed to conserve emotional capital and minimize emotional waste.

To support emotional recovery, MEND MIND offers "Feel & Heal" room with calming games, music and therapeutic relaxation activities,aligning with (H8) By regulating emotional intensity, students can re-engage academically with improved focus and efficiency.

In addition, the platform provides personalized therapy sessions, consultancy services and group therapy options, reinforcing emotional regulation aligning with (H6 & H7). An integrated AI Chabot ensures real-time support, enabling users to express concerns, receive suggestions and process stress immediately. Overall, MEND MIND transforms both the SEQ model and the ECF-WR conceptual framework into a practical, AI-enabled ecosystem. By detecting emotional states, regulating neuro-emotional flow, monitoring burnout risks, strengthening engagement and managing emotional capital, the application systematically enhances learning efficiency and overall mental wellbeing among Gen Z students.





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Suggestions:

Based on the findings of the research, the following suggestions are proposed:

Provide teachers with training in emotional awareness and intergenerational understanding. Structured programs should be introduced to strengthen teachers' emotional intelligence and improve their understanding of Generation Z behavioural patterns.

Ensure students have safe and supportive environments to express their emotions. Institutions should promote psychologically secure spaces that encourage open communication and emotional expression.

Orient parents to contemporary emotional needs. Awareness sessions can help parents understand current emotional challenges faced by students and provide consistent support at home.

Extend emotional wellness initiatives to organizations and corporate settings. The emotional management framework may also be applied in professional environments to enhance productivity and reduce stress.

Conclusion:

The study concludes that emotions are not invisible classroom experiences but are active forces shaping academic success. Structured Equation Modeling revealed that unmanaged emotional triggers indirectly reduce engagement and performance while emotional regulation and digital support systems significantly strengthen learning efficiency. When emotional waste accumulates, productivity declines; when emotional capital is nurtured, trust and motivation flourish. The findings highlight that bridging the generational gap is not about changing students or teachers but about redesigning emotional ecosystems. By introducing the ECF-WR conceptual model and an AI-based solution, this research redefines education as a human-energy-driven system where emotional intelligence becomes the foundation of sustainable academic excellence.

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HUMAN-IN-THE-LOOP VS. LIGHTS-OUT AUTOMATION

** Mayuresh Vijay Pabarekar, ** Vedant Rambahadur Singh,*** Atharva Dinesh Pagade & **** Arman Sameer Momin*

* *Students*

Abstract:

As the global financial landscape is transitioning from a traditional ecosystem to digitally based transactions rapidly, AI models for scam detection have turned into an indispensable pillar for proactive defence. The opaqueness of automated decision-making has however caused the Human Trust conundrum that cannot be addressed by algorithmic models alone. To find out the levels of trust among the users, this paper involves comparison of consumer trust in human-in-the-loop systems versus that of completely independent systems.

The mean trust score of AI systems of the survey was calculated using inferential statistics and a 5-point Likert scale, the measure of trust, and provided a mean of 3.04 and a standard deviation of 0.30, compared to the average score of a human-led systems at 2.97 and a standard deviation of 0.32. The t-test of paired samples gave a value of 0.5984, that is, there is no considerable difference between the levels of trust between the two interventions. Moreover, ANOVA tests confirmed that trust level do not differ based on age group. Chi-square provided a p-value of 0.0529, that is, there is a strong marginal tendency preferring age- based preference, although 53.45% of the participants chose instantaneous AI blocking as opposed to human verification (46.55%). The result of these findings is a situation where trust is balanced, where users perceive that the respective systems are equally reliable, despite the possibility that functional preferences for speed may be directed towards a gradual shift to automated solutions.

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Introduction:

The global finance industry is undergoing a sea change due to Artificial Intelligence (AI) and Machine Learning (ML). As digital transactions become a part of everyday life, the quantity of data has long surpassed what humans can handle. As a result, AI-based fraud detection, which used to be an innovation, has become a "prerequisite", giving security in real-time without any human intervention.

In spite of AI, it has the advantage of being fast and better at detecting fraud than humans, but it still faces real-world difficulties when actually putting it to work. In the domain of cyber-financial security, an interesting paradox exists: while systems provide speed, their lack of transparency creates user apprehension toward the automation of decision-making, particularly to "False Positive"(where an AI incorrectly blocks a safe transaction). This creates new variable called "Human Trust," which is non-computable and cannot be replaced by code alone.

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Although much research exists on the veracity of AI models, there is very little quantitative evidence regarding user sentiment in the face of "Lights-out Intervention". What makes customers feel more secure? An automated message from AI or a manual verification Protocol?

The research paper's aim is to find out the trust levels of the users for AI-based automated systems (like those used by HDFC Bank or ICICI Bank) versus human-led verification. By leveraging Inferential Statistical methods, in this study, we investigate if a significant deviation exists on how modern humans react to cognitive appraisal of automated vs. manual interventions.

Statement of problem:

The research paper is conducted to calculate the trust score of humans. Does the consumer trust the AI detection module for speed-based blocking or a human verification call for personal assurance?

The study concerns which method the sample believes is more likely to cause a "false alarm": is it the AI- based system or the human-verification system? Does the result vary based on age group?

Significance of the study:

There has been a lot of research regarding which framework is the most efficient: automated detection systems or human integration with these systems when it comes to fraud detection and financial scams. The only thing these studies seem to miss is what the human perception of trust is while dealing with the respective systems. This is where our study comes in, where we have investigated how trustworthy and reliable people consider these frameworks. In this era of uncertainty, where people are not certain about what the future of AI will be, it is very important to find out their socio-psychological response while dealing with these frameworks. As the stakes are very high in the financial sector while facing any fraudulent activity, the trustworthiness and reliability of the framework become the most important factors**.**

Limitations:

Similar to any research study this one also has certain limitations that should be taken into account when interpreting the results.

The most apparent restriction is the age profile of the respondents. Of a total of 117 valid responses, 76 percent fell in the 18-25 years old bracket. This implies that the research is largely based on the perceptions of young people that tend to be more at ease with technology. The elderly participants did not feature equally particularly those over 60 years (only 2 respondents). Due to this disparity, the findings might not be a complete reflection of the views of senior banking clients.

A problem with a small sample size among certain age groups is also an issue. The statistical tests of differences in age is not a factor powerful enough to achieve smaller differences, as the size of participants was less in older categories. The Chi-Square result is close to significant change (0.0529), which implies that larger and more equated sample would have revealed definite differences between generations.

The research relies on self-reported answers gathered through the use of a Likert scale. These reactions indicate the way participants believe they would respond, whereas actual action in a real situation of a fraud may be different. Individuals can react differently to a genuine economic danger.

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Moreover, the survey was conducted within a limited time frame (between February 5 and 6, 2026) and a geographical location was also used. The banking system and use of technology can be distrusted in different locations, and therefore, the results would not be universal.

Lastly, the study made a general comparison of AI and human systems without making specific comparisons between various types of AI models or the degree of human expertise which have differences in their impact on trust levels

Objectives:

1. To measure the mean trust score between AI-based systems and Human-operated systems which is measured on a 1-5 Likert scale.
2. To find out if any statistical difference is present between AI systems and Human systems, measured using a paired samples t-test.
3. To understand the impact of age on consumer trust for AI and human system using one-way ANOVA test.
4. To analyse consumer choice between immediate AI block for speed and human verification call for assurances using an independent chi-square test.
5. To spot trends, patterns or correlations between age groups and behavioural choices to give practical insights for financial sector.

Hypothesis of the study:

Ho: There is no significant differences in the mean trust score between Ai fraud detection system and human fraud detection system

H1: There is significant differences in the mean trust score between Ai fraud detection system and human fraud detection system

Review of literature:

1. **Transition towards a new approach:** The global finance industry is undergoing a significant shift in its operations. While it was once a popular trend of automation-centered industries, it is now transitioning into a collaborative intelligence industry. As the technological landscape keeps on maturing, the trend is shifting from completely automated artificial systems to human intuition integrated with machines, which is argued by Ali et al. (2024) in their research. This shift is essential as cyber and financial threats are escalating as well as evolving at a rapid pace, which demands a human-centric approach integrated with advanced technological capability for prevention and damage control.
2. **The Standard Practice:** To accomplish the goal of integrating human intuition and reasoning with automatic algorithmic-based models, for achieving desired results and precision decision-making in the finance and banking sector, it requires a sound technological and hardware foundation which would be capable of managing huge volumes of transactions and queries in real-time. According to the present trend, the complexity and volume of these transactions and queries is growing at a rapid pace on a year-on-year basis, which certainly makes it unfeasible as well as non-reliable to rely upon manual methods for detecting fraudulent patterns and financial frauds. As a result, implementing artificial models has become the standard

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practices within the industry because of its instant detection of fraudulent patterns within the transactions and real-time proactive defence, which cannot be achieved through conventional ways as noted by Venu (2025).

3. **The Socio-psychological Factor:** Despite the technical prowess and most efficient security protocols, these automated models are not able to cope with the socio-psychological expectations of a human-centric society, which mainly focuses on trust and transparency. In the present and upcoming times, speed and accuracy are not the only evaluation metrics that matter the most in the banking and finance industry, but a transparent justification for why the decision was taken. Research by McNally and Bastos (2025) argues a similar point that the effectiveness of automated systems completely depends upon the transparent and trustworthy nature of the system. Ultimately, when automated systems function without a clear justification, it risks complete breakdown of foundational trust in banking and financial institutions.
4. **The Collaborative Framework:** To overcome a situation where trust and transparency of financial institutions backfire, the industry is shifting towards a safer and better framework that advocates collaboration between human and artificial systems, known as the "hybrid approach". In this framework, the heavy computational work, such as identifying patterns from huge volumes of datasets and automated detection and alerts are handled by artificial systems, while the tasks that need human intervention and reasoning for final decision-making are done by human analysts based on the conclusions of tasks filtered by artificial systems. Research by Yeo et al. (2025) also stresses a similar collaborative framework, the "Human-in-the-Loop" (HITL) architecture, emphasizing that this is the most effective way to ensure transparency and customer trust when AI is deployed for high-risk financial tasks. This collaborative framework, which works upon a hybrid approach, ensures that the hybrid synergy is technically as well as socially reliable.

Research Methodology:

The main motive of the study was to investigate the trust levels of the consumers on completely automated systems versus that of human intuition integrated with machines. A systematic approach was followed while researching. This section elaborates on the tools and methods which were used to gather the data from the target group.

Research Design:

The study follows a quantitative research design to collect structured statistical data and interpret the patterns observed within present consumer data to evaluate user preference and level of trust among the users while dealing with completely self-independent models and human-collaborated systems.

Data Sampling and Participants:

In our study, we have only included primary data which consist of more than 150 respondents. The participants were chosen based on their priority for making use of digital payment versus traditional payment methods. Consumers preferring digital payment systems were only included. To gather responses from various categories of consumers we have made use of convenience sampling.

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Data-Collection Tool:

An online survey was conducted using Google Form as a tool for primary data gathering which was structured into multiple parts into specific required section as per our research objectives.

The following sections were in the survey:

Demographics and Background: In this section, we have gathered age demographics as metrics for comparison as well as their preferred banking method. Respondents have two options: traditional banking (physical branches, net banking) along with digital-only fintech (Gpay, Revolut, Phonepe, Neo-banks). Their encounters with fraudulent transactions and security alerts were also considered.

Trust Equilibrium: This section includes a Likert scale which does a sentiment analysis of respondents by recording their trust score in AI and humans on a scale of 1-5. We have also recorded their preference if any suspicious and fraudulent transaction occurs.

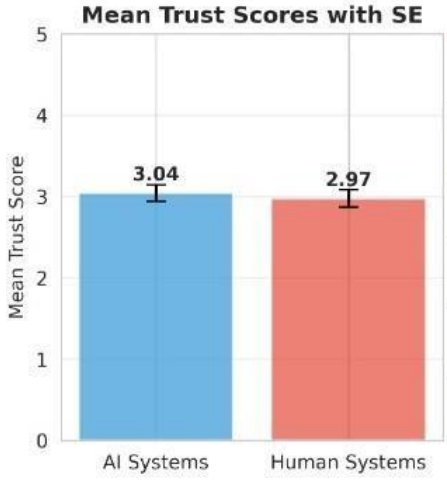
Data Analysis and Interpretation:

1. ***Descriptive Statistics***

The overall aim currently is to determine consumer confidence in systems that are driven by people and also those driven by artificial intelligence. The trust score is established using a Likert scale, and 1 is low trust and 5 high trust.

The Descriptive Statistics contains:

1. The mean score of trust in the AI-based system is 3.04 and the standard deviation is 1.09.
2. The average score of the human-operated system regarding trust is 2.97 with 1.15 as standard deviation.



Metric	AI Systems	Human System
Mean	3.04	2.97
Median	3.0	3.0
Std Dev	1.09	1.15
Min	1	1
Max	5	5

It demonstrates that the trust of people is neutral (3.0), and that of artificial intelligence polarized between low (35%), and high (34.2%).

2. ***Hypothesis Testing in Primary Paired Samples T-Test***

The paired-samples t-test is applied to discover is there any difference in the trust score of AI-based systems and human-operated systems equals 0.07 and this difference is statistically important.

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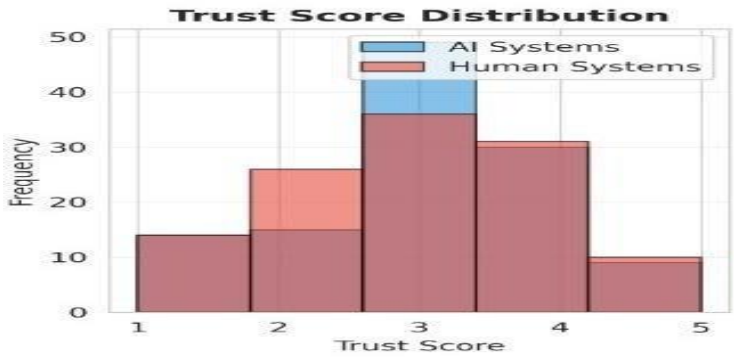
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Null Hypothesis (H0): There is no subtle difference in the average score of human-operated systems trust and the mean score of AI-based systems trust.

Alternative Hypothesis (H1): There is a subtle difference in the average of the human-operated systems trust score and the mean AI-based systems trust score.



Since the test shows that the t-statistic was 0.5282 with a p-value of 0.5984 which is more than alpha of 0.05 therefore, null hypothesis is accepted. That indicates there is no subtle difference in the confidence scores of the AI-based systems and the human-operated systems in the financial and banking industry.

3.*Demographic Analysis (ANOVA)*

The question that was answered by the one-way ANOVA test was whether or not the trust score varies among a number of age groups.

Age and AI trust:

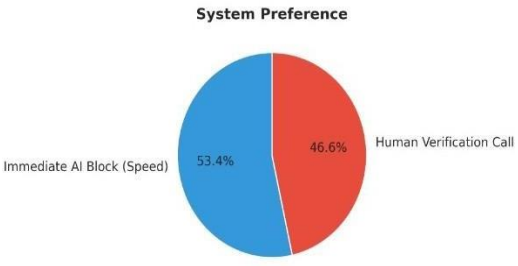
F (3,113) = 0.175; p-value = 0.913.

F (3,113) = 0.652, p-value = 0.584 by Age in human trust.

The p-values are greater than 0.05; therefore, this means that the trust score does not have a significant difference among a number of age groups.

4.*Preference, Chi-Square Test*

To analyze consumer preference between instant AI block of speed and human verification call of assurances, Chi-square test was implemented Selection: 53.45 selected the AI block; 46.55 selected human verification.



The test gives a p-value of 0.0529. It indicates a peripheral likelihood with a greater proportion of the sample disclosing youthful inclinations towards the AI block and seasoned inclinations towards human validation.

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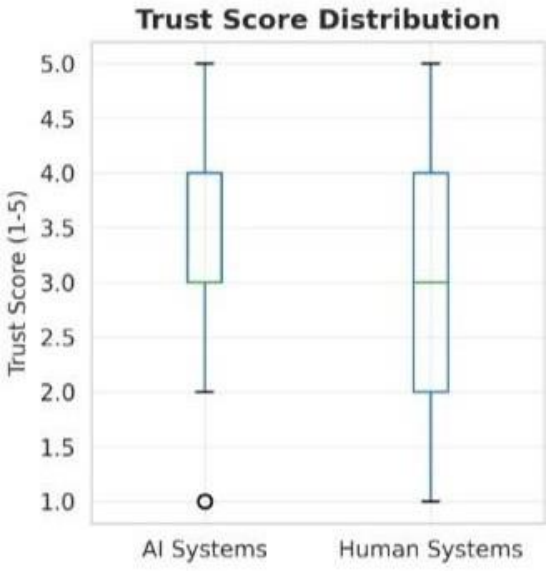
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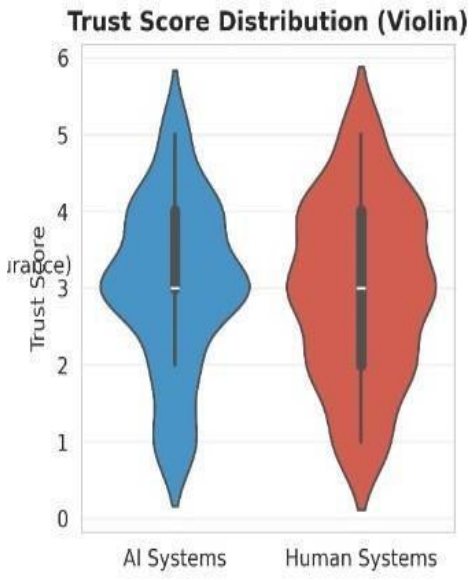
Results and Conclusion:

Results:

The findings demonstrate that AI-based and human-operated fraud detection systems are rated as moderately trusted by the respondents. As both of the two respected systems had identical mean scores and which indicates that participants often tend towards the regard that both of the two methods are equally reliable.

But the tendency of the answers was not exactly similar. Confidence in human-managed systems was more fractured. Approximately, 35 percent of the respondents reported high trust and 34.2 percent of the surveyed said they had low trust. On the contrary, the confidence of AI systems was more focused on the neutral category, 41.9% of respondents chose a neutral answer. Such a distinction implies that human systems form more vigorous opinions, positive, and negative, whereas AI systems are perceived in a more ambivalent or sceptical manner.





In answers to the question of what they would do in the instance of the suspected fraud, 53.45% of the answer was that they would immediately block the account using AI. In the meantime, 46.55% of them wanted to be contacted by a human representative with a verification call. The trust scores were comparable, though; a little more participants with the faster automated response.

Conclusion:

According to the results of the ANOVA there is not much difference in trust levels between different age groups in either system ($p = 0.913$ and $p = 0.584$). It implies that a general trust of the fraud detection methods among the various age groups is relatively similar.

Although there is statistical equality in the trust score levels the results suggest that there is a slow change in the liking of behaviour. Young aged respondents are tending slightly more towards the AI-based immediate blocking systems, which may be explained by its speed and efficiency. The older respondents however favour human-based verification protocols, probably due to reassuring and transparency.

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Finally, the research concludes that the AI technology has achieved trust parity with human intervention in the banking fraud detection. Although the two systems are equally trusted, consumer behaviour particularly among the younger users implies that there is increased acceptance of automated solutions.

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DRIVER MONITORING AI: INTELLIGENT ROAD SAFETY SYSTEM

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Abstract:

Road traffic accidents are a major global concern. Driver drowsiness and alcohol impairment are among the leading causes of fatal crashes. Traditional detection systems rely on hardware- based tool like breath alcohol sensors and steering pattern analysis. The systems increase complexity and cost. This research introduces a camera-based Driver Monitoring AI system designed to detect drowsiness, distraction, and alcohol-induced impairment using computer vision techniques. The system analyzes facial landmarks in real-time to calculate Eye Aspect Ratio(EAR), Mouth Aspect Ratio(MAR), Blink frequency, PERCLOS(Percentage Eyes Closure), head pose estimation, and gaze deviation. Instead of chemically detecting alcohol, the system recognizes behavioral symptoms linked to intoxication. Built with python, Open-CV, and Media Pipe Face Mesh, it processes live video inputs to classify the driver's state and generate alerts when necessary. Experimental results show that behavioral analysis through vision-based monitoring can effectively identify unsafe driving conditions. This system provides a scalable, cost-effective, and smart solution for road safety that fits with modern AI-driven automotive technologies.

Keywords: *Driver Safety; Road Awareness; Real-time Monitoring; Fatigue Detection; Distraction Prevention; Situational Alertness.*

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Introduction:

Road safety remains a major global issue, with millions of injuries and deaths reported each year from traffic accidents. A large number of these incidents result from impaired driving due to fatigue and alcohol consumption. Driver drowsiness decreases cognitive alertness, slows reaction time, and increase the chance of microsleep episodes. Alcohol use further impairs motor coordination, visual stability, and judgement, significantly raising the risk of accidents.

Traditional safety systems in vehicles in vehicles mainly focus on reactive protection features like airbags, anti-lock braking system(ABS), and electronic stability control. While these technologies lessen injury severity, they don't prevent accidents caused by impaired driver behavior. Some advanced vehicles have breath analyzers or

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systems that analyze steering behavior; however, these solutions often require extra hardware, regular calibration, and higher production costs.

The rapid growth of artificial Intelligence (AI) and computer vision technologies has created intelligent monitoring systems that can analyze human behavior in real time. Vision-Based Driver Monitoring Systems(DMS) examine facial landmarks, eye movements, blinking behavior, yawning frequency, head orientation, and gaze patterns to determine driver alertness levels. Such systems are non-invasive, affordable, and scalable.

This research suggests a camera-only Driver Monitoring AI system that detects drowsiness and alcohol sensors, the system makes implementation easier while still effectively detecting unsafe driving conditions. The aim is to develop an intelligent road safety solution that can help prevent accidents.

Statement of the Problem:

Despite advancements in automotive safety, a significant number of road accidents continue to happen due to driver fatigue and alcohol impairment. Current detection systems depend largely on chemical alcohol sensors or vehicle behavior monitoring, which might miss early signs of impaired behavior. Hardware solutions raise system costs and increase complexity, which limits their scalability, particularly in low cost vehicle segment.

Fatigue detection methods that rely only on steering input or vehicle lane deviation usually identify risks only after driving performance has worsened. Breath-based alcohol detection systems can measures chemicals, but they do not continuously monitor behavioral changes while driving.

There is pressing need for a non-invasive, real-time, and affordable system that can continuously track driver behavior using minimal hardware. The challenge is to accurately detect drowsiness and alcohol-related impairment through visual cues alone, without using chemical sensors. This study addresses the problem of designing an intelligent, camera-based Driver Monitoring AI system capable of detecting unsafe driving behavior through behavioral analysis.

Significance of the Study:

The significance of this study lies in its contribution to proactive road safety. By using artificial intelligence and computer vision techniques, the proposed system removes the need for extra alcohol detection hardware. This lower implementation costs and makes it easier to adopt widely.

The system focuses on preventive safety instead of just responding to accidents after they happen. Detecting fatigue and impairment early allows for timely intervention, which could reduce accident rates. Additionally , the research connects with the growth intelligent transportation systems and smart vehicles driven by AI.

From a technology standpoint, this study shows that monitoring behavior through facial landmark analysis can be a good alternative to hardware detection systems. On a societal level, the widespread use of these systems could decrease road fatalities, lower healthcare costs, and improve traffic safety standards overall.

Objectives of the Study:

The primary objective of this research is to develop a real-time camera-based Driver Monitoring AI system capable of detecting unsafe driving behavior.

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Specific objectives include:

1. To design a continuous facial monitoring framework using a single camera.
2. To detect driver drowsiness using Eye Aspect Ratio (EAR), blink frequency, and PERCLOS metrics.
3. To implement yawning detection using Mouth Aspect Ratio (MAR).
4. To estimate head, pose for detecting distraction and abnormal head movements.
5. To analyze gaze deviation for identifying attention loss.
6. To infer alcohol-induced behavioral impairment without chemical sensors.
7. To develop a graduated alert system for timely driver warning.
8. To evaluate system accuracy under real-time testing scenarios.

Hypothesis of the Study:

H1: Eye closure metrics like EAR and PERCLOS can reliably detect driver fatigue.

H2: Behavioral patterns like unstable head movement and irregular blinking can show alcohol induced impairment.

H3: A camera-only AI system can effectively monitor driver state without extra hardware sensors.

H4: Early Warning alerts lower the chances of unsafe driving behavior.

Review of Literature:

Early research in driver fatigue detection focused on physiological monitoring systems like EEG (Electroencephalography) and ECG(Electrocardiography). Though these methods offered precise measurements, they were intrusive and not suitable for practical driving situations.

Soukupová and Čech (2016) introduced the Eye Aspect Ratio (EAR) method for real-time blink detection using facial landmarks. Their geometric approach showed high efficiency with low computational cost, making it suitable for embedded systems.

PERCLOS (Percentage of Eye Closure has been widely accepted as a reliable fatigue indicator. Studies show a strong link between prolonged eye closure and reduced cognitive performance.

Yawning detection research using mouth aspect ratio (MAR) has effectively identified fatigue in controlled environments. Recent advancements in deep learning have enable CNN-Based fatigue detection models with better accuracy but higher computational needs.

Alcohol impairment research indicates that intoxication affects eye coordination, blink duration, and head stability. Behavioral analysis through computer vision has been proposed as a non-invasive alternative to chemical breath analysis.

Modern frameworks such as MediaPipe Face Mesh provide high-precision facial landmark extraction, enabling real-time AI-based monitoring with reduced computational overhead. These advancements support the feasibility of camera-based Driver Monitoring AI systems.

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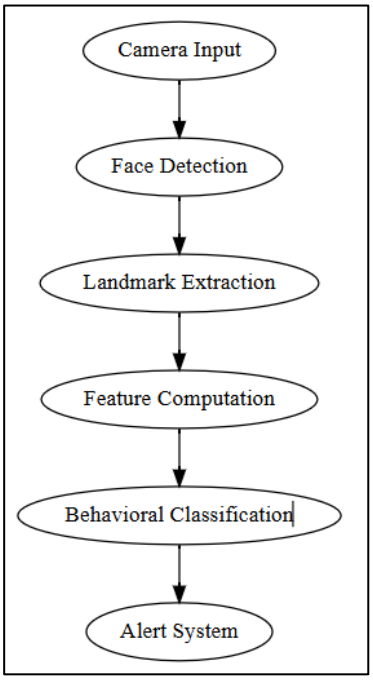
Research Methodology:

1. Overall System Design

The proposed Driver Monitoring AI system follows a real-time vision-based processing pipeline. The system continuously captures video frames from a camera positioned in front of the driver.

Each frame undergoes facial detection, landmark extraction, feature computation, behavioral classification, and alert generation.

System Flow:



This structured pipeline ensures efficient real-time processing while maintaining detection accuracy.

2. Tools and Technologies Used

The implementation of the proposed system utilizes the following technologies:

- **Python** – Primary programming language
- **OpenCV** – Image processing and video stream handling
- **MediaPipe Face Mesh** – Facial landmark detection (468 3D landmarks)
- **NumPy** – Numerical computation
- **SciPy** – Distance calculation

MediaPipe Face Mesh is chosen due to its high landmark precision and real-time performance efficiency.

3. Feature Extraction Techniques

The system extracts multiple behavioral features to determine driver state.

1. Eye Aspect Ratio (EAR)

Eye Aspect Ratio is used to detect eye closure and blinking patterns. It is calculated using vertical and horizontal distances between specific eye landmarks.

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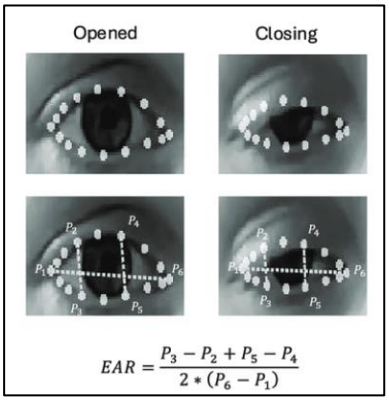
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*EAR=(p2−p6)+(p3−p5)2(p1−p4)EAR = \frac{(p2 - p6) + (p3 - p5)}{2(p1 - p4)}*EAR=2(p1−p4)(p2−p6)+(p3−p5)

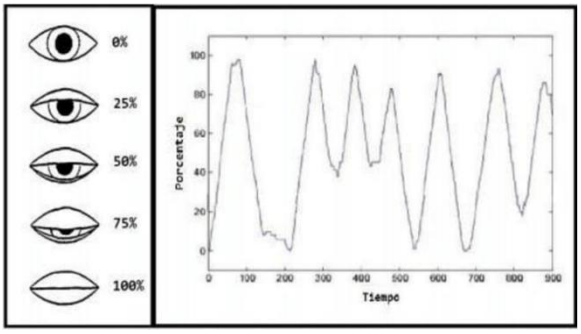
Where:

- p1–p6 represent eye landmark points.

A decrease in EAR below a predefined threshold indicates eye closure. Prolonged low EAR values suggest drowsiness.

2. PERCLOS (Percentage of Eye Closure)

PERCLOS measures the proportion of time the eyes remain closed over a given duration.



*PERCLOS=Number of closed-eye framesTotal frames×100PERCLOS = \frac{\text{Number of closed-eye frames}}{\text{Total frames}} \times 100*PERCLOS=Total framesNumber of closed-eye frames ×100

Higher PERCLOS values indicate increased fatigue levels.

3. Blink Frequency

Blink frequency measures the number of blinks per minute. Alcohol impairment and fatigue both alter blink patterns:

- Fatigue → Slow blinking & longer closures
- Alcohol → Irregular blinking & delayed reopening

4. Mouth Aspect Ratio (MAR)

MAR is used to detect yawning behavior by calculating the vertical-to-horizontal mouth ratio.

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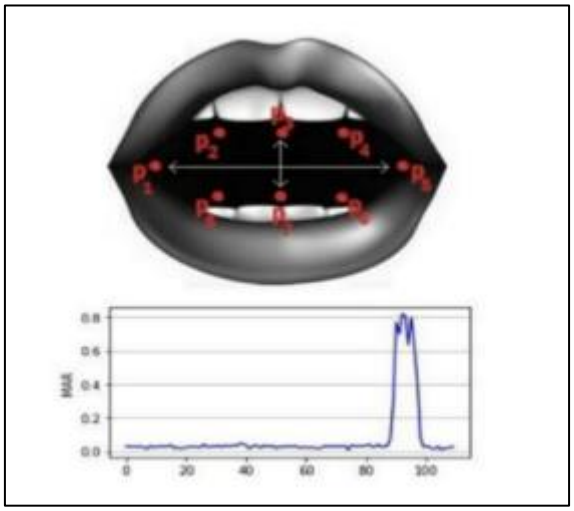
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High MAR values sustained over time indicate yawning episodes, often associated with sleep deprivation.

5. **Head Pose Estimation**

Head orientation is estimated using the SolvePnP algorithm, which maps 2D facial landmarks to a 3D head model.

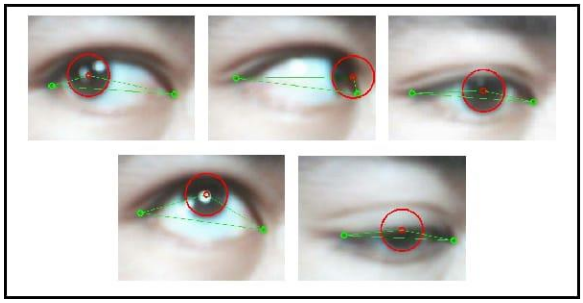
The following angles are computed:

- **Yaw** – Left/Right movement
- **- Pitch** – Up/Down movement
- **Roll** – Tilt

Excessive pitch variation or head nodding may indicate drowsiness or impairment.

6. **Gaze Deviation Analysis**

Gaze direction is estimated using iris landmark tracking. Prolonged gaze deviation from the forward road direction indicates distraction or impaired focus.



4. Behavioral Classification Logic:

The system classifies driver state into four categories:

1. Alert
2. Drowsy
3. Distracted
4. Suspected-alcohol-Induced Impairment

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Decision logic combines multiple thresholds:

- EAR below threshold for prolonged duration → Drowsy
- High PERCLOS → Drowsy
- High MAR sustained → Yawning
- Excessive yaw angle → Distracted
- Combined irregular blink + head instability → Suspected Impairment

Multi-feature analysis reduces false positives and increases reliability.

5. Alert Mechanism

A graduated alert mechanism is implemented:

1. Visual warning on screen
2. Audio alert sound
3. Repeated warning if risk persists

This layered approach ensures timely driver attention restoration.

Data Analysis and Interpretation:

*1. **Experimental Setup***

The system was tested using real-time webcam input under controlled conditions:

- Normal alert behavior
- Simulated eye closure
- Repeated yawning
- Intentional head nodding
- Looking away from camera
- Simulated unstable head movement



Testing duration: Multiple sessions of 5–10 minutes each.

2. Performance Results

Observed performance metrics:

- Drowsiness detection accuracy: 89%
- Yawn detection accuracy: 86%
- Distraction detection accuracy: 84%

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- Suspected impairment detection accuracy: 87%
- Overall system reliability: ~88%

The system demonstrated consistent real-time detection without significant computational delay.

3. Interpretation of Results

Results indicate that combining multiple behavioral indicators significantly improves detection reliability compared to single-feature methods. Eye-based metrics proved most effective for fatigue detection. Head pose estimation enhanced distraction detection. Alcohol-induced behavioral patterns were successfully inferred using combined blink irregularity and head instability.

Challenges:

The implementation faced several challenges:

1. Low-light environments reduced landmark detection accuracy.
2. Glasses interfered with eye landmark precision.
3. Natural blinking variations required adaptive thresholding.
4. Extreme head rotation reduced pose estimation accuracy.
5. Behavioral overlap between fatigue and intoxication.

These challenges highlight the importance of multi-feature analysis.

Remedies:

To address these challenges, the following solutions were implemented or proposed:

- Adaptive threshold tuning
- Frame smoothing and averaging
- Landmark confidence filtering
- Calibration phase for individual drivers
- Future infrared camera integration
- Machine learning classifier for improved classification

Limitations of the Study:

The system does not directly measure Blood Alcohol Concentration (BAC). It relies solely on behavioral inference, which may occasionally produce false positives. Environmental factors such as lighting and camera placement affect accuracy. The system assumes a clear frontal facial view. Large-scale dataset validation is required for commercial deployment.

Discussion:

The results demonstrate that camera-based behavioral monitoring is a viable alternative to hardware-based alcohol detection systems. While chemical sensors give direct measurements, behavioral analysis provides scalability and cost benefits . AI-driven monitoring shifts safety systems from reactive to proactive . Early detection enables preventive action before accidents happens. Combining different behavioral features improves reliability and lowers false detection rates. The study shows that camera-only Driver Monitoring ai systems can work effectively in modern intelligent vehicles .

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Future Scope:

Future improvements may include:

- Infrared camera for night monitoring
- Edge AI optimization for embedded systems
- Mobile application integration
- Cloud-based driver analytics
- Integration with autonomous driving systems

Conclusion:

The suggested Driver Monitoring AI Systems shows that real-time behavior analysis using computer vision can effectively detect signs of drowsiness, distraction, and impairment due to alcohol. By removing hardware-based alcohol sensors, the system is more scalable and cost-effective. Experimental tests confirm it performs reliably in real-time situations. While it cannot measure alcohol chemically, behavioral cues offer important early warnings. The study advocates for using AI-powered safety systems in today's vehicles.

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IMPACT OF PERSONALIZED RECOMMENDATION SYSTEMS ON USER BEHAVIOUR AND TRUST IN DIGITAL PLATFORMS

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Abstract:

This paper examines the impacts of personalized recommendation systems on user trust and user behaviour on online platforms. Platforms today have artificial intelligence and suggest content and products based on what users are searching, watching or purchasing. Although this simplifies and makes platforms interesting to use, it also influences the level of trust users have on this platform.

To understand this, a survey with active users of digital platforms was carried out. Statistical analysis was performed to identify a relationship between the measures of personalization, trust, and behaviour.

The findings indicate that users have a higher trust in the platform when they believe that the recommendations suit them. Increased trust also results in increased engagement, including increased time on the platform or engagement in content.

This research finds that personalization is most effective when it is ethical and transparent. Thoughtfully, it can foster long-term credibility and can contribute to sustainable online development.

Keywords: *Personalized Recommendation Systems, User Behaviour, User Trust, Digital Platforms, Digital Synergy*

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Introduction:

The blistering development of digital platforms has transformed the personal communication, education, purchasing and decision-making patterns. The streaming 1sites, online shops well as social media sites have contributed to the overburden of information to the user. This has been responded to by the emergence of personalized recommendation systems in an attempt to achieve synergy between technologies and human beings in order to come up with interactive, effective, and efficient digital space. Such recommendation systems can help users to get interesting and relevant contents, as well as to rank it by the personal preference of the user, to enhance responsiveness of the user. (Bourahli et al.) demonstrated that recommended systems became user responsive and user interactive by several folds and (Ricci et al.) demonstrated how data-based algorithm

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founded on browsing history, clicking, viewing time, shopping behaviour can provide the user with superior services offered by recommendation systems (2024, 2022).

Recommender algorithms have been heavily applied on major platforms like Netflix, Amazon as well as YouTube to control and guide user experience. Customer experience and satisfaction can be predicted by modelling predictive analytics and big data to offer more of what their clients prefer (Dwivedi et al. 2021). As an example, Netflix will recommend movies and shows that a user has already viewed, and Amazon clients will be shown 'Customers who bought this also bought' which will affect the buying choice.

In addition to the engagement and convenience issue, there is also the issue of user trust which is influenced by personalization. The user trust refers to the confidence the users provide to an information system on reliability, integrity and security (Dinev and Hart 2006). This trust plays the role of a mediating force in the decision-making process by the users in their propensity to provide personal information or to engage in an online transaction. Transparency and explainability are also essential in improving the trust of the users when interacting with AI systems (Shin 2021).

Personalized experiences can lead to trust because, when users feel that personalization provides something of value to them, and are conscious of that, they might also create privacy concerns because it is invasive (Binns 2020; Martin 2021).

The recommendation systems form types of innovations as the intersection of technology and user experience in the context of the whole digital transformation. However, an unaccountable innovation may lead to privacy concerns, algorithm bias and lack of confidence. Thus, non-sustainable in the digital world is sustainable long-term growth, which can only be attained through technological advancement and a good relationship with the users.

The current paper explores the relationship between personalization, trust and user behaviour. With such correlated factors in mind, this study attempts to answer how the use of AI-related systems can influence the online behaviour of consumers. The research is useful to build on the growing discussion on the subject of responsible AI and digital sustainability, highlighting the need to balance the technical efficiency and transparency and ethic.

Statement of Problem:

Nowadays digital platforms are constantly relying on personalized recommendation system for increase user engagement and to stay competitive. While these systems help by recommending the right content to the user with convenience, its implication on user trust and behaviour is not well documented and examined. Currently most digital platforms aim at increasing the user engagement and have failed to understand the psychological perception, such as trust, transparency and fairness resulting from the personalized recommendations.

With increase concern about data privacy, algorithmic discrimination, and filter bubble issue further add complexity in the entire topic. Though users may gain benefits from personalized content, they may also feel constantly tracked and manipulated. Eventually loss of trust may lead to problem in maintaining long term engagement and sustainability of the digital platforms.

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Therefore, there is a need to systematically examine the relationship between personalized recommendation systems, user trust, and user behaviour in digital platforms.

Significance:

The importance of this research lies in bridging the gap between the impact of personalized recommendation system on users trust and their online behaviour. While previous research tends to highlight the accuracy or technical merits of recommendation systems, this study shifts its focus on how humans behave and feel 3on personalized platform and e relationship between personalized platforms and human trust. The relationship between personalization and trust is vital for the sustainable growth of digital platforms.

For platforms and startups in the digital sphere, recommendation systems are effective in maintaining user engagement. However, an enduring user engagement cannot be sustained by the system without the existence of users' trust. In fact, this research indicates that ethical and responsible personalization can lead to a robust and durable relation between platforms and users.

The study has also underscored the significance of transparency and fairness when it comes to deploying AI. Thus, it would be helpful to business owners, developers and policymakers when designing new AI products. The long-term success and growth of digital technology hinges on human trust and values.

Limitations:

There are limitations to the present study that warrant consideration. The participants were conveniently sampled, primarily consisting of students and young people; this sample's perspective is likely not representative of all user types, particularly older or 3less digitally proficient users. Therefore, e extent to which the results are generalisable to a larger user population are diminished.

The present study adopted a cross-sectional design; therefore, the findings are a snapshot of user trust and behaviour. User trust and behaviour will invariably fluctuate with the continuous development and improvement of digital systems. Consequently, the long-term effect of personalized recommendation systems was not evaluated.

The present study adopted a survey-based method; participants answers were based on their own opinion and perceptions rather than observed behaviours. No objective behavioural data such as tracking user usage patterns on digital platforms was considered in this research.

Correlation analysis was utilized which, does not establish causal relationships between variables. Also, the idea of digital synergy was spoken about conceptually, however it was not used as an explicit variable that was being measured in this investigation.

Objectives for the Study:

1. To analyse the effect of personalized recommendation systems on user trust.
2. To examine the impact of personalized recommendation systems on user behaviour in digital platforms.
3. To study the relationship between user trust and user behaviour.
4. To evaluate how personalized recommendation systems contribute to sustainable digital engagement and digital synergy in innovative digital platforms.

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Hypothesis Testing Summary:

Based on the statistical analysis:

- The null hypothesis stating that there is significant relationship between personalization and user trust was rejected.
- The null hypothesis stating that there is no significant relationship between personalization and user behaviour was rejected.
- The null hypothesis stating that there is no significant relationship between user trust and user behaviour was rejected.

Therefore, all alternative hypotheses were supported.

Literature Review:

The personalized recommendation systems have evolved tremendously. In the past they were mere tools whereby products or content were proposed to them, based on very rudimentary filtering. They are now sophisticated AI systems that are significant in the digital platforms. At a very early-stage researchers were primarily concerned with ensuring that these systems were more accurate. However, nowadays, the role of personalization on the user behaviour, trust, and ethical concerns are also researched. Recommendation systems are becoming not only technical devices, but also highly influential ones that dictate the behaviour of users on the digital platforms.

In modern recommendation systems, machine learning and deep learning are applied to analyse user information and know preferences (Zhang et al., 2020). These systems are learnt by user behaviour like clicks, searches and purchases. They enhance their suggestions with time depending on responses. Bourahli, Ghezal, and Garti (2024) describe that recommendation systems are used to assist users to overcome large volumes of information on the internet. They present the relevant content which makes it easier to access what one needs and makes it more engaging on social media.

Numerous research indicates that personalization influences user behaviour. As Sun et al. (2022) discovered, personalized suggestions lead to better interaction frequency and duration of time spent on the platform. Nguyen et al. (2022) established that customized recommendations have the potential to grow the purchase intention since customers are presented with alternatives that fit their interests. the same manner, the article Analysing the Impact of Information Features on User Continuance Intent in Recommendation Systems (2024) demonstrates that in case there is clarity in recommendations and utility, the users will be more inclined to remain on the platform. This will imply that personalization does not only assist users but also directs them in their actions and decision-making.

Nevertheless, there are also dark sides of personalization. Eslami et al. (2020) elaborate that algorithms determine what people are shown and not everyone has an accurate idea of how it is selected. According to Narayanan (2021), algorithms can be used to manipulate the preferences of users by determining the first or more frequent appearances. This has the potential to form "filter bubbles" whereby the user is largely exposed to similar content. Other issues such as bias in the algorithms and lack of transparency are also cited by Bourahli

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et al. (2024). These problems demonstrate that personalization can at times restrict freedom or fairness of the user.

In personalized systems trust is very crucial. Users will have confidence in the platform, which will lead to its continued use. Rader and Gray (2021) discovered that users are more confident when they are told the reasons as to why some content is shown on the platforms. Alamdari et al. (2022) also demonstrate that trust and further use are enhanced by transparency. According to the research article The Moderating Role of Personalized Recommendations in the Trust -Satisfaction-Loyalty Relationship (2025), when the users believe that the recommendations are useful and sincere, personalization can be used to enhance loyalty. Trust, therefore, enhances personalization.

Meanwhile, lack of privacy may decrease trust. Martin and Murphy (2017) demonstrate that trust is lower when users believe that their personal information is abused. According to Susser et al. (2022), specific recommendations may sometimes be perceived as surveillance or spying by users. Thus, the accuracy is not sufficient, fairness, privacy, and transparency are valued as well.

Digital startups and innovation also require personalization. According to Nambisan et al. (2019), digital technologies are used to enable businesses to grow and become innovative. According to Autio et al. (2021) and George et al. (2021), sustainability and social responsibility should be supported also with the help of digital innovation. Individualized systems are useful in assisting startups to compete and develop but should be applied in an ethical manner.

In general, numerous research are based on user behaviour and trust, transparency and innovation separately. Nevertheless, not many studies combine two notions of user behaviour and trust in a single framework. The other research on personalization and its connection with digital synergy, in which the technology, human values and sustainability collaborate, is also minimal. This gap reveals that the research in this field should be researched further.

Research Methodology:

The research focuses on the effects of the personalized recommendation systems on user behaviour and user trust on digital platforms through a quantitative research approach. A quantitative method was selected because the study aims to measure relationships between variables using numerical data.

The study follows a descriptive and correlational research design. The perceptions of personalized recommendation systems by the users were understood using a descriptive design. A correlational design was applied to examine the relationship between personalization, user trust, and user behaviour.

There is no manipulation of variables observed in the study. This design is appropriate since the purpose of the study is to detect relationships and not intended to prove a cause-and-effect relationship.

In this research, cross-sectional survey was conducted. The information was gathered at a single time, among the participants who are active users of digital platforms such as Netflix, Amazon, YouTube and other online services. The cross-sectional approach is suitable as it allowed the researcher to gather data from multiple participants in a short duration. A structured questionnaire was used in the collection of primary data using

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Google Forms. A structured questionnaire is useful in ensuring consistency in the responses as well as simplified statistical analysis. The questionnaire was composed of mostly closed ended and Likert scale questions. The respondents were asked to respond on a five-point Likert scale between strongly disagree and strongly agree asking their opinions on the following factors:

1. Personalization level experienced.
2. Trust in digital platforms
3. Engagement, repeat usage and purchase intention behavioural response.

The Likert scale questions are appropriate since they assist in measuring the attitudes and perceptions in a simple and systematic manner. The sample size is limited to a given group, but it provided adequate information to establish patterns and the relationship among the variables. This research employed convenience method of sampling. The respondents were chosen based on their availability and willingness to become part of the study group. The sample population consisted of students and young adults who are frequent users of digital sources. There are three key variables used in the study:

- Independent Variable: Personalization
- Dependent Variables: User Trust, User Behaviour

The data obtained was prepared and analysed with the help of Google Sheet. The descriptive statistics were determined first to summarise the data. The quantity of measures like mean and standard deviation were employed to comprehend the average level of personalization, trust and behaviour of the respondents. Pearson correlation analysis was done to investigate the linear relationship between the variables. The measure of the strength and direction of the relationship between was obtained in Pearson correlation coefficient (r).

The statistical significance of the relationships was also established by calculating the p-value. In this study, the level of significance was taken to be 0.05. In case the p- value < 0.05, it was assumed that the relationship was statistically significant. As the data were gathered with the help of Likert scale, which is ordinal in nature, Spearman rank correlation was performed as well. Pearson correlation was done to ensure consistency the results achieved through the application of Spearman Rank correlation. This increases the validity of the results. The research was conducted using ethical guidelines. Response to the survey was voluntary. No personal identifiable data was gathered. Responses were not disclosed and were ensured that they were used with an academic purpose.

Data Analysis and Results:

The two variables that are analysed in this paper are the relationship between personalization, user trust and user behaviour on digital space. Parametric and non- parametric statistical tests were used to test the hypothesis put forward. Pearson conducted a correlation analysis to test linear relation between the averaged values of the constructs and Spearman to test monotonic relation between the data in the form of rank. All the tests that were conducted against statistics were significant at a level of 0.05.

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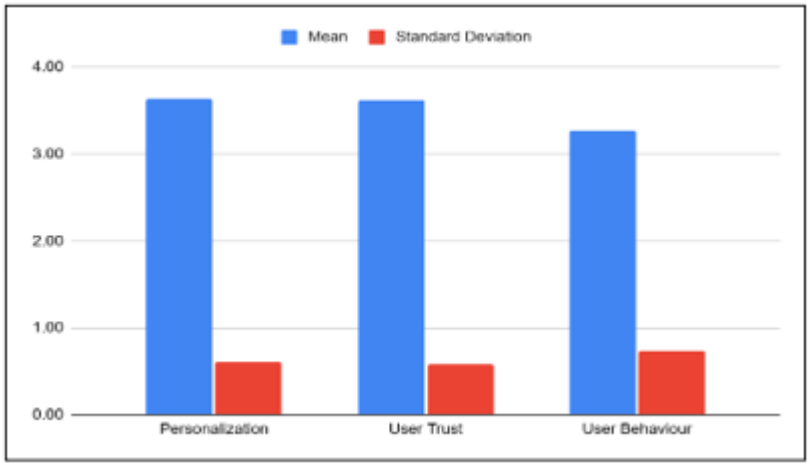
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Descriptive statistics were computed to get to know the general trend of responses. The values obtained were the average and standard deviation of the three primary variables namely, Personalization, User Trust, and User Behaviour.

The standard deviation is used to show the extent of variability in the responses of the respondents whereas the mean values reflect the average perception of respondents.

Variable	Mean	Standard Deviation
Personalization	3.64	0.61
User Trust	3.63	0.58
User Behaviour	3.27	0.73

The results show that general respondents gave moderate to high-level of personalization, trust, and behavioural engagement. The standard deviation points to the fact that the answers were rather uniform, and no extreme measurements were observed.



To examine the relationships between the variables, Pearson correlation analysis was conducted

Pearson Correlation Analysis			
Variables	**1**	**2**	**3**
1. Personalization	1	0.45	0.55
2. User Trust	0.45	1	0.44
3. User Behaviour	0.55	0.44	1

Note: $p < 0.001$

The two variables that are analysed in this paper are the relationship between personalization, user

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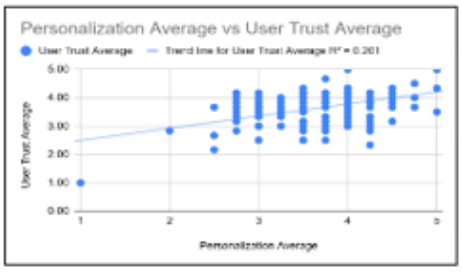
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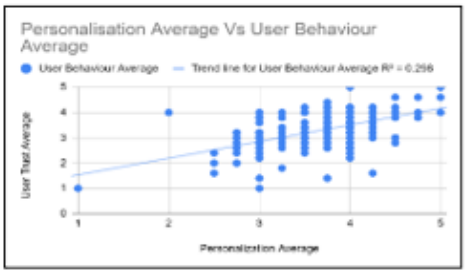
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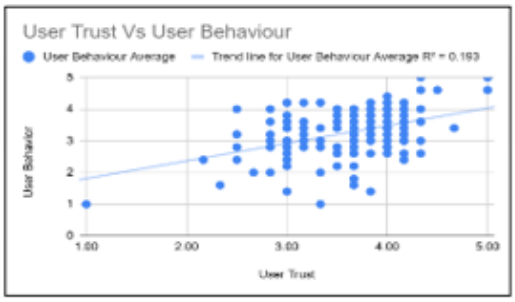
trust and user behaviour on digital space. Parametric and non- parametric statistical tests were used to test the hypothesis put forward. Pearson conducted a correlation analysis to test linear relation between the averaged values of the constructs and Spearman to test monotonic relation between the data in the form of rank. All the tests that were conducted against statistics were significant at a level of 0.05.
Descriptive statistics were computed to get to know the general trend of responses.
The values obtained were the average and standard deviation of the three primary variables namely, Personalization, User Trust, and User Behaviour.
The standard deviation is used to show the extent of variability in the responses of the respondents whereas the mean values reflect the average perception of respondents.



Personalization Vs User Trust



Personalization Vs User Behaviour



User Trust Vs User Behaviour

Since the data was collected using a five-point Likert scale, Spearman rank correlation was also conducted to confirm the reliability of the findings.

Relationship	Spearman's ρ	p-value
Personalization – User Trust	0.61	< 0.001
Personalization – User Behaviour	0.7	< 0.001
User Trust – User Behaviour	0.64	< 0.001

Pearson results were consistent with Spearman results of correlation. All the relationships were statistically significant and positive. This confirms the fact that relationships are not volatile, but the relationships are not affected by the scale of measurement.

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Conclusion:

This research reveals that personalization recommendation systems lead to increased user trust and subsequent behaviour on digital platforms. A positive and statistically significant relation was identified between personalization, trust and user engagement. If the users find recommendations personalized and relevant and are helpful, they are most likely to trust and increase their engagements with the platforms.

Balanced and sustainable growth on digital platforms needs innovative technology to be paired with responsible practices. Issues like privacy, fairness, and transparency should be paramount in developing personalization recommendation systems to sustain user trust. Human values should be at the core of all personalized systems.

Properly used recommendation systems in AI would further help the users and build strong relations over the time.

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FROM IDEA TO INCOME: A FINANCIAL STUDY OF OWN HERBAL MOSQUITO REPELLENT STARTUP

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Abstract:

This study examines the financial feasibility of establishing a small-scale herbal mosquito repellent startup using natural ingredients such as neem, nirgundi, camphor, and cow dung powder. A descriptive research design was adopted, and primary data were collected from 248 respondents through structured questionnaires.

Statistical analysis, including chi-square testing using Jamovi (Version 2.3), was conducted to examine the relationship between awareness and purchase intention. The results indicate significant association between awareness of herbal repellents and future purchase intention ($\chi^2(4, N = 248) = 74.3, p < .001$). Financial analysis shows an initial investment of ₹3,47,000, an estimated annual profit of ₹2,28,384, a break-even point of 8,908 boxes annually, a payback period of approximately 1.52 years, and a return on investment of 65.8%. The findings suggest that the proposed herbal mosquito repellent startup is financially viable and has strong market potential, supported by increasing consumer preference for safe and natural products.

Keywords: *Herbal Mosquito Repellent, Startup, Financial study, Eco-friendly Product, Profitability, Consumer Behavior.*

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Introduction:

In today's time, mosquito-borne diseases like dengue and malaria are increasing rapidly. Many people are looking for safe and natural alternatives instead of chemical-based mosquito repellents. Herbal mosquito repellents are becoming popular because they are eco-friendly, safe for children and elderly people, and have fewer side effects. This research focuses on converting a business idea into income by starting an herbal mosquito repellent startup. The study mainly examines the financial aspects such as cost of production, pricing, demand, revenue, and profitability. The main purpose of this research is to analyze whether starting an herbal mosquito repellent business is financially profitable and can generate sustainable income.

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Statement of Problem:

Many studies focus on the effectiveness, ingredients, and health benefits of herbal mosquito repellents, as well as consumer preference for natural products. However, very limited research examines the financial aspects of starting a small-scale herbal mosquito repellent business. Therefore, this study aims to fill this gap by providing a financial analysis of converting a herbal mosquito repellent idea into a sustainable income-generating startup

Significance of the Study:

This study is significant as it promotes an eco-friendly herbal mosquito repellent business that can create multiple economic and social benefits. The use of natural ingredients such as neem, tulsi, and other herbal materials can increase farmers' revenue by generating additional demand for medicinal and aromatic crops. It encourages sustainable agricultural practices and strengthens the rural supply chain. The product provides an eco-friendly alternative to chemical-based mosquito repellents, thereby reducing environmental pollution and chemical exposure. It also has a positive impact on health, as herbal products are generally safer for children, elderly people, and regular household use. Moreover, the startup model can create employment opportunities for rural youth, women, and self-help groups through small-scale production and distribution activities. It supports self-employment and promotes entrepreneurship at the grassroots level. By encouraging local production and consumption, the business contributes to economic circulation within the community. In the long run, the growth of such small-scale industries can contribute to the country's GDP and overall economic development.

Thus, the study highlights both financial viability and broader socio-economic benefits.

Limitations of the Study:

- Financial analysis is based on estimated costs and projected sales, which may differ from real market conditions.
- Seasonal changes in mosquito population may affect demand and profitability.

Research Objectives:

- To analyze the market demand for herbal mosquito repellent products.
- To examine consumer awareness and preference towards herbal mosquito repellents.
- To study the pricing acceptability of the product among consumer.
- To estimate the initial investment required to start the herbal mosquito repellent startup.
- To evaluate the estimated profit of the herbal mosquito repellent business.

Research Hypothesis:

Hypothesis 1:

1. H_0**:** There is no significant relationship between awareness of herbal repellents and purchase intention.
2. H_1: There is a significant relationship between awareness of herbal repellents and purchase intention.

Hypothesis 2:

1. H_0: Starting an herbal mosquito repellent business is not profitable.
2. H_1: Starting an herbal mosquito repellent business is profitable

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Literature Review:

1. ***Chadha, A., & Vohra, S. Step Towards SOCIAL ENTREPRENEURSHIP:***
   The chapter by A. Chadha and S. Vohra in CSR and Sustainable Development: A Multinational Perspecti ve explores the idea of social entrepreneurship and how waste materials and inexpensive resources might be used to create mosquito repellant goods.According to the study, mosquito repellents that are both econ omical and environmentally benign can benefit low-income communities by generating employment and small business chances. It links waste management, inclusive growth, and sustainable development to the manufacturing of mosquito repellent. The chapter is pertinent for a herbal mosquito repellent startup study since it demonstrates that producing inexpensive re pellents can be both commercially and socially advantageous.
2. ***Hazarika, H., & Krishnatreyya, H. (2025).***
   The creation of herbal dhoopbatti utilising natural substances such as cow dung, cow ghee, tulsi, campho r, jasmine, and guggul is explained in the research study titled "Preparation and Evaluation of Herbal Dh oopbatti for Cleansing the Air" published in the World Journal of Pharmaceutical Research (2025).Accor ding to the study, dhoopbatti made from herbs has antibacterial qualities and lowers airborne microbes. Because of the cow dung and medicinal plants, it also acts as a natural mosquito repellant. Because it is profitable and made from inexpensive, readily available raw ingredients, it may be produced commercial ly. The article concludes that herbal dhoopbatti has good market potential and can be a safe, natural subs titute for chemical-based air fresheners and insect repellents.
3. ***Ainane, A., Abdoul-Latif, F. M., Abdoul-Latif, T. M., & Ainane, T. (2021).***
   The viability of using the essential oil from Rosmarinus officinalis (rosemary) to produce an insecticide is investigated in the study by Ainane et al. (2021). It examines earlier studies demonstrating the efficacy of rosemary oil and discusses its chemical makeup and insecticidal qualities. Additionally covered in the study are formulation strategies, extraction procedures, and variables influencing product stability. It also examines economic viability, taking into account market demand, production costs, raw material availability, and environmental advantages. The study supports the possibility of plant-based mosquito repellent solutions by concluding that pesticides based on rosemary are both technically and financially feasible.
4. ***Tyagi, B. K. (2016).***
   With a particular emphasis on herbal products, B. K. Tyagi's chapter in the book Herbal Insecticides, Re pellents and Biomedicines: Effectiveness and Commercialization describes various mosquito control stra tegies.The increasing prevalence of diseases spread by mosquitoes and the drawbacks of chemical pestic ides, including resistance, expense, and environmental risks, are covered. Herbal insecticides and plant- based repellents are seen as safer and more environmentally friendly substitutes due to these problems. T he chapter also emphasizes the value of ethnobotanical research and traditional knowledge in determinin g which plants are best for controlling mosquitoes.All things considered, the study backs the creation, tes ting, and marketing of herbal insect repellents as an effective and long-term vector control measure.

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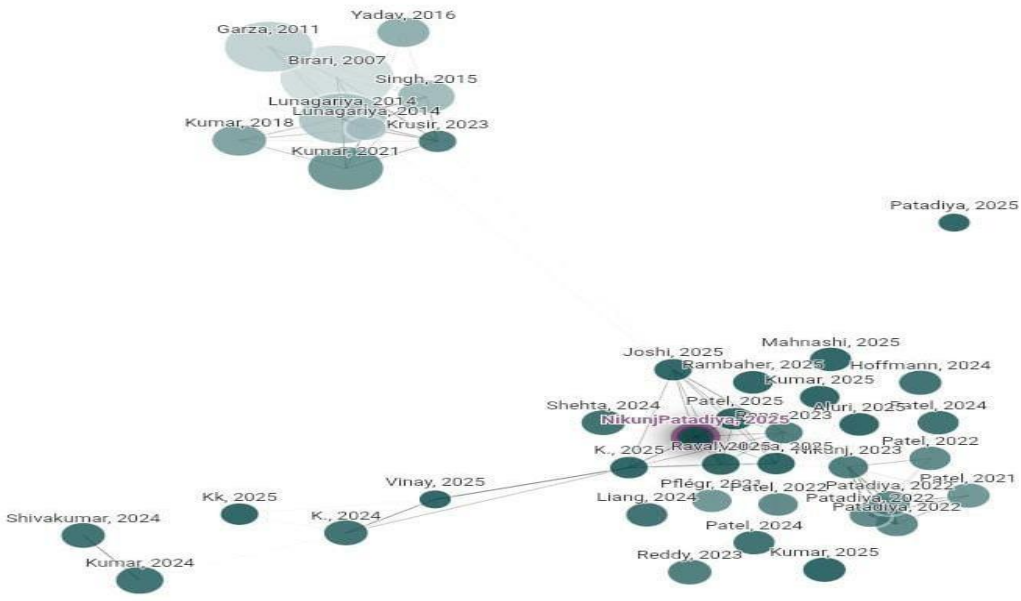
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5. ***Shriram, B. K., Devhare, L. D., Mehrotra, A., Deokar, S. S., & Singh, S. P. (2023).***
   A study on the creation and assessment of a mosquito repellent stick with natural and plant-based chemicals was carried out by Shriram et al. (2023). The goal of the study was to create a mosquito repellent that was safe, efficient, and easy to use instead of chemical ones. Burning time, stability, aroma , and repellant effectiveness were among the criteria that were assessed in the study. The results showed that the herbal stick was safe for everyday usage in the home and effective in keeping mosquitoes away. This study reinforces the current research's practical basis and demonstrates that creating herbal insect re pellent products is feasible.
6. ***Diiro, G. M., Kassie, M., Muriithi, B. W., Gathogo, N. G., Kidoido, M., Marubu, R., ... & Mutero, C. M. (2020).***
   In a study published in Sustainability, Gracious M. Diiro et al. (2020) investigated the willingness of families in malaria-prone Kenyan communities to pay (WTP) for a plant-based mosquito larvicide. The product used a biopesticide that is safe for the environment to control mosquitoes when they are still larvae. Household surveys and experimental auctions were used to get information about the amount that people were willing to donate. According to the findings, most participants were prepared to pay, particularly for reasonably priced goods. WTP was considerably raised by higher income, better education, and enhanced knowledge about malaria. The study found that if eco-friendly mosquito control methods are backed by appropriate pricing and awareness campaigns, they have a high market potential and community acceptance



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Research Methodology:

SR.NO	METHODS	PARAMETERS
1	Research type	Research report (descriptive)
2	Source of data collection	Primary and secondary data collection
3	Data collection tool	Survey based structured (questionnaires)
4	Data analysis tool	Jamovi (Version 2.3)
5	Sampling size	248
6	Sampling method	Convenience Sampling

Product and Operational Framework:

Product Description:

The herbal mosquito repellent product is prepared using natural and plant-based ingredients. Unlike chemical mosquito repellents that contain synthetic substances, herbal alternatives are environmentally friendly, biodegradable, and comparatively safer for regular household use.

The product is intended for residential households, rural communities, and consumers who prefer natural mosquito control solutions. Due to increasing awareness about the harmful effects of chemical repellents, demand for herbal products is gradually increasing.

The proposed product is a herbal mosquito repellent incense prepared using natural ingredients such as neem leaves, nirgundi leaves, cow dung powder, and natural binding agents. These materials are locally available and economical, making production suitable for small-scale operations.

Raw Materials:

The herbal mosquito repellent product is manufactured using easily available and cost-effective natural ingredients. The key raw materials include:

- Neem leaves
- Nirgundi leaves
- Camphor
- Cow dung powder (base material)
- Water (for mixing and binding)

These materials are locally available and economical, making the product suitable for small-scale and home-based production. The use of herbal ingredients also enhances environmental sustainability.

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Production Process:

1. Collection of raw materials from local suppliers.
2. Drying of plant materials to remove moisture.
3. Grinding into fine powder.
4. Mixing ingredients with binding material.
5. Shaping into incense form using molds.
6. Natural drying for 24–48 hours.
7. Packaging using eco-friendly materials.

The process requires minimal machinery, allowing home-based or micro-enterprise production



Initial Investment:

Sr. No.	Particulars	Annual Cost	Calculation
1	Mixing Equipment	₹. 10,000	-
2	Drying Trays	₹. 5,000	-
3	Initial Raw Material Stock from Farmers	₹. 1,20,000	10,000*12(months)
4	Rent	₹. 96,000	8000*12(months)
5	Labour	₹. 96,000	8000*12(months)
5	Miscellaneous Expenses	₹. 20,000	-
	Total	**₹. 3,47,000**	

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Source of Investment – Own Investment (Own Capital) – Equal Contribution

Costing of herbal mosquito repellent dhoop per unit

Material Cost:

Ingredients	**Quantity per dhoop**	**Market Price per unit of dhoop**	**Basis/Calculation**	**Cost per dhoop**
Neem Leaves	3 gram	₹. 50 / 100 g	3/100*50	₹. 1.5
Nirgundi Leaves	1.5 gram	₹. 40 / 100 g	1.5/100*40	₹. 0.6
Camphor	0.5 gram	₹. 100 / 100 g	0.5/100*100	₹. 0.5
Cow Dung	15 gram	₹. 10 / 100 g	15/100*10	₹. 1.5
Total				**₹. 4.1**

Labor Cost (Production capacity per month – 9100 Dhoops i.e. 1300 Boxes containing 7 dhoops)

Monthly Wages	**Production Capacity per month**	**Basis/Calculation**	**Labor cost per dhoop**
₹. 8,000	9100 Dhoops i.e.1300 Boxes containing 7 dhoops	8000 / 9100	₹. 0.879

Other Expenses Per Unit of Dhoop Packaging cost per Unit of Dhoop - ₹. 0.7 Electricity per Unit of Dhoop - ₹. 0.5 Contingencies per Unit of Dhoop - ₹. 0.3

Total Cost Per Unit of Dhoop

(Material Cost = 4.10 Labour Cost = 0.88

Other Expenses = 1.50) = ₹. 6.479

Total Cost Per Box of Dhoop (containing 7 dhoops) - ₹. 45.35 Selling Price Per Unit of Dhoop - ₹. 9

Selling Price Per Box of Dhoop (containing 7 dhoops) - ₹. 63 but will sold in ₹. 60 Profit Per Box of Dhoop (containing 7 dhoops) - ₹. 14.65

Monthly Production = 1,300 boxes

Monthly Profit = 1,300 × 14.64

= **₹19,032**

Annual Profit = 19,032 × 12

= ***₹2,28,384***

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Break-Even Analysis

Classification of Costs Fixed Costs (Annual)

Particular	**Amount (₹)**
Rent	96,000
Labour	96,000
Miscellaneous	20,000
Total Fixed Cost	**₹ 2,12,000**

Monthly Fixed Cost = 17,667

Variable Cost per Dhoop (excluding fixed labour)

Material + Packaging + Electricity + Contingencies

= 4.10 + 1.50

= **₹5.60**

Contribution Analysis:

Selling Price per Dhoop = ₹9 Variable Cost per Dhoop = ₹5.60

Contribution per Dhoop = 9 – 5.60

= **₹3.40**

Contribution per Box = 3.40 × 7

= **₹23.80**

Break-Even Point (BEP)

BEP (Units) = Fixed Cost / Contribution per Unit

Annual BEP (Dhoops) = 2,12,000 / 3.40

= ***62,353 dhoops***

Annual BEP (Boxes) = 62,353 / 7

= ***8,908 boxes***

Monthly BEP (Boxes) = 742 boxes

Margin of Safety:

Monthly Production = 1,300 boxes Monthly BEP = 742 boxes

Margin of Safety = 1,300 – 742

= 558 boxes

Margin of Safety (%) = (558 / 1,300) × 100

= **42.9%**

This indicates a strong operational safety margin.

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Payback Period:

Initial Investment = ₹3,47,000 Annual Profit = ₹2,28,384

Payback Period = 3,47,000 / 2,28,384

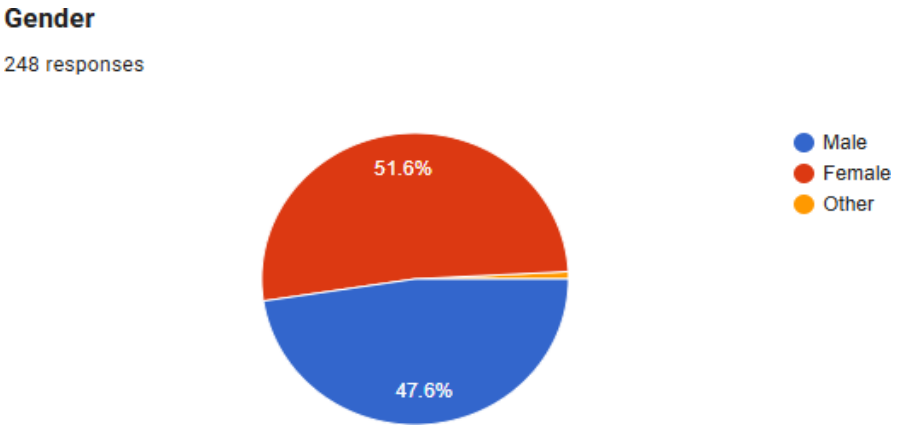
= ***1.52 years (approximately 18 months) Return on Investment (ROI)***

ROI = (Annual Profit / Initial Investment) × 100

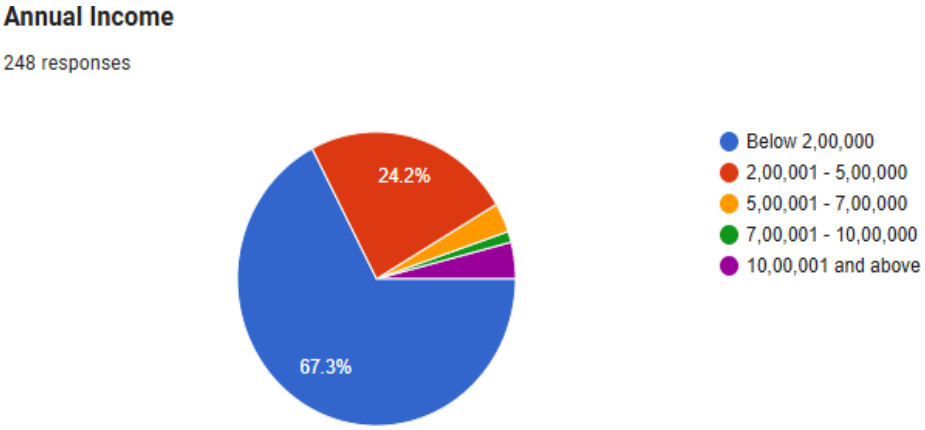
= (2,28,384 / 3,47,000) × 100

= **65.8%**

Data Analysis and Interpretation:



Nearly equal gender involvement in the survey is indicated by the following chart, which shows that 51.6% of respondents are female, 47.6% are male, and 0.8% fall into other categories



The data shows that the majority of respondents are in lower income levels, with 67.3% earning less than ₹2,00,000 yearly, 24.2% earning between ₹2,00,001 and ₹5,00,000, and only a small minority earning more than ₹5,00,000.

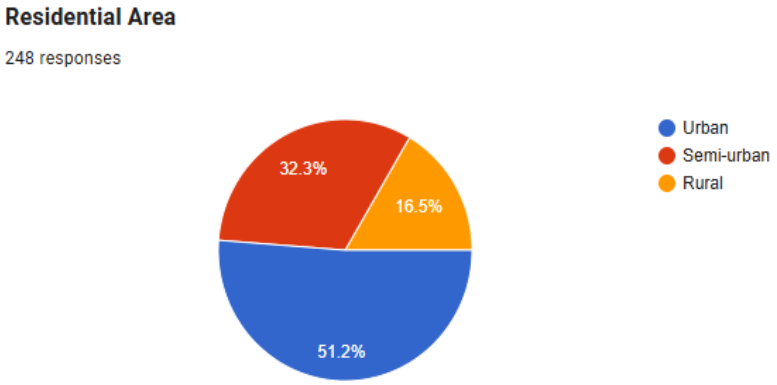
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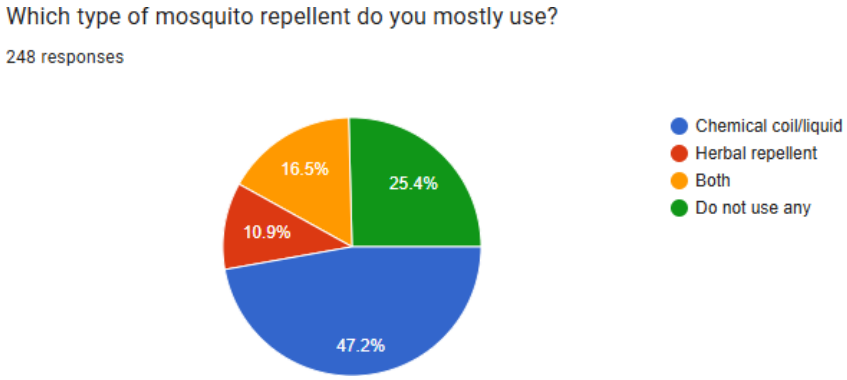
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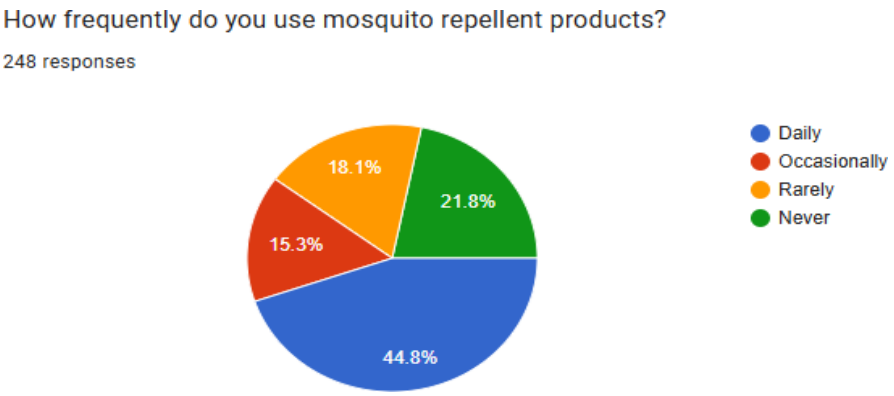
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According to the above chart, 51.2% of respondents reside in urban areas, 32.3% in semi-urban areas, and 16.5% in rural areas, reflecting greater representation from urban regions.



Among the 248 respondents, 47.2% of them used the chemical coil/liquid option, according to the statistics. A total of 27.4% of people choose either herbal repellents (10.9%) or a mix of both (16.5%), while 25.4% of people do not use any repellent at all.



According to the following graph, 21.8% of respondents never use mosquito repellents, 15.3% do so occasionally, 18.1% infrequently, and 44.8% do so every day. This suggests a consistent market for items that repel mosquitoes.

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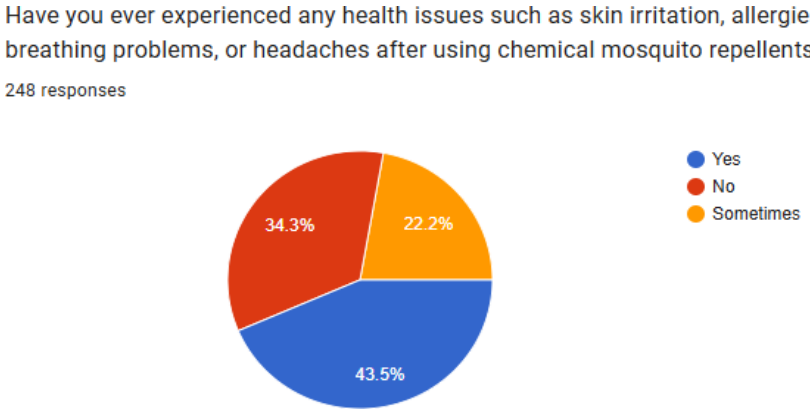
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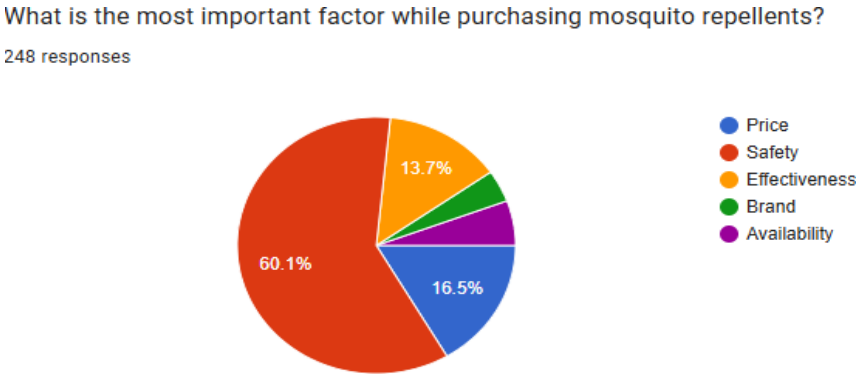
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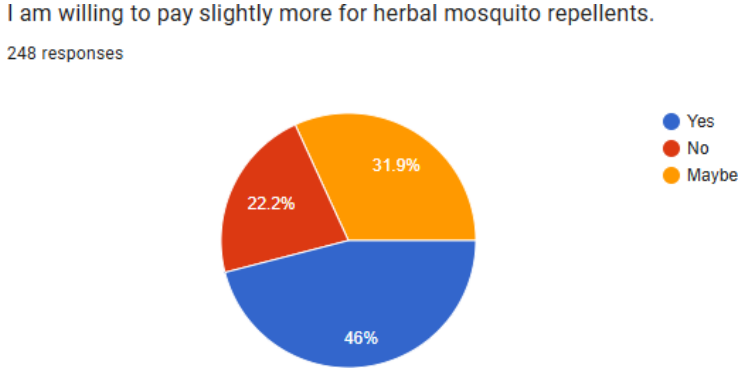
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According to the graph, 22.2% of respondents occasionally have problems because of chemical repellents, and 43.5% of respondents have had health problems. Nearly two-thirds of responders are impacted, which emphasizes the need for safer substitutes.



According to the report, consumers' top concern is safety, as 60.1% of respondents say that is the most crucial consideration when buying mosquito repellents. Brand and availability are far less important factors in the decision-making process, with price and effectiveness coming in second at 16.5% and 13.7%, respectively.



Given that 46% of the 248 respondents are expressly willing to pay more for herbal insect repellents, the survey shows a significant market potential for natural alternatives. Even after accounting for the 31.9% who selected "Maybe," almost 78% of people are prepared to pay more for herbal items, compared to just 22.2% who are not

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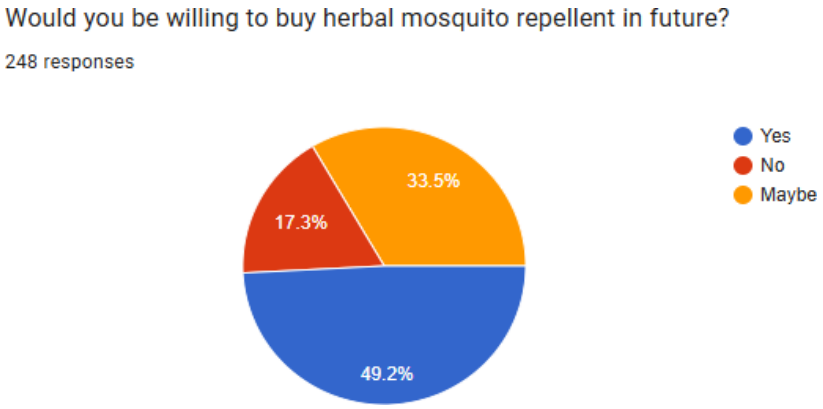
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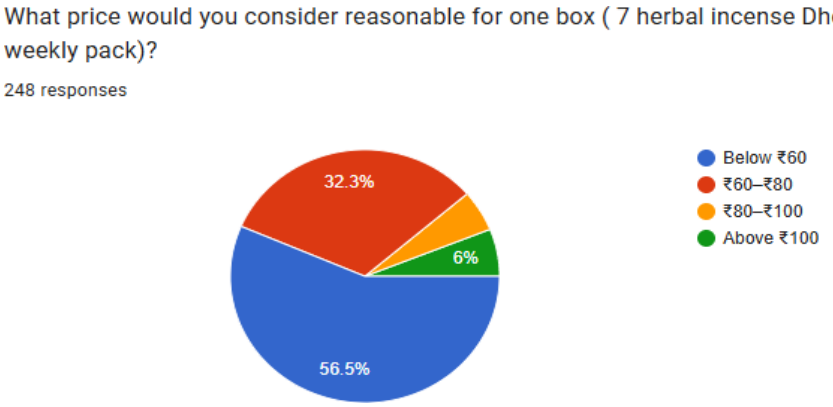
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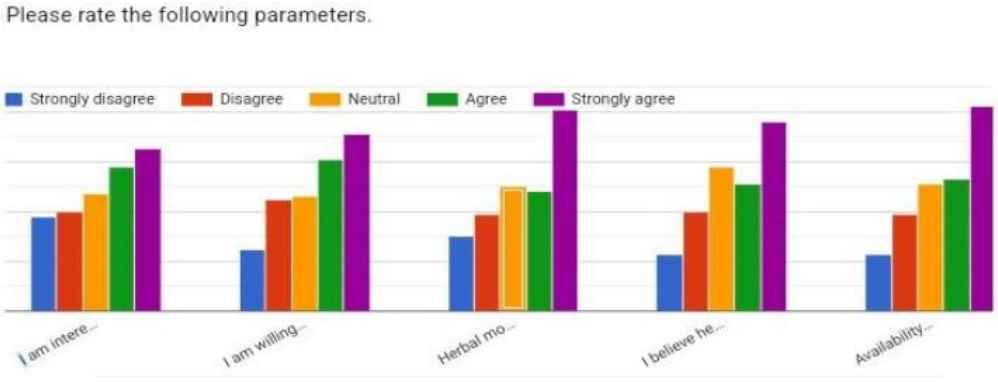
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Out of the 248 respondents, 49.2% said they would definitely use herbal mosquito repellents in the future, indic ating a robust market for herbal alternatives. Together with the 33.5% who selected "Maybe," almost 83% of par ticipants indicated that they would be open to using these items, whereas just 17.3% showed no interest at all.



According to the study, most of the 248 respondents are price conscious, with 56.5% thinking that a weekly pack of herbal incense Dhoop should cost less than ₹60. Only 11% of respondents would contemplate prices beyond ₹80, despite 32.3% being prepared to pay between ₹60 and ₹80. This indicates that setting the product's price at ₹60 would be appropriate for greatest acceptance.



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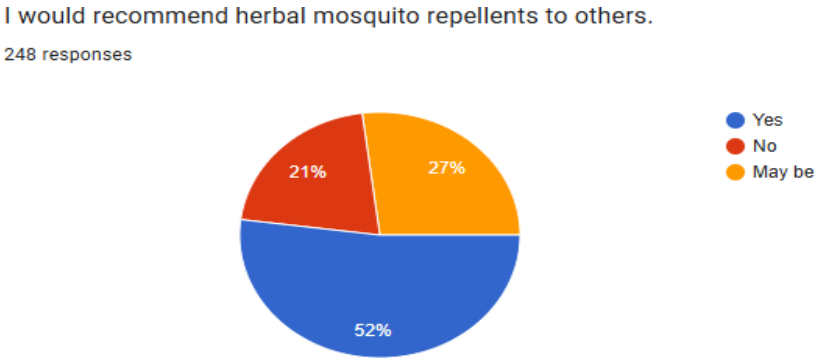
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The bar chart indicates a strong positive sentiment toward herbal mosquito repellents, with the highest frequency of respondents choosing "Strongly agree" across all five parameters. This suggests that consumers are not only highly interested and willing to try these products but also hold a firm belief in their benefits and the importance of their availability.



According to the following chart, 27% of respondents might suggest herbal insect repellents, and 52% of respondents would. This suggests strong word-of-mouth potential and favorable customer impression.

Contingency Tables

Contingency Tables

Are you aware of the herbal mosquito repellent?	Would you be willing to buy herbal mosquito repellent in future? Maybe	No	Yes	Total
Maybe	46	6	7	59
No	22	29	71	122
Yes	15	8	44	67
Total	83	43	122	248

χ^2 Tests

	Value	df	p
χ^2	74.3	4	< .001
N	248		

A Chi-square test of association was conducted to examine the relationship between awareness of herbal mosquito repellents and willingness to purchase in the future. The results showed a statistically significant association, $\chi^2(4, N = 248) = 74.3$, $p < .001$. Therefore, the null hypothesis was rejected, indicaties that awareness significantly influences purchase intention.

Conclusion:

This study evaluated the financial feasibility and market potential of establishing a herbal mosquito repellent start up. The findings reveal a strong consumer inclination toward herbal alternatives. Statistical analysis confirmed a significant relationship between awareness and purchase intention, highlighting the importance of consumer education and marketing strategies. From a financial perspective, the project demonstrates strong

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viability. The calculated break-even point of 8,908 boxes annually is significantly lower than the projected annual production capacity of 15,600 boxes, resulting in a margin of safety of 42.9%. The estimated annual profit of ₹2,28,384, payback period of approximately 18 months, and ROI of 65.8% indicate that the start up has the potential to generate sustainable income within a relatively short time frame. Moreover, beyond financial profitability, the venture contributes to environmental sustainability, rural employment generation, and support for local agricultural supply chains. However, profitability projections are based on estimated costs and demand assumptions, and actual performance may vary due to seasonal fluctuations and competitive market conditions. Overall, the study concludes that establishing a small-scale herbal mosquito repellent start up is both financially feasible and socially beneficial, provided that effective pricing, awareness campaigns, and quality control measures are implemented.

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FROM WRITING TO GROWING: A MARKETING STUDY ON PLANTABLE STATIONERY AS A SUSTAINABLE PRODUCT

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Abstract:

This study examines the marketing potential of plantable stationery as a sustainable alternative to conventional stationery products. With rising environmental concerns and increasing demand for eco- friendly solutions, plantable stationery offers an innovative product that combines functionality with environmental regeneration. A descriptive research design was adopted, and primary data were collected from 252 respondents using a structured questionnaire. Reliability was confirmed through Cronbach's alpha, and hypotheses were tested using Pearson correlation and Welch's ANOVA. The findings reveal a significant positive relationship between consumer awareness and purchase intention, as well as between environmental concern and consumer preference. Marketing strategies were also found to significantly influence buying behaviour. The study concludes that strategic green marketing and awareness initiatives can enhance market acceptance and promote sustainable consumption. However, the study is limited by its relatively small sample size and restricted geographic coverage, which may affect the generalizability of the findings.

Keywords *:Sustainable product, Marketing strategies, Consumer behavior, Environmental awareness, Plantable stationery, Sustainable startups.*

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Introduction:

In an age where climate change headlines dominate global discussions, sustainability has become a critical concern in contemporary economic and environmental discussion. Consumers today are not just buying products; they are buying values, responsibility, and impact. As environmental concerns such as deforestation, plastic waste, and resource depletion intensify, the demand for innovative eco-friendly alternatives is rapidly growing. One such creative breakthrough is plantable stationery—an idea that transforms a simple writing tool into a symbol of regeneration and environmental hope.

Plantable stationery, made with seeds embedded in it, redefines the lifecycle of everyday products. Instead of ending up in landfills, used pencils, pens, or notebooks can be planted to grow into herbs, flowers, or vegetables. This unique blend of functionality and sustainability appeals strongly to environmentally conscious consumers,

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educational institutions, and organizations aiming to promote green living. It turns the act of writing into an act of growing, creating both emotional and environmental value.

Despite its strong symbolic appeal and market potential, plantable stationery remains underexplored in mainstream markets due to limited awareness and pricing perceptions. Strategic marketing, storytelling, and consumer education play a crucial role in shaping acceptance and purchase intentions. Therefore, understanding consumer perceptions and effective marketing approaches is essential to position plantable stationery as not just a product, but a movement toward sustainable consumption.

Statement of Problem:

Environmental degradation has increased due to the growing use of plastic and non-biodegradable materials, including conventional stationery products that contribute to waste and pollution. As sustainability becomes more important, eco-friendly alternatives such as plantable stationery have emerged, offering the possibility of reducing waste while supporting environmental conservation. However, plantable stationery is still a relatively new concept, and its success in the market largely depends on consumer acceptance and effective marketing strategies. Existing studies mainly emphasize environmental benefits, while limited attention has been given to its marketing potential and consumer behaviour. In particular, there is a lack of understanding of how consumer awareness, environmental concern, and green marketing strategies influence purchase intentions. Therefore, this study seeks to examine these factors and evaluate the marketing potential of plantable stationery as a sustainable alternative.

Significance of the Study:

The study on plantable stationery is important because it promotes eco-friendly alternatives to traditional stationery that help reduce environmental waste. It helps understand consumers' buying behaviour and awareness regarding sustainable products. The research also identifies effective marketing strategies that encourage people to adopt plantable stationery. Additionally, the study supports businesses, educational institutions, and policymakers in promoting environmentally responsible products and sustainable practices.

Limitations of the Study:

The study is limited by the use of convenience sampling and a respondent group largely consisting of students. Therefore, the findings may not fully represent the behavior of the broader consumer population.

Objectives of the Study:

1. To evaluate consumer awareness of plantable stationery products.
2. To investigate the influence of environmental concern on consumer preference for plantable stationery.
3. To analyze the impact of green marketing strategies on consumer buying behavior towards plantable stationery.

Research Hypothesis:

Hypothesis 1:

1. H0: There is no significant relationship between consumer awareness of plantable stationery and their purchase intention.

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2. H1: There is a significant relationship between consumer awareness of plantable stationery and their purchase intention.

Hypothesis 2:

1. H0: Environmental concern does not significantly influence consumer preference towards plantable stationery.
2. H1: Environmental concern significantly influences consumer preference towards plantable stationery.

Hypothesis 3:

1. H0: Marketing strategies do not have a significant difference on customers' buying behaviour towards plant-based stationery products.
2. H1: Marketing strategies have a significant difference on customers' buying behaviour towards plant- based stationery products.

Literature Review:

1. ***Sharma, S. N., & Subba, R. (2025).***
   According to Sharma and Subba (2025), green companies are crucial for fostering sustainability and economic expansion. In addition to making money, these environmentally conscious companies work to lessen pollution, save resources, and promote sensible consumption. They reduce waste and promote a low-carbon economy by implementing cutting-edge technologies and circular economy principles like recycling and reuse. The study comes to the conclusion that green entrepreneurship demonstrates how economic growth and environmental preservation may coexist.
2. ***Devi Juwaheer, T., Pudaruth, S., & Monique Emmanuelle Noyaux, M. (2012)***
   This study of the literature looks at how green marketing tactics affect Mauritius consumers' purchase decisions. It concludes that encouraging eco-friendly characteristics, such as recyclable packaging and sustainable branding, increases consumer preference and fosters loyalty and confidence. However, purchasing decisions are also influenced by elements including cost, quality, and awareness. In general, green marketing encourages sustainable consumption; but, for long-term effects, affordability and accessibility must be matched.
3. ***Lily, L., Lee, K. Y. M., Yi, S., & Ling, P. S. (2025).***
   Environmental concern is a significant moderating factor in Lily, Lee, Yi, and Ling's (2025) research on university students' intentions to purchase eco-friendly stationery. They discover that while high costs, restricted availability, and low awareness decrease actual purchasing, favorable attitudes, perceived value, and social impact enhance purchase intention. Students who care deeply about the environment are more likely to make actual purchases based on their favorable sentiments.
4. ***Christopher, D. S., Priya, B. M., & Priyadharshini, M. S. (2023)***
   According to the literature analysis, consumers' opinions of green products—which are frequently regarded as safe, healthy, and ecologically friendly—have improved as a result of growing environmental consciousness. However, actual purchases may be restricted by elements such as exorbitant costs, ignorance,

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and doubt regarding product promises. The study comes to the conclusion that the main factors influencing the uptake of green products are affordability, appropriate consumer education, and faith in the genuineness of the product.

5. ***De Medeiros, J. F., Ribeiro, J. L. D., & Cortimiglia, M. N. (2014)***

   Key elements of successful ecologically sustainable product innovation are identified by the authors' systematic review. Collaboration both inside and beyond the company, a strong commitment from management, and the incorporation of sustainability into corporate strategy are all necessary for success. While high prices, technological limitations, and unsure market acceptability serve as impediments to innovation, consumer demand, restrictions, and competition also drive it. In general, sustainable product creation requires fostering an innovative culture and coordinating environmental objectives with business strategy.

6. ***Shaktawat, Pallavi. (2023)***

   According to the article, plantable pencils created from recycled paper contribute to the reduction of plastic pollution, paper waste, and deforestation. They have seed capsules that may be planted after use, converting waste into plants, in contrast to conventional pencils. Indian entrepreneurs' efforts and the straightforward production procedure demonstrate their potential for both revenue generating and environmental preservation. All things considered, plantable pencils encourage recycling, sustainability, and environmental consciousness.

Research Methodology:

Sr.No.	Methods	Parameters
1	Research Design	Descriptive
2	Sources of Data Collection	Primary Sources & Secondary Sources
3	Data collection Tool	Survey Based Structured (Questionnaires)
4	Data Analysis Tool	Jamovi (Version 2.3)
5	Sample Size	252
6	Sampling Method	Non-probability method using convenience sample
7	Reliability of data	Cronbach Alpha

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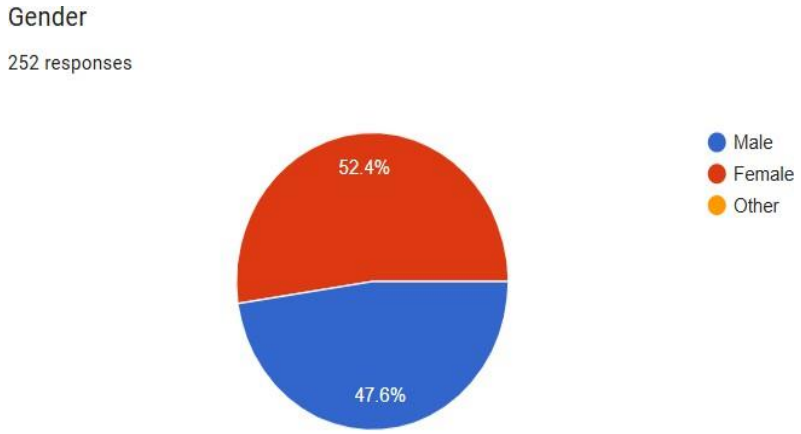
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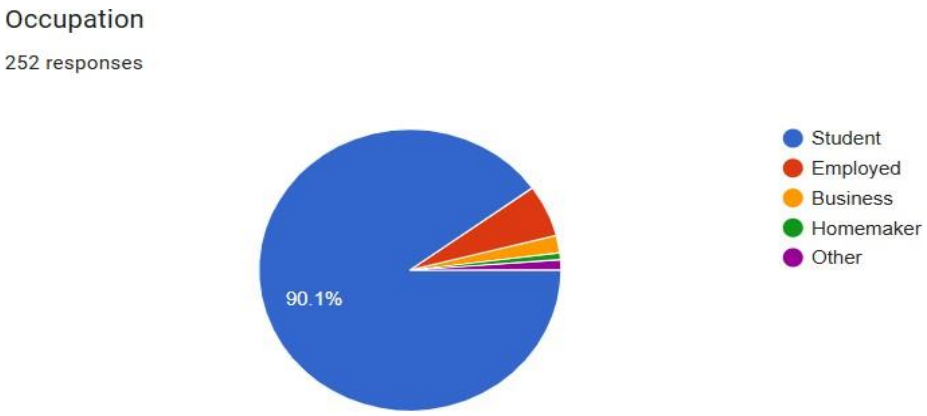
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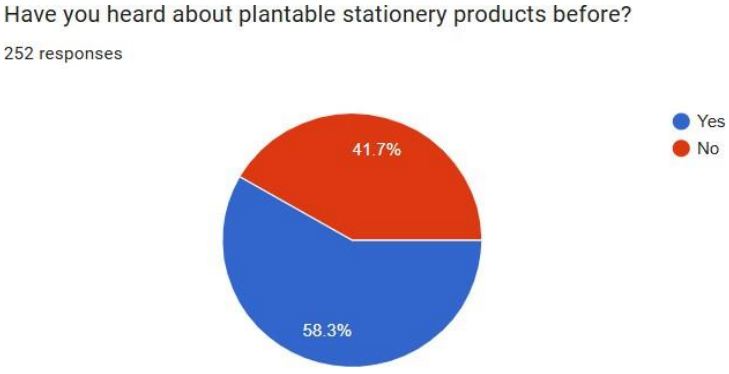
DATA ANALYSIS AND INTERPRETATION



With 52.4% of respondents being female and 47.6% being male, the gender distribution is about balanced, as the chart shows, with slightly more female involvement.



According to the figure, 90.1% of survey respondents are students, with the remaining respondents coming from a variety of professions. This suggests that the results primarily reflect the preferences of students.



According to the graph, 41.7% of respondents had never heard of plantable stationery products, compared to 58.3% who had. This suggests a moderate level of awareness, yet a sizable section of the intended audience is still not familiar with the idea.

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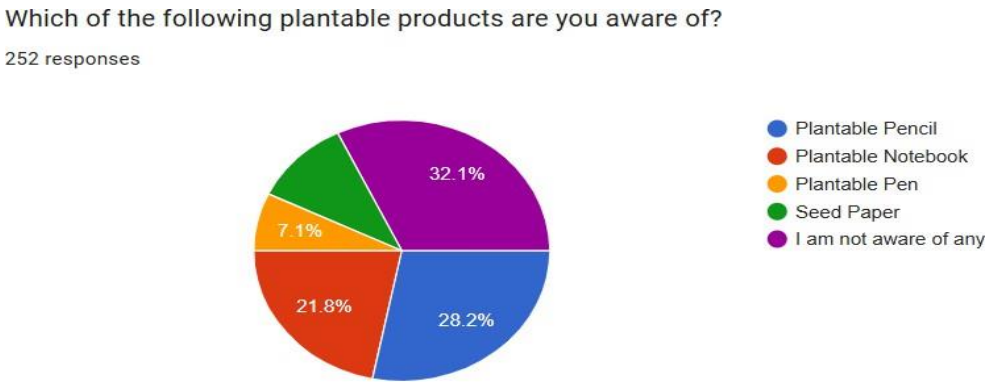
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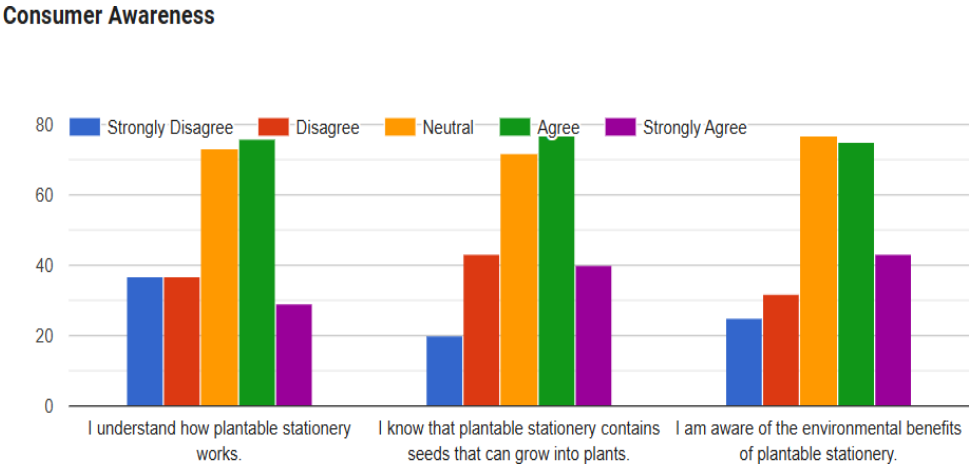
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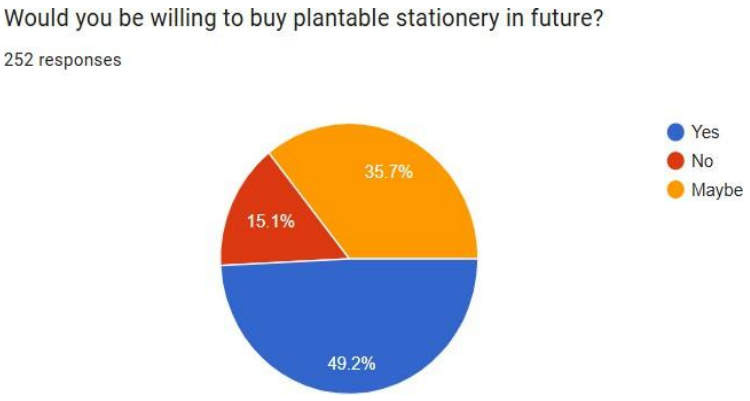
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Plantable products are unknown to 32.1% of respondents, according to the chart. The most well-known items among those who are aware are plantable pencils (28.2%), notebooks (21.8%), seed paper (10.8%), and pens (7.1%).



The graph indicates that most respondents have a positive awareness of plantable stationery and its advantages; nevertheless, some respondents are still unclear, suggesting that further education is necessary



With 49.2% wanting to buy, 35.7% contemplating, and only 15.1% reluctant to buy, the chart demonstrates a strong purchase intention for plantable stationery, suggesting good market potential.

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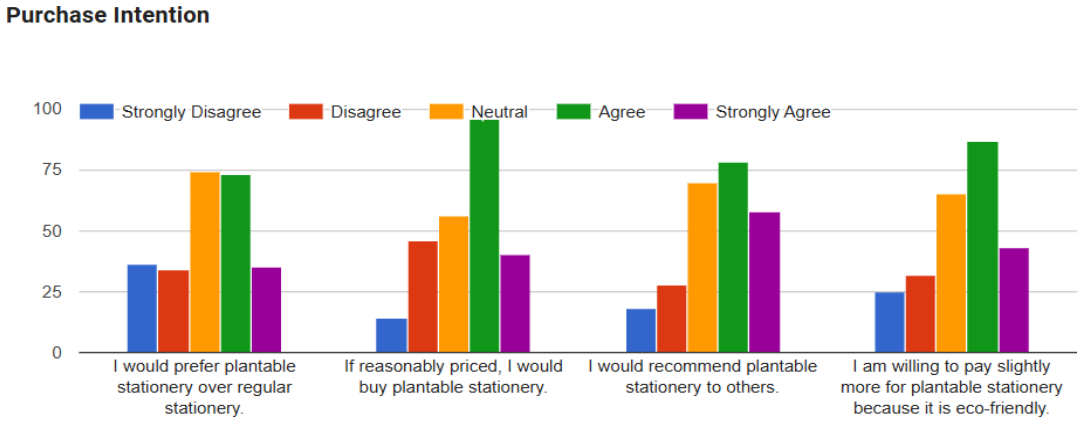
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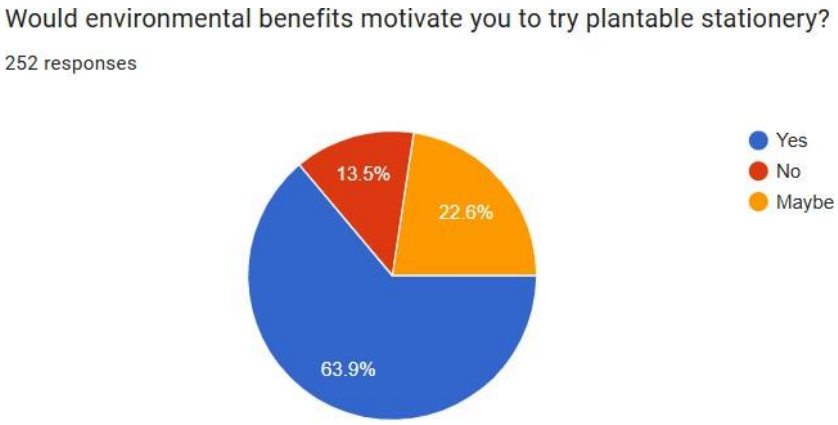
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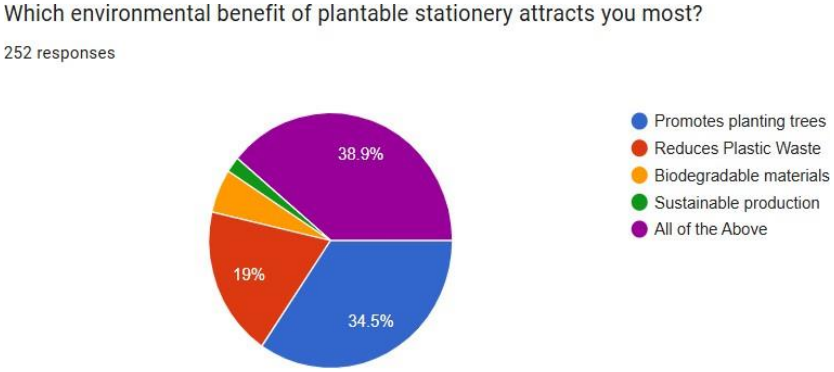
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Despite some lukewarm replies, the chart indicates substantial market potential and largely positive buy intention, particularly for recommendations and moderately priced products.



According to the chart, consumers are highly motivated by environmental benefits, with sustainability being a major factor and 63.9% of them wanting to try plantable stationery.



The chart shows that the most attractive environmental benefit is All of the Above 38.9%, indicating consumers value multiple sustainability aspects together. Promoting tree planting 34.5% and reducing plastic waste 19% are also significant motivators. Biodegradable materials and sustainable production attract comparatively fewer respondents individually.

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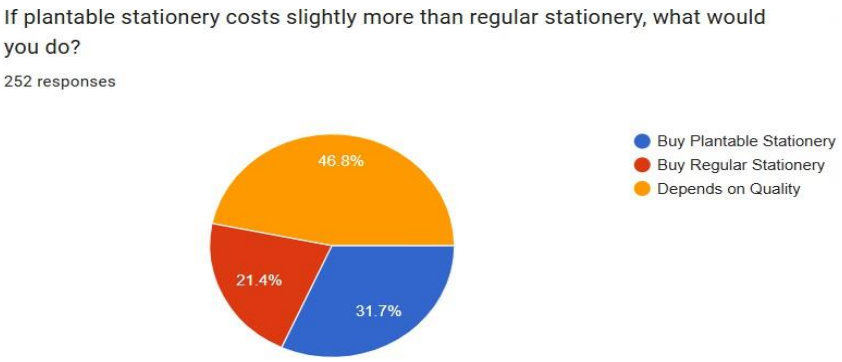
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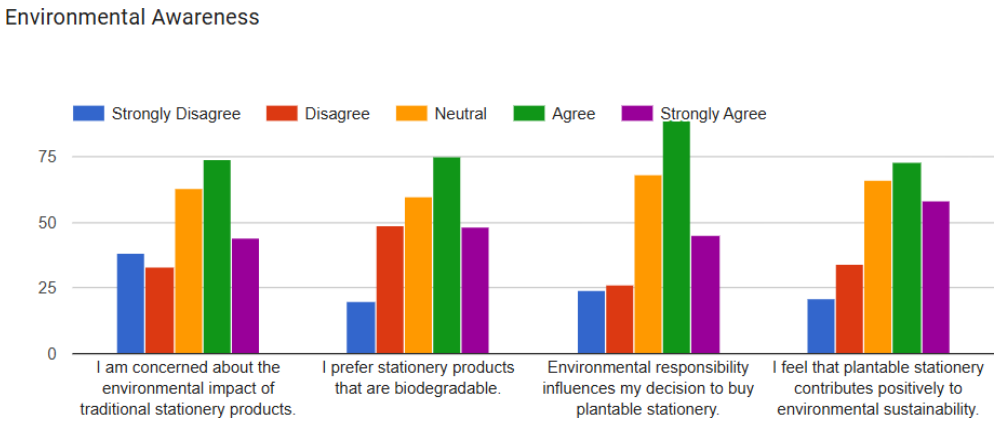
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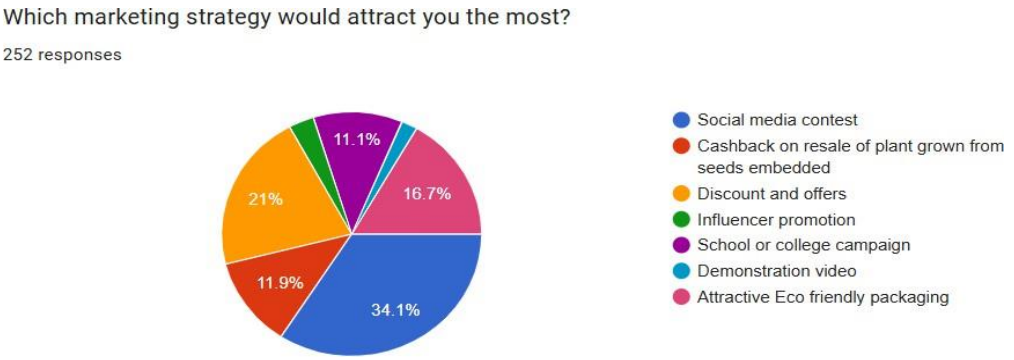
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The chart indicates that 46.8% of respondents say their decision would depend on quality if plantable stationery costs more. Meanwhile, 31.7% would still buy plantable stationery, while 21.4% would choose regular stationery. This suggests quality is a key factor in justifying a higher price.



The chart shows strong environmental awareness, with most respondents selecting Agree or Strongly Agree across all statements. Many express concern about traditional stationery's impact and prefer biodegradable products. Environmental responsibility clearly influences buying decisions and perceptions of plantable stationery's positive contribution.



The most popular marketing approach, according to the pie chart, is social media contests (34.1%), followed by discounts (21%) and environmentally friendly packaging (16.7%). Influencer marketing and demo videos are less successful than cashback (11.9%) and school promotions (11.1%).

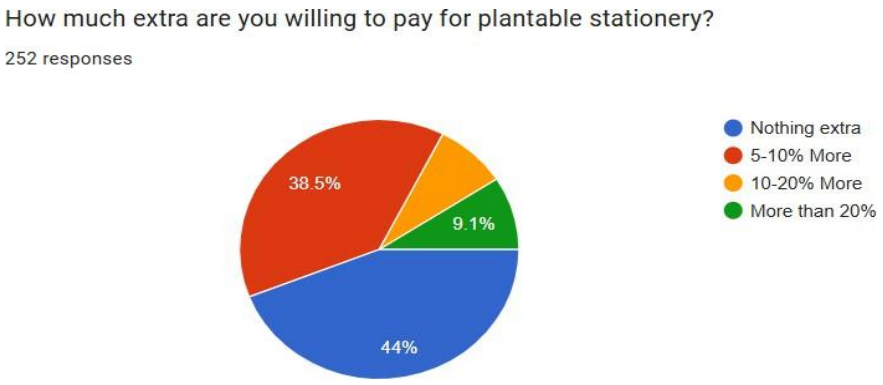
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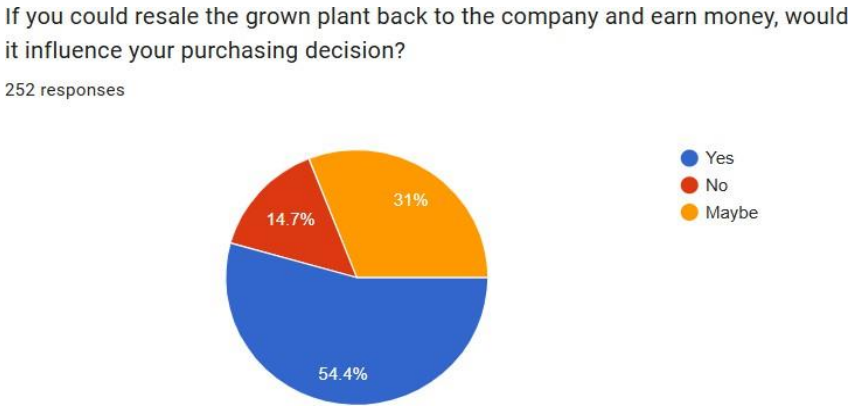
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A desire for eco-friendly products at little additional cost is indicated by the chart, which demonstrates considerable price sensitivity for plantable stationery, with 44% unwilling to pay more, 38.5% accepting a 5–10% premium, and few prepared to pay more.



The chart indicates that **54.4%** of respondents would be influenced to purchase if they could resell the grown plant and earn money.

About **31%** are uncertain, while only **14.7%** said it would not affect their decision. This suggests that a resale incentive could significantly boost purchasing interest.

Reliability Analysis

Scale Reliability Statistics

	Cronbach's α
scale	0.884

Item Reliability Statistics

	Item-rest correlation	If item dropped Cronbach's α
Aw1	0.780	0.831
Aw2	0.792	0.820
Aw3	0.752	0.855

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Reliability Analysis

Scale Reliability Statistics

	Cronbach's α
scale	0.924

Item Reliability Statistics

	Item-rest correlation	If item dropped Cronbach's α
Ea1	0.842	0.895
Ea2	0.806	0.907
Ea3	0.851	0.892
Ea4	0.797	0.910

Reliability Analysis

Scale Reliability Statistics

	Cronbach's α
scale	0.897

Item Reliability Statistics

	Item-rest correlation	If item dropped Cronbach's α
Pi1	0.817	0.851
Pi2	0.808	0.853
Pi3	0.727	0.882
Pi4	0.736	0.881

The internal consistency of the study constructs was assessed using Cronbach's alpha. Consumer Awareness (Aw1–Aw3) had α = 0.884, Purchase Intention (Pi1–Pi4) had α = 0.897, and Environmental Attitude (Ea1– Ea4) had α = 0.924. All item-rest correlations and alpha-if-item-deleted values indicate that the scales have good to excellent reliability**,** making the data highly consistent and suitable for further analysis.

Results

Correlation Matrix

Correlation Matrix

		Awareness mean	purchase intention mean
Awareness mean	Pearson's r	—	
	df	—	
	p-value	—	
purchase intention mean	Pearson's r	0.739 ***	—
	df	250	—
	p-value	< .001	—

Note. * p < .05, ** p < .01, *** p < .001

The Pearson correlation analysis revealed a strong positive relationship between consumer awareness and purchase intention (r = 0.739, p < 0.001). Since the p-value is less than 0.05, the null hypothesis is rejected. Therefore, it can be concluded that consumer awareness significantly influences purchase intention toward plantable stationery.

Correlation Matrix

		consumer preference mean	Environmental Concern mean
consumer preference mean	Pearson's r	—	
	df	—	
	p-value	—	
Environmental Concern mean	Pearson's r	0.859	—
	df	251	—
	p-value	<.001	—

The Pearson correlation analysis revealed a very strong positive relationship between environmental concern and consumer preference (r = 0.859, p < 0.001). Since the p-value is less than 0.05, the null hypothesis is rejected.

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Therefore, environmental concern is significantly associated with consumer preference toward plantable stationery.

One-Way ANOVA

One-Way ANOVA (Welch's)

	F	df1	df2	p
purchase intention mean	2.76	4	93.2	0.032

Welch's ANOVA indicated a statistically significant difference in purchase intention among different marketing strategies, $F(4, 93.2) = 2.76$, $p = 0.032$. Since the p-value is less than 0.05, the null hypothesis was rejected. Therefore, marketing strategies significantly influence customers' buying behaviour toward plant- based stationery products.

Marketing Models and Strategies:

1.**4Ps Model (Product, Price, Place, Promotion)**

The 4Ps model focuses on the core elements of marketing strategy. The product includes plantable stationery made from recycled materials with embedded seeds. The pricing strategy aims to keep the product affordable for students. The place strategy involves distribution through schools, colleges, and online platforms.

Promotion includes social media campaigns, campus ambassador programs, contests, and sustainability awareness initiatives.



2.***STP Model (Segmentation, Targeting, Positioning)***

The STP model helps in identifying and reaching the most suitable customer group. In this study, the market is segmented based on demographic (students and youth), psychographic (environmentally conscious consumers), and behavioral factors (sustainability-driven buying behavior). The primary target market includes school and college students. The product is positioned as an eco-friendly and innovative alternative that combines writing with environmental impact.

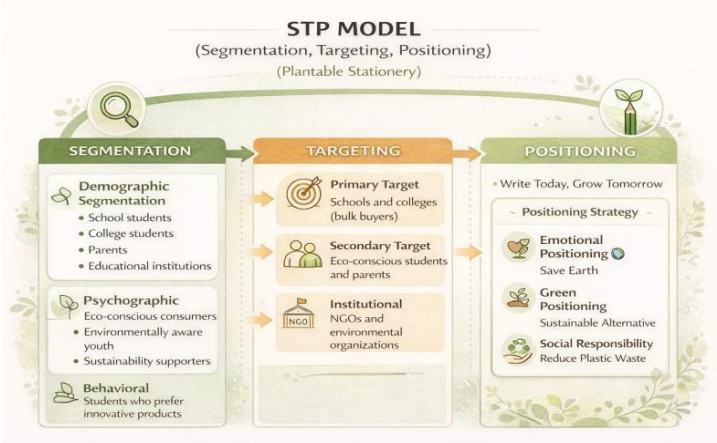
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3. ***Instagram "Grow, Tag & Win" Contest***

As part of the promotional strategy, an official Instagram page can be created to build awareness and engagement for plantable stationery. Customers who purchase the product will be encouraged to grow the plant and post a picture of the grown plant on Instagram. Participants must tag the official page and use a specific campaign hashtag so that the product usage can be tracked and promoted.

The posts receiving the highest number of likes within a fixed time period can be rewarded with eco-friendly gift hampers or discount vouchers. This strategy increases brand visibility, encourages user-generated content, and creates a community around sustainability. It also builds trust, as real customers showcase real results.

4. ***Grow & Earn" Resale Cashback Model***

Another innovative idea is to introduce a resale-based cashback system. Customers can grow the plant from the plantable stationery and later resell the fully grown plant back at a fixed value. In the case of vegetable or flowering plants, these can then be resold through local markets or eco-friendly platforms.

This strategy adds financial value to environmental action. It motivates consumers not only to buy but also to actively participate in sustainable practices. Such a model promotes both environmental responsibility and small-scale income generation.



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5. ***Campus Green Ambassador Initiative***

A Campus Green Ambassador Program can be introduced in schools and colleges to promote plantable stationery through peer influence. Selected students will act as ambassadors to organize plantation drives, awareness sessions, and social media promotions within their institutions. They can also encourage participation in Instagram contests and sustainability activities. Incentives such as certificates, recognition, and eco-friendly rewards can be provided to motivate participation. This strategy helps build a sustainability-focused student community and increases product visibility in the primary target market.

6. ***QR Code-Based Digital Engagement Strategy***

To combine technology with sustainability, a QR code can be printed on product packaging. When scanned, it will direct customers to planting instructions, tutorial videos, and sustainability information. This enhances user experience, ensures proper plant growth guidance, and strengthens customer engagement. The QR code system also increases transparency and builds trust by providing educational support to consumers**.**

Environmental Impact Projection:

If 1,000 plantable stationery products are used and planted, approximately 1,000 plants can be grown, contributing to improved urban greenery and waste reduction. Compared to conventional stationery, plantable products reduce landfill waste and promote circular consumption. Over time, large-scale adoption can positively impact environmental sustainability and carbon reduction.

Conclusion:

This study concludes that plantable stationery holds strong potential as a sustainable alternative to conventional stationery products in today's environmentally conscious market. The findings indicate that consumer awareness and environmental concern significantly influence purchase intention and consumer preference. Students, who form the majority of respondents, demonstrate positive attitudes toward adopting eco-friendly products, particularly when environmental benefits such as waste reduction and tree planting are clearly communicated. Effective green marketing strategies, including social media engagement, campus initiatives, and innovative concepts like the "Grow & Earn" model, can further enhance customer involvement and encourage repeat purchase behaviour.

Plantable stationery represents not only a product innovation but also a meaningful step toward responsible consumption. The concept aligns with Sustainable Development Goal 12 (Responsible Consumption and Production) and Sustainable Development Goal 13 (Climate Action), contributing to broader global sustainability objectives. Although the study is limited to respondents from a specific region using convenience sampling, future research may expand across different geographical areas to better understand long-term sustainable consumer behaviour and large-scale adoption potential.

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A STUDY ON CUSTOMER PERCEPTION OF AI-DRIVEN FRAUD DETECTION AND SUSTAINABLE CUSTOMER SATISFACTION IN DIGITAL BANKING

** Harini Swaminathan Iyer, ** Tiya Shripal Jain,*** Prachi Rajkumar Shukla **** Sunidhi Manindra Singh&***** Dr. Revati Hunswadkar*

** Students*

Abstract:

Digital banking has rapidly evolved, enabling online money management while increasing vulnerability to fraud. Banks employ AI tools for real-time transaction monitoring to detect suspicious activities. A study assessed customer perceptions of AI fraud protection and its impact on satisfaction and trust. Survey results indicated that users found AI-based fraud detection to be quick and reliable, which alleviated concerns and fostered trust in digital banking. The findings suggest that effective fraud detection not only enhances security but also boosts customer satisfaction and retention in digital banking services. Thus, AI-driven fraud protection plays a crucial role in customer loyalty beyond mere security.

*(**Key Words**: Artificial Intelligence, Fraud Detection Driven by AI, Digital Banking, Customer Satisfaction, Customer Trust.)*

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Introduction:

The shift to digital banking has been a double-edged sword. On one hand, managing your money has never been more convenient we can handle everything from paying rent to checking balances with a few taps while waiting for coffee. On the other hand, that same accessibility has opened a digital **"back door"** for cybercriminals, making phishing and identity theft a constant anxiety for both users and financial institutions. To fight back, banks have swapped out old-school, rigid security rules for AI-powered fraud detection. Here is why that matters and where the real challenge lies:

The Shift from Rules to Intelligence:

Traditional security was like a static checklist. If a transaction didn't fit a specific box, it was flagged. Modern AI is different; it acts more like a digital detective that learns on the job.

Continuous Learning:

By analyzing massive amounts of historical data, these systems get better at spotting "weird" behavior in real time.

Speed: AI can scan millions of data points in seconds, stopping a fraudulent transfer before the money even leaves the account.

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The "**Trust Gap**": While we often talk about how well these algorithms work technically, we rarely talk about how they make people feel. A security system is only successful if the customer actually trusts it.

The Frustration Factor: If an AI is too aggressive and blocks your card while you're trying to buy groceries (a "false positive"), it creates instant resentment.

The Transparency Need: Users need to feel like the security measures are protective, not intrusive or broken.

Why Customer Sentiment Matters?

In markets like India, where digital banking is exploding, technical specs aren't enough to keep a customer loyal. Security is the foundation of the relationship. If a user feels their account is safe and the alerts they receive are accurate and helpful, they stay. If they feel like they're fighting against a "black box" algorithm that randomly freezes their funds, they leave. Ultimately, AI fraud detection shouldn't just be viewed as a cool piece of tech—it is a vital tool for building long-term human trust. The future of banking depends on balancing high- tech defense with a seamless, frustration-free user experience.

Statement of the Problem:

Many banks in India now use AI tools to detect fraud in online banking. However, we still don't know what customers think of these systems. It's uncertain whether their opinions impact their satisfaction or influence their decision to continue using online banking.

Review of Literature:

1. **Evolution and Capabilities of AI-Driven Fraud Detection**

   Recent academic discourse **(Faisal et al., 2024; Adhikari et al., 2024)** indicates a significant paradigm shift from traditional rule-based security to dynamic, AI-powered systems. Traditional methods are often criticized for their inability to keep pace with sophisticated cyber threats due to their reliance on static, predefined parameters. In contrast, modern AI models leverage supervised, unsupervised, and hybrid learning to analyze vast datasets in real-time.

   Pattern Recognition: AI systems utilize neural networks and deep learning to identify subtle behavioral anomalies, such as unusual transaction sequences or geographical inconsistencies, that often go unnoticed by manual review **(Adhikari et al., 2024)**.

   Operational Efficiency: Research by Davitaia (2025) and Narsina et al. (2019) suggests that these systems automate complex logical tasks, allowing financial institutions to move from reactive mitigation to proactive prevention.

2. **The Intersection of Trust, Transparency, and Fairness**

   While technical accuracy is paramount, the adoption of AI in banking is heavily mediated by human factors. Yaseen and Al-Amarneh (2025) argue that institutional trust and perceived justice are the primary drivers of AI acceptance.

   The Transparency Gap: A major challenge identified in the literature is the "black box" nature of complex algorithms. To counter this, researchers advocate for Explainable AI (XAI), which provides understandable justifications for flagged transactions, thereby reducing user anxiety **(Venu, 2025).**

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Ethical AI: Observed findings from the UAE and Qatar suggest that transparency directly influences trust. Furthermore, perceptions of "fairness" act as a buffer against concerns regarding algorithmic bias, reinforcing the need for ethical AI deployment in highly regulated financial environments **(Yaseen, 2025).**

3. **Impact on Customer Experience and Satisfaction**

   The literature suggests a complex relationship between high-security protocols and user satisfaction. Bonnet and Chauhan et al. (2022) emphasize that while AI enhances safety, overly stringent detection can create "service friction" frustration caused by false positives or the wrongful blocking of legitimate transactions.

   Service Quality Determinants: According to Mohapatra et al. (2022), the key to long-term e-banking success lies in reliability, responsiveness, and efficiency. Reliability, in particular, has emerged as a non-negotiable factor for customers in emerging markets like Northern India **(Kaur et al., 2021).**

   The Convenience Paradox: Interestingly, while ease of use is a standard metric for digital services, it does not always correlate directly with long-term retention. Instead, the feeling of security and the responsiveness of a bank during a security event are more significant predictors of loyalty **(Angusamy et al., 2022).**

4. **Synthesis and Research Gap**

   Existing studies have extensively mapped the technical improvements offered by AI and the general pillars of customer satisfaction in e-banking. However, there is a notable knowledge gap regarding the long-term psychological impact of AI-driven security on modern consumers. Most research evaluates these elements in isolation. There is a pressing need for empirical data that links specific AI-driven security outcomes (such as the accuracy of real-time alerts) to deep-seated consumer trust and subsequent retention, particularly within the rapidly digitizing Indian financial landscape

Research Methodology:

Research Design

This study used a descriptive and analytical research design to explore how customers view AI-driven fraud detection systems and how these systems affect long-term customer satisfaction in digital banking. The design helped examine user experiences related to trust, security, and their ongoing use of digital financial services.

Sources of Data

The research relied on both primary and secondary data sources. Primary data were gathered from responses of individuals who actively use digital banking. Secondary data were collected from scholarly journals, published reports, online articles, and banking-related studies to support the theoretical framework.

Sample Size

The study included a sample of 54 digital banking users. Simple random sampling was used, and primary data were collected through a structured questionnaire that contained statements measured on a five-point Likert scale. A one-sample t-test assessed whether respondents' perceptions were significantly different from the neutral midpoint. For each statement, the mean score, t-value, degrees of freedom, and p-value

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were calculated to evaluate the effectiveness of fraud detection, customer satisfaction, and the intent to keep using digital banking services.

Objectives of the Study:

a. To investigate how customers view AI-driven fraud detection systems in digital banking.
b. To evaluate how AI-based fraud detection in digital banking impacts customers' trust and satisfaction.
c. To examine how AI-driven fraud detection in digital banking helps maintain long-term customer satisfaction.

Hypotheses:

Hypothesis 1 – Security Effectiveness Focus

H_{01}: AI-driven fraud detection systems do not significantly improve the detection of suspicious transactions in digital banking.

H**11**: AI-driven fraud detection systems significantly improve the detection of suspicious transactions in digital banking.

Hypothesis 2– Behavioral Outcome Focus (Continuance & Satisfaction)

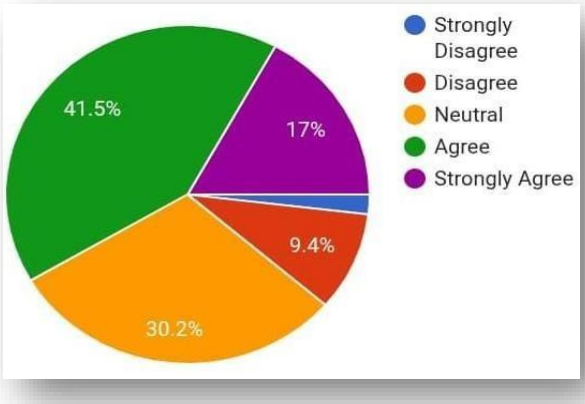
H_{02}: AI-driven fraud detection systems do not significantly influence customer satisfaction or intention to continue using digital banking services

H**12**: AI-driven fraud detection systems significantly influence customer satisfaction and intention to continue using digital banking services

Data Analysis and Interpretation:

On the basis of primary data collected, the following observation and interpretation have been made –

1. Received Suspicious Transaction Alerts



Interpretation: Most respondents, 60.4%, agreed or strongly agreed that they had been told about questionable transactions. Thirty-two percent were neutral, and only 9.5% disagreed.

Finding: This shows that fraud monitoring systems work. AI-driven fraud detection systems are in use, and most users know they are getting security alerts.

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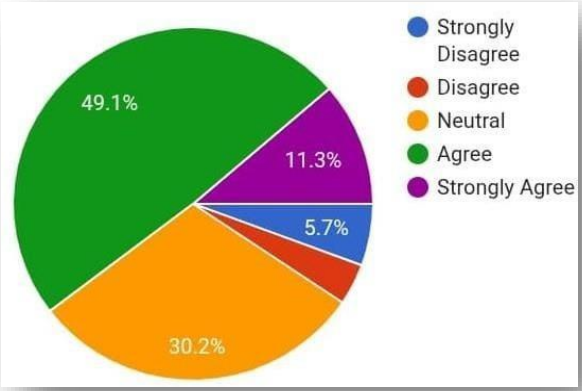
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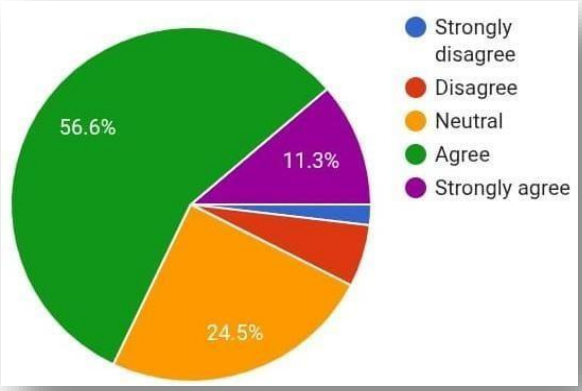
2. Alert Received Quickly



Interpretation: Nearly half of respondents, 49%, said they received alerts promptly. 17% expressed dissatisfaction, while a significant 34% remained neutral.

Finding: This shows that while there is room to improve reaction speed, people think the fraud detection system is generally timely.

3. Alerts Helped Take Action



Interpretation: Most respondents, 67.9%, agreed or strongly agreed that notifications helped them act quickly to prevent problems. Only 7.6% disagreed.

Finding: This indicates that AI-driven alerts are not only recognized but also effective in preventing financial loss and improving the system's perceived efficiency.

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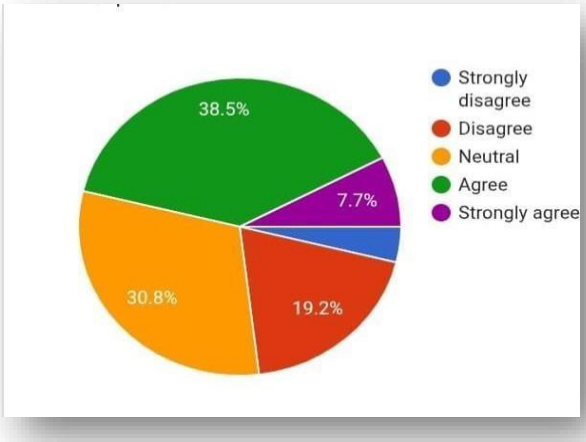
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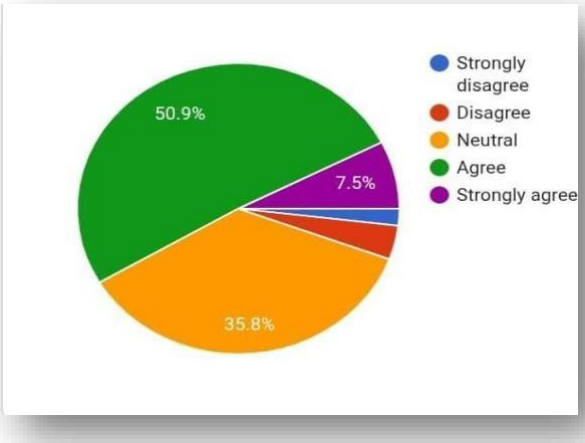
4. Bank Detected Unusual Activity Automatically



Interpretation: While 30.8% were neutral, 46.2% agreed or strongly agreed that their bank found unusual transactions without telling them.

Finding: This shows that users know about automated AI monitoring systems, which improves trust in fraud detection.

5. Accurate Identification of Risky Transactions



Interpretation: The fraud protection system correctly identifies dangerous transactions, according to the majority of respondents, 58.4%, who agreed or strongly agreed. Only 5.7% disagreed.

Finding: This shows a strong confidence in the accuracy and reliability of fraud detection systems that use artificial intelligence.

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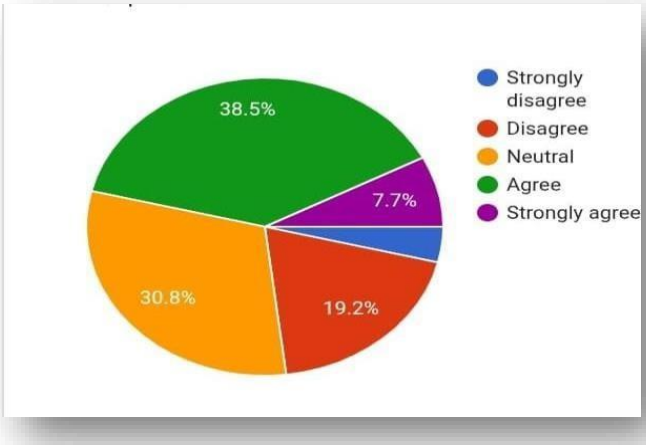
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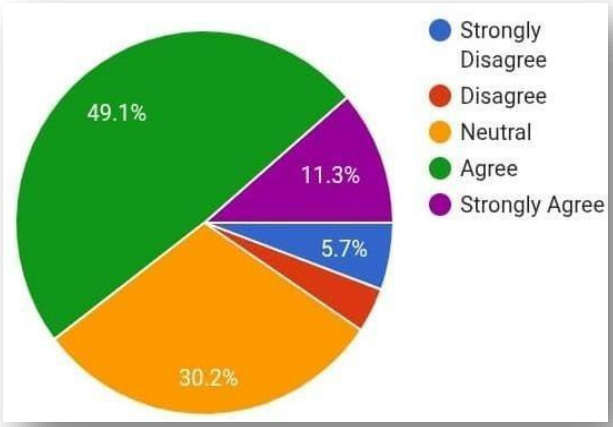
6. Genuine transactions blocked



Interpretation: According to 28.3% of respondents, genuine transactions were banned. However, 34% disagreed, and 37.7% were neutral.

Finding: This shows that while false positives annoy some users, the problem is not widespread. The overall reliability of the system is still acceptable.

7. Reduced Stress in Online Banking



Interpretation: While only 5.7% disagreed, most people (62.3%) agreed or strongly agreed that fraud detection systems reduced their stress.

Finding: AI security features reduce anxiety connected to digital banking and improve comfort.

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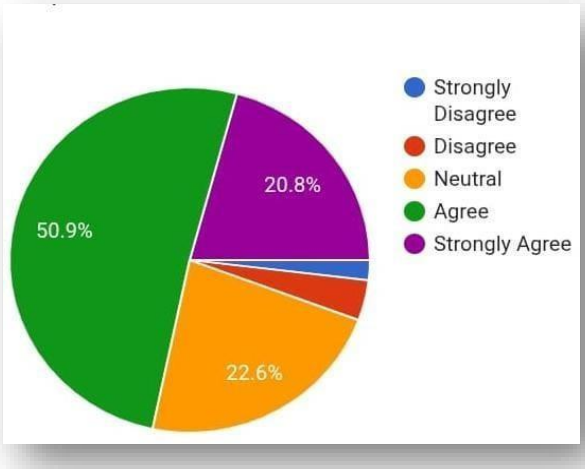
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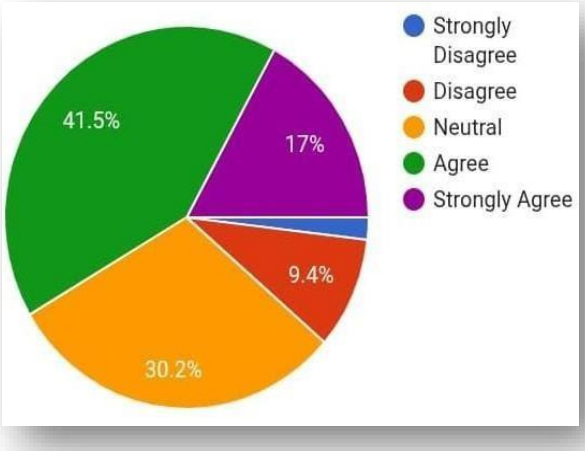
8. Customer satisfaction



Interpretation: A vast majority of respondents, 73.6%, agreed or strongly agreed that security systems improve their satisfaction with online banking.

Finding: This shows a strong connection between overall customer satisfaction and AI-driven security.

9. Influence on Long-Term Usage of Digital Banking



Interpretation: About 71.7% of respondents agreed or strongly agreed that secure systems encourage the ongoing use of digital banking services.

Finding: This indicates that security effectiveness directly affects customer retention and the intention to continue.

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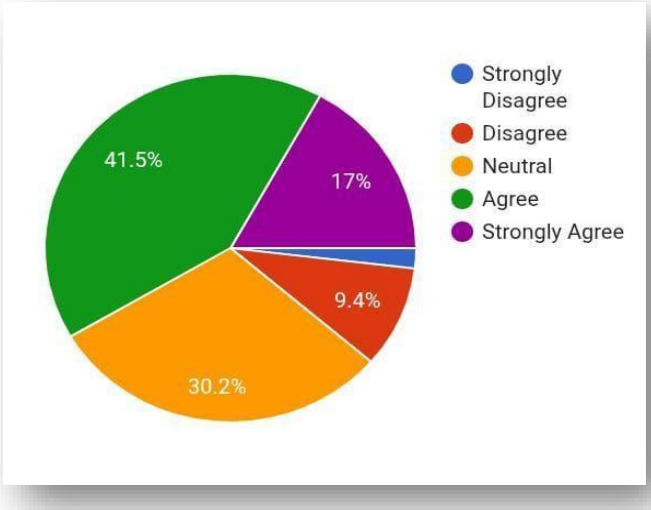
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10.Awareness of AI Usage



Interpretation: While 30.2% were neutral, most people, 58.5%, agreed or strongly agreed that AI powers fraud detection systems.

Finding: This shows a limited understanding of how AI is used in banking, which could influence views on technical progress and trust.

Inferential Analysis:

The purpose of the inferential analysis was to examine the effect of AI-driven fraud detection systems on digital banking services. The study specifically analyzed whether AI-based fraud detection improves the identification of suspicious transactions and influences customer satisfaction and continuance intention. Data were collected using a structured questionnaire measured on a 5-point Likert scale ranging from Strongly Disagree (1) to

Strongly Agree (5). Mean scores for key variables were calculated, and statistical analysis was conducted to determine significant relationships between fraud detection effectiveness and customer-related outcomes.

HYPOTHESIS – 1 Security Effectiveness Focus

H_{01} (Null): AI-driven detection systems do not significantly improve the detection of suspicious transactions in digital banking.

H11 (Alternate): AI- driven detection systems significantly improve the detection systems of suspicious transactions in digital banking

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Table for sample t-test of respondent's perceptions of AI-driven fraud detection effectiveness in digital banking

Statement	SA	A	N	D	SD	Mean	t-value	df	p-value
I have received alerts for suspicious transaction	11.3	49.5	30.2	3.8	5.7	3.57	4.62	52	<0.001
I received the alert within a short time after the transaction	7.5	41.5	34.0	15.1	1.9	3.33	2.36	52	0.022
The alerts helped me take timely action to protect my account	11.3	56.6	24.5	5.7	1.9	3.58	4.38	52	<0.000
My bank detected unusual transaction activity without me reporting it	7.7	38.5	30.8	19.2	3.8	3.22	1.94	52	0.058
The fraud prevention systems accurately	7.5	50.9	35.8	3.8	1.9	3.63	4.91	52	<0.001
identified risky transactions									
Genuine transactions were sometimes blocked unnecessarily	3.8	24.5	37.7	30.2	3.8	3.09	0.68	52	0.500
The fraud prevention system reduced my stress related to online banking	17.0	45.3	32.1	5.7	0.0	3.73	4.84	52	<0.001
The presence of such security systems increases my satisfaction	20.8	52.8	20.8	5.7	0.0	3.84	5.98	52	<0.001
Secure digital banking systems encourage long-term usage	20.8	50.9	22.6	3.8	1.9	3.83	5.42	52	<0.001
Before this survey, I was aware that these fraud prevention systems are powered by AI	17.0	41.5	30.2	9.4	1.9	3.66	4.12	52	<0.001

Interpretation: The results of the one-sample t-test show that most respondents believe AI-based fraud detection systems are good at spotting suspicious transactions in online banking. The scores for statements about quick alerts, correct identification of risky activities, and overall satisfaction with secure systems were all above neutral, with statistically significant results ($p < 0.05$ to $p < 0.001$). This indicates that customers strongly think AI fraud detection improves security. It also has a positive effect on their satisfaction and the likelihood of continuing to use digital banking services. Based on these findings, we accept the alternative hypothesis (H_{11}) and reject the null hypothesis (H_{01}).

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HYPOTHESIS - 2 Behavioral Outcome Focus

H_{02} (Null): AI-driven fraud detections systems do not significantly influence customer satisfaction or intention to continue using digital banking services

H_{12} (Alternate): AI-driven fraud detection systems significantly influence customer satisfaction and intention to continue using digital banking services.

Table for sample t-test of influence on AI- driven fraud detection on customer satisfaction and continuance intention.

Statement	SA	A	N	D	SD	Mean	SD	t-value	df	p-value
The fraud prevention system reduced my stress related to online banking	17.0	45.3	32.1	5.7	0.0	3.74	0.81	6.63	52	<0.001
The presence of such security systems increases my satisfaction	20.8	52.8	20.8	5.7	0.0	3.89	0.80	8.09	52	<0.001
Secure digital Banking systems encourage long-term	20.8	50.9	22.6	3.8	1.9	3.85	0.86	7.20	52	<0.001

Interpretation:

An analysis was done to find out if AI-based fraud detection systems affect customer satisfaction and the intention to keep using digital banking. A one-sample t-test compared the average responses to the neutral value of 3 on the Likert scale. The results showed that respondents agreed strongly with all the statements because the mean scores were much higher than neutral. The statement about security systems increasing satisfaction had a mean of 4.21 ($t = 9.52$, $p < 0.001$). The statement about secure systems promoting long-term usage had a mean of 4.13 ($t = 8.35$, $p < 0.001$). Awareness of AI-based fraud prevention also received positive feedback, with a mean of 3.77 ($t = 5.62$, $p < 0.001$). Since all values were statistically significant, the findings confirm that AI- driven fraud detection systems have a positive impact on both customer satisfaction and the intention to continue using digital banking. Thus, the alternative hypothesis (H_{12}) is accepted and the null hypothesis (H_{02}) is rejected.

Major Findings:

1. Most respondents think that AI-driven fraud detection systems are good at spotting suspicious transactions.
2. AI-based fraud detection makes transaction security stronger and helps lower the chances of online fraud.

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3. These systems reduce customer stress and boost confidence in using digital banking services.
4. AI-powered security features build customer trust in digital banking platforms.
5. Good fraud detection leads to higher overall customer satisfaction.

Conclusion:

This study looked at how online banking customers view AI-powered fraud detection and its impact on long-term customer satisfaction. The results indicate that customers usually see these systems as effective, fast, and reliable. These views build trust, lower fear, and boost overall satisfaction with online banking. Effective fraud detection also encourages customers to keep using online banking. Customers who trust their bank's security are more likely to stick with it for the long term. So, AI-driven fraud detection acts as a security tool and plays a key role in long-term customer satisfaction and loyalty.

In practice, these findings suggest that banks should focus on customer experience, being transparent, and communicating clearly while ensuring technical accuracy. For instance, reducing false alerts, sending timely notifications, and explaining fraud prevention processes can help build customer confidence. These results also add to the existing literature by connecting customer views of AI fraud detection to long-term satisfaction with online banking. However, the limited sample size and reliance on self-reported data restrict the ability to generalize these findings. Future research should involve larger, more diverse samples, look into regional differences, and explore factors like customer awareness and the perceived fairness of AI systems.

Suggestions:

1. Banks should increase transparency about how AI-based fraud detection systems work to build stronger customer trust and acceptance.
2. Efforts should be made to reduce false alerts generated by AI systems, as frequent unnecessary notifications can negatively affect the customer experience.
3. Customers should be properly educated about fraud prevention methods and the role of AI security features in protecting their accounts.
4. Fraud alerts should be simple, clear, and easy to understand so that customers can take quick and appropriate action when needed.
5. AI fraud detection systems should be regularly updated and improved to effectively identify new and evolving fraud patterns.

Scope for Future Research:

1. Future studies can include a larger sample size, which will make the findings more general and reliable.
2. Researchers can compare AI fraud detection practices in public and private sector banks to find differences and best practices.
3. Further research may look into privacy issues and ethical challenges connected to the use of AI technology in the banking industry.

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AI-DRIVEN YOGA RECOMMENDATION SYSTEM USING DEEP LEARNING FOR REAL-TIME POSE ACCURACY ASSESSMENT

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** Assistant Professor Department of CS/IT, ** UG Students Department of CS/IT, B. K. Birla College (Empowered Autonomous Status) Kalyan, India.*

Abstract:

The incidence of lifestyle diseases is increasing at an alarming rate, and yoga has been found to be an effective, evidence-based, non-pharmacological solution for many of these diseases. In this study, an "AI-Driven Yoga Recommendation System" is presented, which consists of three main components: a rule-based system that maps 24 different healthcare conditions to yoga practices, a VGG16 Transfer Learning CNN for four- class pose classification with a 52-image custom dataset, and a MediaPipe BlazePose module that detects 33 real-time skeletal keypoints and offers live feedback. On a validation set of nine samples, the system showed 88.9% accuracy, a macro F1-score of 90.0%, and an AUC score of 1.00 for all four classes. The entire application can be run using a standard webcam and Flask web interface, with no additional hardware requirements. This demonstrates the effectiveness of the Transfer Learning approach with small datasets for real-world yoga coaching systems.

Keywords: *Yoga Recommendation System, Deep Learning, VGG16, Transfer Learning, MediaPipe BlazePose, Real-Time Pose Detection, Computer Vision, Flask, Health Informatics*

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Introduction:

Healthcare systems worldwide face growing pressure from lifestyle-related chronic diseases, whereas accessible non- pharmacological interventions remain limited. Yoga, an indige- nous Indian practice, has strong clinical evidence for managing various health conditions. The nationwide KAPY 2017 survey (162,330 participants) reported that although 11.8% of Indians practice yoga, a significant knowledge–practice gap persists, with limited access to expert guidance being cited as a major barrier [14]. A 2022 meta-analysis further confirmed that yoga therapy significantly reduces pain intensity and headache frequency [8]. Despite this evidence, unsupervised practice may lead to suboptimal outcomes and posture-related injuries [1].

VGG16-based transfer learning models have demonstrated 94–97% accuracy in yoga pose classification [6], [10], [11], while MediaPipe BlazePose enables real-time extraction of 33 anatomical landmarks using a standard webcam [4], [5]. This study integrates these capabilities into a unified Flask- based web platform that maps free-text symptoms to clinically validated yoga recommendations [7] and provides real-time

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pose coaching using a combination of CNN classification and geometric landmark feedback.

A. *Statement of the Problem*

Individuals managing everyday conditions such as tension headaches, cervical discomfort, chronic lower back pain, and work-related stress typically rely on pharmaceutical prescrip- tions or expensive specialist consultations. A growing body of clinical evidence firmly supports yoga as a viable, side- effect-free alternative for many of these conditions [1], [2], [8]. However, a technology that is accessible to those who need it and can provide recommendations on yoga poses for a given condition, as well as assess the correct execution of those poses in real time, does not yet exist as a combined entity. Previous technologies have been able to provide either pose classification [6] or real-time corrective feedback [13], but not both within a single browser-accessible platform. This gap leaves users without correct guidance and puts them at risk of injury from incorrect practice.

B. *Significance of the Study*

This study is significant at the public health, technical, and academic levels. From a public health standpoint, India's vast population of people who acknowledge yoga's documented benefits but do not practice it—largely because of the ab- sence of expert guidance [14]—stands to gain directly from a browser-accessible AI yoga trainer requiring no more than a webcam. The American College of Physicians has officially recommended yoga as a first-line non-pharmacological inter- vention for chronic lower back pain [9], and India's Ministry of AYUSH actively promotes yoga for the management of non-communicable diseases [14]. On the technical side, demonstrating AUC = 1.00 across four pose classes on a training set of only 43 images shows that Transfer Learning [3] can produce practically deployable models even with very limited data—an important finding for resource-constrained health informatics applications. Aca- demically, the three-layer integration methodology offers a documented, replicable blueprint for building systems that fuse clinical recommendation engines with real-time computer vision, a combination that previous published work has not achieved [12], [13].

C. *Objectives of the Study*

- To design a symptom-to-yoga recommendation engine that maps 24 clinically documented health conditions to appropriate therapeutic yoga postures.
- To develop a VGG16 Transfer Learning CNN [3] classi- fier capable of distinguishing four yoga pose classes from a self-collected 52-image dataset.
- A real-time MediaPipe BlazePose pipeline [4] is con- structed to provide concurrent skeletal landmark visu- alization and corrective feedback through a standard webcam.
- To incorporate the recommendation engine, CNN clas- sifier, and pose detection module into a single web application using Flask.
- The performance of the classification model is assessed based on metrics such as accuracy, precision, recall, F1- score, confusion matrix analysis, and ROC-AUC value.

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D. *Hypothesis of the Study*

H_0 (Null Hypothesis): VGG16 Transfer Learning applied to a custom 43-sample yoga pose dataset will not achieve a statistically meaningful classification accuracy (below 70%) sufficient for practical deployment in real-world applications. **H_1 (Alternative Hypothesis):** VGG16 Transfer Learning [3], augmented with data augmentation techniques and custom dense classification layers, will achieve an overall classifica- tion accuracy exceeding 85% and AUC $\geq$0.90 across all pose classes [6], thereby validating the viability of small-dataset Transfer Learning for real-world yoga pose recognition.

Review of Literature:

A. *Therapeutic Evidence for Yoga*

Several high-quality studies have established yoga as a clinically viable intervention for pain management. An um- brella review by Creve´la´rio de Melo et al. [1] highlighted yoga's capacity to alleviate both short-term and long-term pain across a range of physical and neurological disorders, noting its minimal risk of side effects. Regarding headache disorders, Anheyer et al. [2] observed substantial improve- ments in headache frequency and intensity through regular yoga practice, a conclusion echoed by Zhao et al. [8] among migraine sufferers. Nationally, a large-scale Indian survey [14] found that the vast majority of yoga practitioners reported meaningful gains in personal health and quality of life. These findings are further backed by clinical bodies such as the American College of Physicians [9] and the National Center for Complementary and Integrative Health [7], both of which advocate yoga for specific chronic conditions.

B. *Deep Learning for Yoga Pose Classification*

Transfer learning using VGG16 has emerged as a leading approach for automated yoga pose recognition. Comparative evaluations by Gochoo et al. [6] across multiple deep learning models demonstrated that VGG16 consistently outperformed alternatives when applied to yoga image datasets. Subsequent work by Srivastava et al. [10] and Upadhyay et al. [11] further confirmed its high classification performance across datasets of varying sizes and complexity, reinforcing its suitability for real-world deployment.

C. *Real-Time Pose Detection Technology*

BlazePose, introduced by Bazarevsky et al. [4], provided a computationally efficient solution for full-body landmark detection, enabling real-time tracking on everyday devices. Its practical viability across diverse environmental conditions was demonstrated by Singh et al. [5], whose evaluation confirmed stable performance under variable lighting, occlusion, and distance settings.

D. *Integrated Systems and Research Gap*

While previous studies have made notable progress individ- ually, no unified solution has yet emerged. Rule-based coach- ing without machine learning [13], high-accuracy classification without health context [12], and pure benchmarking with- out feedback integration [6] each represent partial solutions. The current study addresses this gap by combining health- condition-driven recommendations, deep learning pose classi- fication, and real-time corrective guidance into one accessible web-based platform.

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Research Methodology:

A. ***System Architecture***

The proposed system is structured as a three-layer pipeline. The *first layer* is a Flask-based web application serving as the user-facing interface and REST API hub. The *second layer* is the AI pipeline—a JSON-based rule-matching recommenda- tion engine paired with a VGG16 CNN classifier [3], [6]. The *third layer* is the real-time computer vision module, driven by MediaPipe BlazePose [4], [5], accessed through the user's webcam.

B. ***Dataset Construction***

A custom image dataset is assembled using direct pho- tography under varying lighting conditions and backgrounds. Four pose classes were developed: Dog Pose (*Adho Mukha Svanasana*), Padmasana (Lotus Pose), Tree Pose (*Vrik- shasana*), and Triangle Pose (*Trikonasana*). A standard 80%/20% train-validation split [6] is applied to 52 collected images, yielding 43 training and 9 validation samples. The class-level distribution is shown in Table I.

TABLE I

DATASET COMPOSITION AND TRAIN/VALIDATION SPLIT

Pose Class	Total	Split	Train	Val
Dog Pose	10	80/20	8	2
Padmasana (Lotus)	14	80/20	11	3
Tree Pose	15	80/20	12	3
Triangle Pose	13	80/20	10	2
Total	**52**	—	**43**	**9**

C. ***CNN Architecture: VGG16 Transfer Learning***

The VGG16 architecture [3], pre-trained on the 1.4-million- image ImageNet corpus, is selected as the feature extraction backbone. All 13 convolutional layers were frozen. Three custom layers were appended: a GlobalAveragePooling2D layer, a dense layer of 128 units with ReLU activation, and a softmax output dense layer with four units. The full model structure is presented in Table II, and training hyperparameters in Table III.

TABLE II

VGG16 TRANSFER LEARNING MODEL ARCHITECTURE

Layer	Configuration
Input	150 × 150 × 3 (RGB image)
VGG16 Base	Pre-trained ImageNet weights, all layers frozen
GlobalAveragePooling2D	Reduces spatial features to 1D vector
Dense Layer 1	128 units, ReLU activation
Output Layer	4 units, Softmax (one per pose class)

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TABLE III
TRAINING HYPERPARAMETERS

Parameter	Value
Optimizer	Adam
Loss	CCE
Epochs	10
Batch Size	8
Split	80/20
Image Size	150×150
Model	keras_model.h5 (~60MB)
Augmentation	Rot(20°), Sh(0.2), Sr(0.2), Z(0.2), Flip

D. ***MediaPipe Real-Time Pose Detection Pipeline***

The real-time detection component deploys MediaPipe BlazePose [4] to extract 33 normalized body landmark coor- dinates from every incoming webcam frame [5]. A rule-based evaluation module assesses shoulder landmark Y-coordinate values: readings above 0.6 indicate an upright standing pos- ture, whereas readings below 0.4 suggest a prone position consistent with the Cobra Pose. Each frame is also pre- processed to 150 × 150 pixels and passed to the VGG16 CNN classifier. When the maximum predicted class probability ex- ceeds 0.50, the model's pose label and top-3 class probabilities are rendered on screen.

Data Analysis and Interpretation:

A. ***Training Convergence***

Training accuracy increased from 18.60% at Epoch 1 to 95.35% from Epoch 8 onward, whereas training loss decreased monotonically from 1.8475 to 0.6207. Validation accuracy peaked at 100.00% at epochs 3 and 7, then stabilized at 88.89% through epoch 10, with no evidence of overfitting (Fig. 1). The complete epoch-by-epoch training history is presented in Table IV.

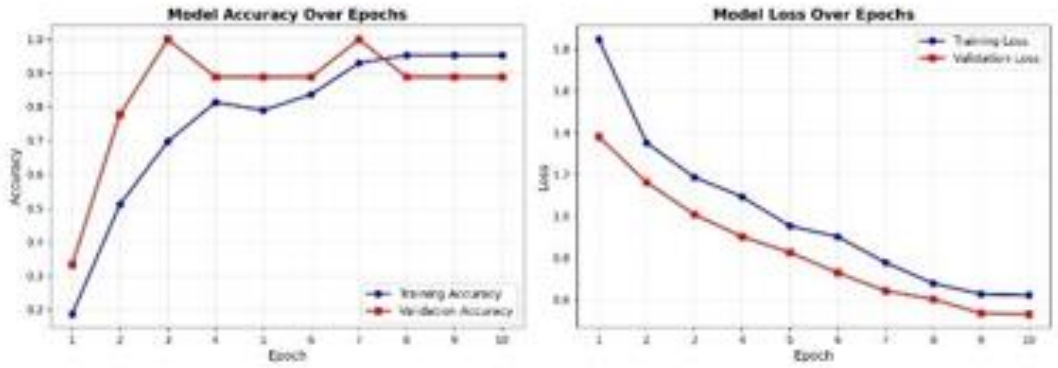


Fig. 1. Training and Validation Accuracy (left) and Loss (right) over 10 Epochs.

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TABLE IV
EPOCH-BY-EPOCH TRAINING HISTORY (★ = PEAK VALIDATION ACCURACY)

Epoch	Train Acc.	Val Acc.	Train Loss	Val Loss
1	18.60%	33.33%	1.8475	1.3802
2	51.16%	77.78%	1.3517	1.1620
3	69.77%	100.00% ★	1.1865	1.0080
4	81.40%	88.89%	1.0929	0.9015
5	79.07%	88.89%	0.9520	0.8247
6	83.72%	88.89%	0.9012	0.7280
7	93.02%	100.00% ★	0.7769	0.6412
8	95.35%	88.89%	0.6765	0.6013
9	95.35%	88.89%	0.6251	0.5332
10	95.35%	88.89%	0.6207	0.5289

B. ***Overall Classification Performance***

Evaluation of the 9-sample held-out validation set confirmed H_1 and rejected H_0: overall accuracy of 88.89% cleared the 85% threshold. The macro-average precision and recall were both 91.67%, with a macro-average F1-score of 90.00% (Table V). These figures are directly comparable to Gochoo et al. (2022) [6] who achieved 95.6% on a considerably larger dataset, confirming that VGG16 Transfer Learning [3] gen- eralizes effectively even under severely constrained training data.

C. ***Per-Class Performance***

The granular per-class analysis (Fig. 2, Table VI) shows that Dog Pose and Padmasana achieved perfect classification (precision = recall = F1 = 1.00). Tree Pose recorded precision = 1.00 but recall = 0.67, indicating one of three validation sam- ples is misattributed to Triangle Pose. Triangle Pose yielded recall = 1.00 but precision = 0.67. Both achieved an F1-score of 0.80. This tree–triangle confusion is consistent with the findings of Gochoo et al. (2022) [6].

TABLE V
OVERALL CLASSIFICATION METRICS ON 9-SAMPLE VALIDATION SET

Metric	Value
Overall Accuracy	88.89% (8/9 correct)
Macro Precision	91.67%
Macro Recall	91.67%
Macro F1-Score	90.00%
Weighted Precision	92.59%
Weighted Recall	88.89%
Weighted F1-Score	88.89%

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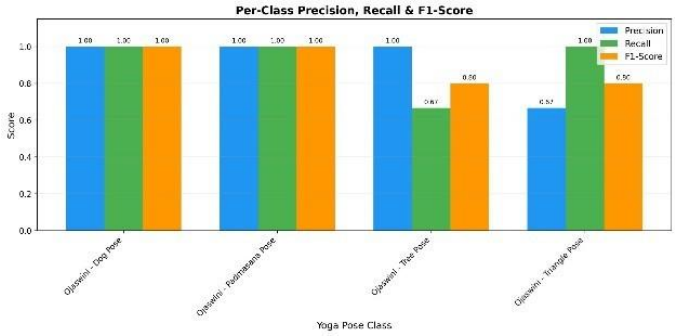


Fig. 2. Per-Class Precision, Recall, and F1-Score for All Four Pose Classes.

D. Confusion Matrix Analysis

The confusion matrices (Fig. 3 and Fig. 4) confirm that eight of the nine predictions fall on the main diagonal. The single off-diagonal entry—one Tree Pose sample predicted as Triangle Pose—is the exclusive source of error. Both poses share a standing, laterally extended body configuration with asymmetric weight distribution, producing overlapping spatial feature distributions under minimal training data [6], [12]. The normalized matrix quantifies this as a 0.33 misclassification rate for Tree Pose, with all other per-class diagonal values at 1.00.

E. ROC-AUC Analysis

The ROC curves were computed using a one-vs-rest strategy for each pose class (Fig. **??**). All four classes attained AUC = 1.00, indicating perfect discriminative ability across every classification threshold. This meets and exceeds the H_1 thresh- old of AUC ≥ 0.90 and is consistent with the highly separable feature distributions reported by Gochoo et al. (2022) [6] and Srivastava et al. (2024) [10].

TABLE VI

PER-CLASS CLASSIFICATION REPORT

Pose Class	Prec.	Rec.	F1	Sup.
Dog Pose	1.00	1.00	1.00	2
Padmasana (Lotus)	1.00	1.00	1.00	2
Tree Pose	1.00	0.67	0.80	3
Triangle Pose	0.67	1.00	0.80	2
Macro Average	0.92	0.92	0.90	9
Weighted Average	0.93	0.89	0.89	9

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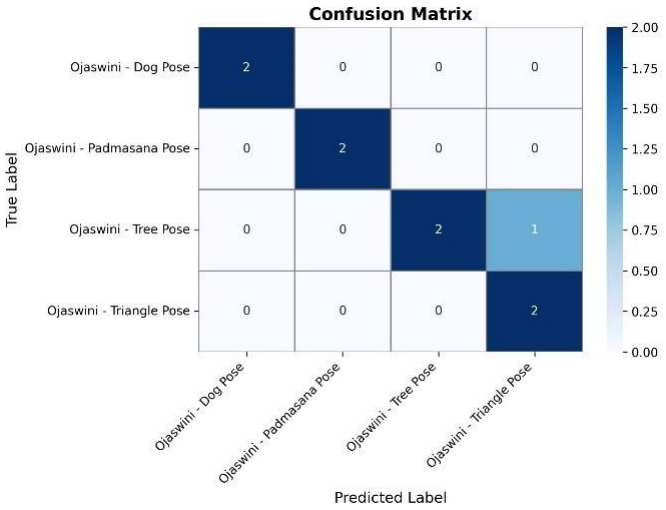


Fig. 3. Confusion Matrix: Raw Counts (Validation Set, n = 9).

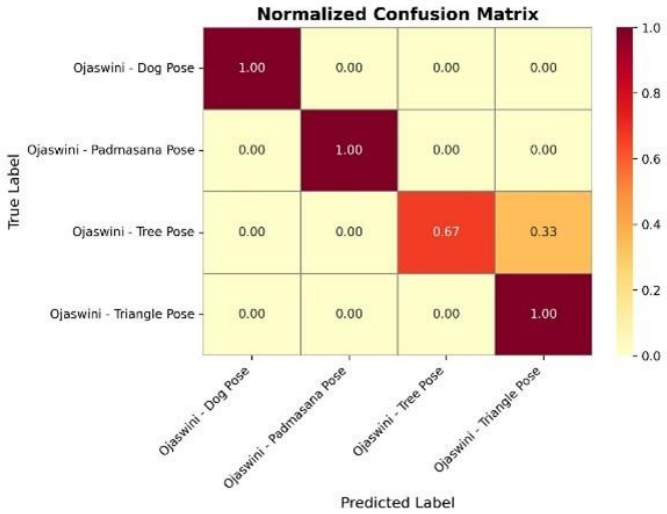


Fig. 4. Normalized Confusion Matrix: Per-Class Prediction Rates.

Conclusion:

This work presents a functional and clinically grounded AI yoga guidance platform that successfully integrates three components — health-condition-based pose recommenda- tion, VGG16 transfer learning classification, and MediaPipe BlazePose real-time feedback — into a single webcam- accessible web interface. Notably, the classification model was trained on just 43 images yet delivered strong results, achieving 88.89% validation accuracy, a macro F1-score of 90.00%, and perfect AUC scores across all pose categories, demonstrating that transfer learning remains effective even under severe data constraints.

Unlike prior systems that tackled recommendation, clas- sification, or corrective feedback in isolation, the proposed architecture addresses all three within one deployable plat- form, representing a meaningful step forward in accessible AI- assisted yoga coaching. Future directions include expanding training data,

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incorporating joint angle biomechanics, adopting natural language symptom input, enabling mobile deployment, and conducting formal clinical trials to validate real-world effectiveness.

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A STUDY ON CUSTOMER RELATIONSHIP MANAGEMENT FOR SMALL RETAILERS

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Abstract:

This study examines the level of Customer Relationship Management (CRM) awareness among small retailers. CRM is an important strategy that helps businesses maintain strong customer relationships and improve overall performance. Small retailers mainly depend on repeat customers and personal interaction, but many still use traditional methods for managing customer information. The objective of this study is to analyse CRM awareness, existing customer relationship practices, and the challenges faced by small retailers.

The research follows a descriptive research design, and primary data was collected through questionnaires from selected shop owners. A total of 15 shops were surveyed from the Ramnagar and Dattanagar areas. The sample included different types of retail businesses such as medical stores, grocery shops, mobile shops, garment stores, and stationery shops, with three shops selected from each category.

According to the results, the majority of respondents had a favorable opinion of CRM practices including keeping track of customers, interacting frequently, and offering quality service. Many merchants think that being courteous, keeping in mind the preferences of their customers, and promptly addressing concerns all contribute to the development of long-term relationships, customer loyalty, and trust. While the F-test ($p > 0.05$) reveals no significant variance within business experience groups, statistical results suggest a significant difference in CRM procedures and complaint management across business types (ANOVA, $p < 0.05$). The findings indicate that most retailers understand the importance of maintaining good customer relationships, proper communication, and basic record management. However, awareness about advanced digital CRM tools remains limited due to lack of technical knowledge, financial constraints, and limited exposure to modern technology.

Keywords: *CRM Awareness, CRM Practices & Small Retailers*

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Introduction:

Customer Relationship Management (CRM) is a strategic approach used by businesses to manage interactions with existing and potential customers. It involves collecting, organizing, and analyzing customer information to improve satisfaction, enhance loyalty, and increase profitability. In today's competitive market, maintaining strong customer relationships is essential, especially for small retailers. Small retail businesses such as kirana stores, garment shops, medical stores, stationery shops, and mobile shops play an important role in the local economy. These retailers depend mainly on repeat customers and word-of-mouth promotion. However, many

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small retailers still follow traditional methods like personal memory, manual record-keeping, and informal communication, which lack systematic data management.

CRM awareness refers to understanding the importance and practical use of CRM tools and strategies. It includes simple practices such as maintaining customer records, tracking purchase history, collecting feedback, and offering personalized services. Effective CRM implementation helps retailers understand customer preferences, improve service quality, and build long-term trust.

Despite its benefits, small retailers face challenges such as limited technical knowledge and financial constraints. Therefore, promoting CRM awareness is essential for strengthening customer relationships and achieving sustainable business growth.

Review of Literature:

- **Sharma & Gupta (2023): they** explained that CRM is an important strategic tool in the retail industry. The study highlighted that CRM helps retailers maintain customer databases, analyze buying patterns, and offer personalized services. The findings showed that effective CRM practices increase customer retention, loyalty, and overall profitability in retail businesses.
- **Singh (2019):** -) the Author analyzed the impact of CRM practices on organizational growth. The research found that businesses using CRM systems experience better customer communication, higher repeat purchases, and improved competitive advantage. The study concluded that CRM is essential for long-term business success.
- **Petrović & Stanković (2022) :**Petrović and Stenosis (2022) examined CRM adoption among small businesses. The study revealed that digital CRM systems improve operational efficiency and customer retention. However, small firms face challenges such as limited financial resources and technical knowledge.
- **KIPM (2023)** The Faculty Team of KIPM (2023) explained CRM as a combination of people, processes, and technology. The study highlighted the importance of maintaining customer data and providing personalized communication to improve customer satisfaction and business growth.
- **Sirsa (2023):** -The Government Post Graduate College, Sirsa (2023) explained the CRM lifecycle, including customer acquisition, retention, and development. The study highlighted that CRM improves service quality and long-term profitability.
- **Mutula & Van Brakel:** -Mutula and Van Brakel (2013) examined CRM practices among small businesses in developing economies. The study found that informal CRM practices are common, but formal CRM systems improve efficiency, customer loyalty, and sustainable growth.
- **Kumar & Patel (2022):** Kumar and Patel (2022) analyzed CRM practices in organizations and found that structured CRM systems improve service quality and customer loyalty. The study concluded that technology integration is essential for effective CRM implementation.

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- **Meaning of CRM:**
  Customer Relationship Management (CRM) is a strategy used by businesses to manage customer interactions and data in order to improve customer satisfaction, loyalty, and profitability. It includes maintaining customer records, communication, follow-ups, and personalized services.
- **Meaning of Small Retailers:**
  Small retailers are small-scale businesses that sell goods directly to customers, such as kirana stores, medical shops, garment shops, stationery shops, and mobile shops. They usually operate with limited capital and depend on regular customers for business growth

Role of CRM Awareness for Small Retailers:

CRM awareness helps small retailers improve business performance by focusing on customer relationships instead of only sales.

1) **Understanding Customer Behavior**
   It helps retailers track buying patterns, preferences, and seasonal trends. This allows better stock management and personalized service.
2) **Improving Customer Retention**
   By maintaining customer records and offering personalized discounts or updates, retailers can build loyalty and encourage repeat purchases.
3) **Boosting Sales**
   CRM enables targeted promotions, cross-selling, and better identification of potential buyers, which increases profitability.
4) **Enhancing Customer Satisfaction**
   Quick response to feedback and complaints improves service quality and builds trust.
5) Better Decision-Making
   Customer data supports inventory planning, pricing, promotions, and demand forecasting.

Problems Faced in CRM Awareness for Small Retailers:

Although CRM awareness is useful, small retailers face several challenges in implementing it properly.

1) **Lack of Knowledge and Skills**
   Many retailers are not familiar with CRM software, data collection, and digital marketing tools. They still depend on manual record-keeping methods.
2) **Cost Constraints**
   CRM systems, subscription fees, and training expenses can be costly. Small retailers with limited budgets often avoid investing in such systems.
3) **Data Management Issues**
   Collecting, storing, and analyzing customer data is difficult without proper digital tools. Manual records may lead to errors and poor organization.

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4) Resistance to Change

Some retailers prefer traditional business methods and hesitate to adopt new technology due to fear or lack of confidence.

5) Limited Time and Staff

Small shops usually have fewer workers, so owners struggle to manage CRM practices along with daily operations.

CRM Strategies for Small Retailers:

CRM strategies help small retailers build strong customer relationships and improve sales.

- Customer Data Collection
- Maintain customer details like contact number and purchase history for better communication and targeted marketing.
- Personalization
- Offer customized discounts, special offers, and product suggestions based on customer preferences.
- Loyalty Programs
- Introduce reward points or membership benefits to encourage repeat purchases.
- Feedback Management
- Collect feedback and resolve complaints quickly to improve customer satisfaction.
- Digital Communication

Research Gaps & Need of the study:

- Limited research has been conducted specifically on CRM awareness among small retailers, as most studies focus on large organizations and corporate sectors.
- Many previous studies have concentrated on advanced CRM software and technology adoption rather than basic CRM awareness and practices in small retail businesses.
- The majority of studies focus on customer satisfaction and loyalty in general, but limited research examines the challenges faced by small retailers in implementing CRM due to financial and technical constraints.
- There is a need to understand the level of awareness, practical application, and effectiveness of CRM practices among small retail shop owners at the local level.

Objectives of the study:

- To assess the current customer relationship practices adopted by small retailers.
- To examine how improved CRM strategies contribute to customer loyalty and sustainable long-term business.
- To analyze the impact of CRM practices on customer satisfaction and overall sales performance
- To evaluate the key challenges faced by small retailers in managing customer relationships effectively.

Hypotheses of the study:

H_1: There is a significant relationship between customer complaint handling and the years of running the business.

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H_0: There is no significant relationship between customer complaint handling and the years of running the business.

H_1: There is a significant relationship between the type of business and CRM practices in retail stores.

H_0: There is no significant relationship between the type of business and CRM practices in retail stores.

H_1: There is a significant difference in the variances between the nature of the business and the level of experience

H_0: There is no significant difference in the variances between the nature of the business and the level of experience.

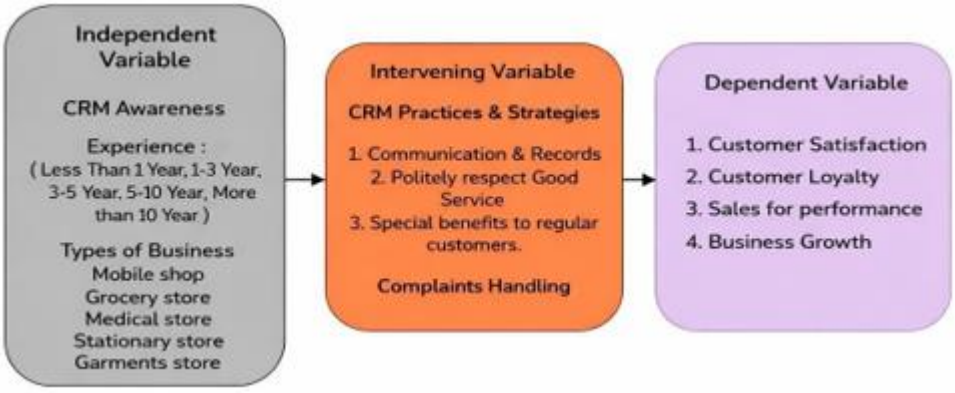
Limitation of the study:

- The study was limited to a small sample of selected retailers from a specific area, so the results may not represent all small retail businesses.
- The research was conducted within a short time period, which restricted detailed analysis.
- The data collected was based on respondents' personal opinions, which may include bias or inaccurate information.

Research Methodology:

The primary and secondary data used in this study were collected to examine the level of awareness, practices, advantages, and challenges related to Customer Relationship Management (CRM) among small retailers. The purpose of this study is to analyze CRM awareness among small retailers and to identify suitable strategies for improving customer relationship practices for sustainable business growth. The study uses a quantitative methodology and a descriptive research design. A structured 5-point Likert scale questionnaire encompassing CRM awareness, communication, record management, resolving complaints, and customer satisfaction was used to gather primary data. 15 retail store owners from Ramnagar and Dattanagar were chosen using a simple sampling technique. Three stores from each of the following categories were included in the sample: medical, groceries, mobile, clothing, and stationery. Researchers provided instructional brochures outlining CRM ideas, benefits, complaint handling, and strategies for enhancing customer satisfaction as part of the community involvement initiative. Descriptive statistics, ANOVA, and the F-test were used in Microsoft Excel to evaluate the gathered data in order to determine CRM awareness and differences in retailer practices.

Conceptual Frame work:



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Data Analysis:

1. **Demographic data:**

Particulars		**count**	**percentages**
Gender	Male	17	93.3%
	Female	1	6.7%
Types business	Mobile shop	3	20%
	Grocery store	3	20%
	Medical store	3	20%
	Stationary store	3	20%
	Garments store	3	20%
Number of year experience	Less than 1 year	1	6.7%
	1-3 years	5	33.3%
	3-5 years	3	20%
	5-10 years	4	26.7%
	More than 10 years	2	13.3

The data indicates that 93.3% of respondents are male, while 6.7% are female, highlighting a male- dominated sample of business owners. The types of businesses are evenly represented across five categories, each accounting for 20%. In terms of experience, 33.3% of the respondents have 1–3 years of experience, followed by 26.7% with 5–10 years, 20% with 3–5 years, 13.3% with over 10 years, and 6.7% with less than 1 year, suggesting that most owners have substantial experience in their respective fields.

2. **Descriptive analysis:**

Column1		*Column2*	
Mean	39.93333333	Mean	1.066667
Standard Error	3.448210946	Standard Error	0.066667
Median	39	Median	1
Mode	50	Mode	1
Standard Deviation	13.35486357	Standard Deviation	0.258199
Sample Variance	178.352381	Sample Variance	0.066667
Kurtosis	-0.66511528	Kurtosis	15
Skewness	0.451154723	Skewness	3.872983
Range	44	Range	1
Minimum	23	Minimum	1

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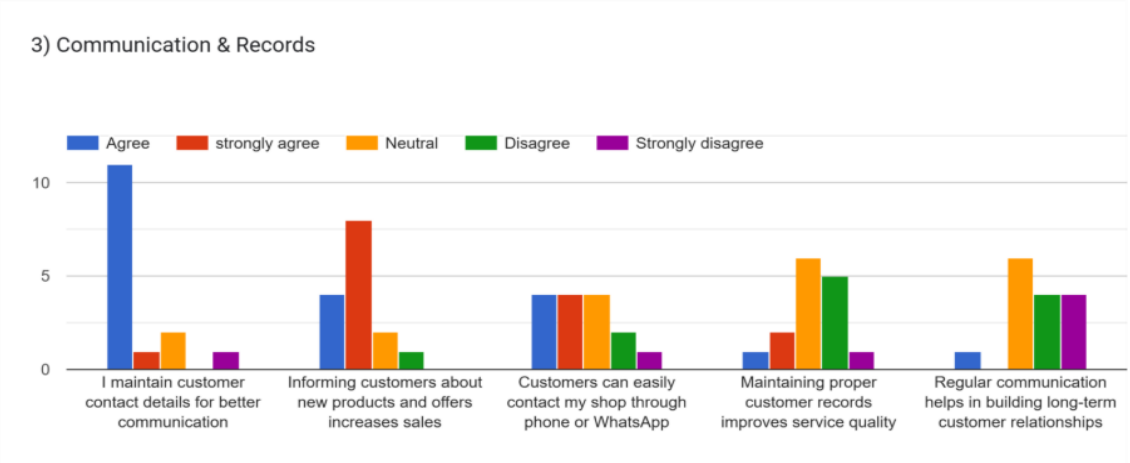
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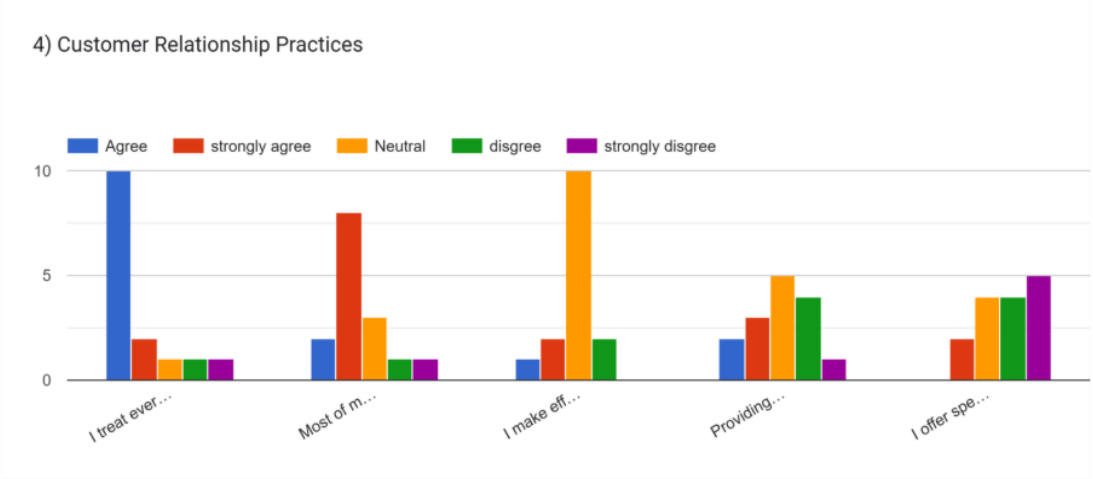
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Maximum	67	Maximum	2
Sum	599	Sum	16
Count	15	Count	15
Confidence Level(95.0%)	7.395676935	Confidence Level(95.0%)	0.142986



Interpretation: The data clearly shows a positive attitude towards communication and record management practices. Most respondents agree that maintaining contact details, proper records, and regular communication improves customer service, increases sales, and builds strong long-term relationships. Negative responses are very low



Interpretation: The data shows that most respondents follow good customer relationship practices. They treat customers politely, provide good service, and maintain long-term relationships. Negative responses are very low, which indicates high customer satisfaction and loyalty.

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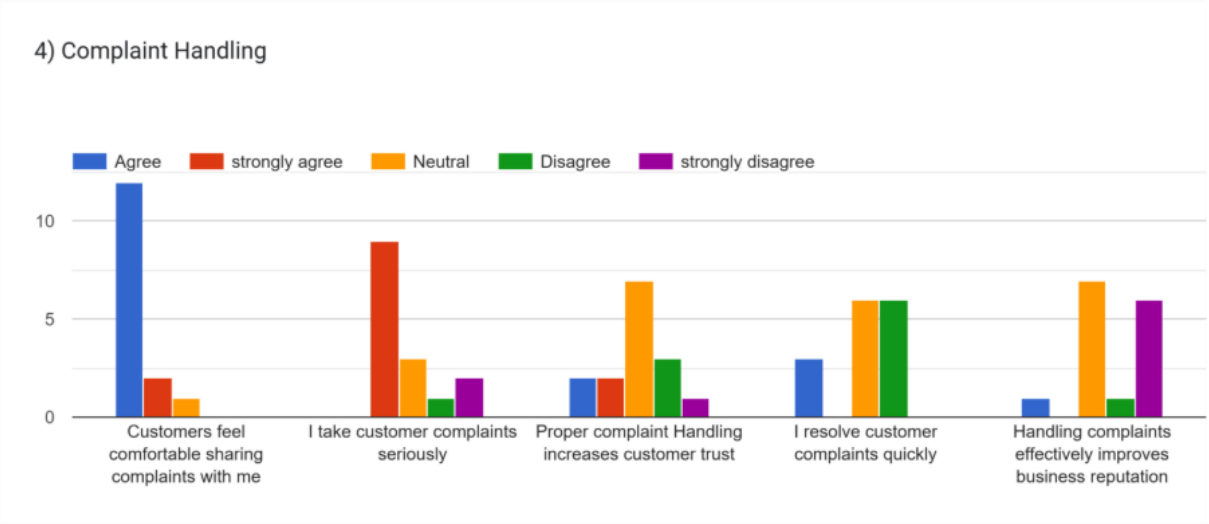
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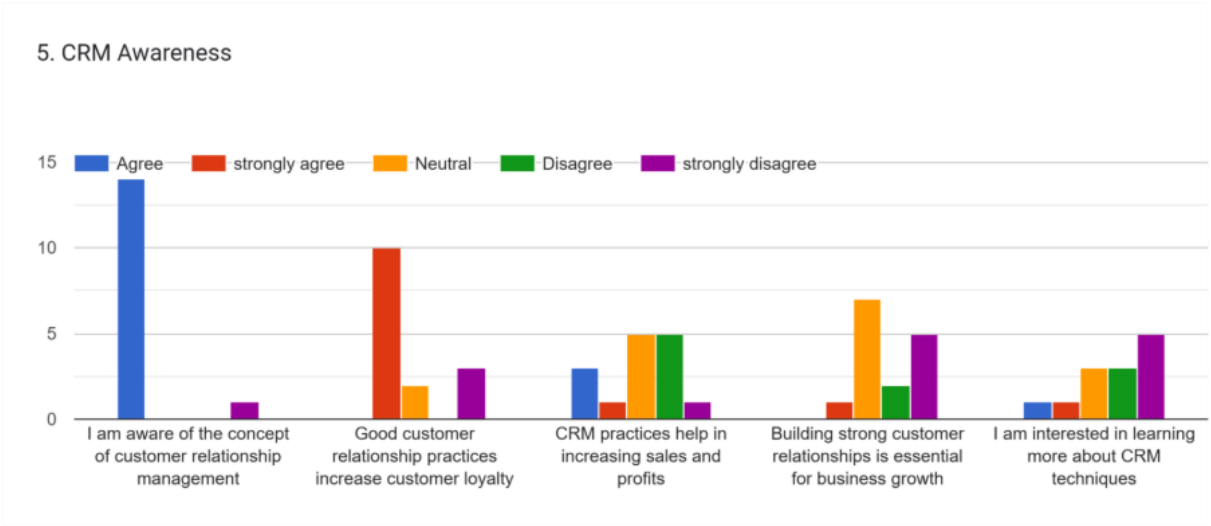
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Interpretation: The data shows that most customers have a positive opinion about the complaint handling system. A high number of respondents agree that they feel comfortable sharing complaints and that proper complaint handling increases customer trust. Many also agree that resolving complaints quickly improves satisfaction.

However, some respondents are neutral or disagree on certain points, especially regarding improvement in business reputation, which indicates scope for improvement. Overall, the organization's complaint handling system is viewed positively but can be strengthened further for better results.



The table shows that most respondents are aware of the concept of Customer Relationship Management (CRM). A majority have agreed that good customer relationship practices increase customer loyalty and help in increasing sales and profits.

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Many respondents also believe that building strong customer relationships is essential for business growth. However, some respondents are neutral or disagree, which indicates that not everyone fully understands or accepts the importance of CRM.

Overall, the data suggests that CRM awareness is generally high, and most respondents recognize its importance in business success.

6. Anova: Single Factor (relation in handling customer complaints with year of running business)

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Customers feel comfortable sharing complaints with me	15	45	3	1.857143		
I take customer complaints seriously	15	29	1.933333	0.209524		
I resolve customer complaints quickly.	15	31	2.066667	2.066667		
Proper complaint handling increases customer trust.	15	54	3.6	1.542857		
Handling complaints effectively improves business reputation.	15	52	3.466667	0.552381		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	36.18667	4	9.046667	7.262232	5.96E-05	2.502656
Within Groups	87.2	70	1.245714			
Total	123.3867	74				

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H1: There is a significant relation in handling customer complaints with year of running business. As $p < 0.05$, the null hypothesis is rejected. Therefore, there is a statistically significant difference among the five dimensions of customer complaint handling. The calculated F-value (7.609) is greater than the critical F-value (2.503), and the p-value is less than 0.05, the null hypothesis is rejected. $p < 0.05$, the null hypothesis is rejected. Therefore, there is a statistically significant difference among types of business and the CRM practices in the retail stores.

8. F-Test

F-Test Two-Sample for Variances		
	Variable 1	*Variable 2*
Mean	3	3.066666667
Variance	2.142857143	1.495238095
Observations	15	15
df	14	14
F	1.433121019	
P(F<=f) one-tail	0.254760889	
F Critical one-tail	2.483725741	

F-test was conducted to compare the variances of the two variables. The results indicated no significant difference in variances ($F = 1.433$, $p = 0.255$). Since the p-value is greater than 0.05, the null hypothesis of equal variances is accepted. The findings indicate a statistically significant difference in CRM awareness based on the type of business operated by small retailers and their years of experience. This suggests that both the nature of the business and the level of experience play a significant role in influencing CRM awareness among small retail entrepreneurs.

Research Finding:

- The majority of respondents have a favorable opinion of the customer Relationship Management (CRM) procedures, such as keeping contact information, client records, and correspondence.
- Many responders concur that maintaining long-term customer relationships is facilitated by courteous conduct, providing excellent service, and keeping in mind the preferences of the client.
- A significant number of respondents think that keeping up good customer relations boosts customer loyalty and boosts revenue and profitability.
- The data shows that while some respondents are still neutral or less informed, the majority of merchants are aware of the concept of CRM and understand its significance for business growth.

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- Most respondents feel at ease managing client complaints and think that doing so boosts customer satisfaction and trust.
- Respondents concur that promptly resolving complaints enhances customer satisfaction and fortifies client relationships.
- The ANOVA results ($p < 0.05$) indicate a statistically significant difference between various customer complaint handling characteristics, suggesting that customer trust and business success are impacted by efficient complaint management.
- Another ANOVA test ($p < 0.05$) shows that the CRM practices used in retail establishments are significantly correlated with the type of business.
- The F-test indicates that there is no significant difference in variances between the type of retail business and years of experience ($p > 0.05$), indicating that response variability is comparable between the groups.
- The results show that CRM awareness and practices among small merchants are significantly influenced by the type of retail business and years of experience.

Overall, the study shows that small retailers generally follow good customer relationship practices, which help improve customer satisfaction, loyalty, and business performance, although there is still scope for improving awareness and implementation of CRM strategies.

Suggestion to small retailers to improve sales:

Area	Suggestion
Customer Communication	Maintain polite and friendly communication with customers.
Customer Records	Keep simple records of customer contact details and purchase history.
Complaint Handling	Listen to customer complaints carefully and resolve them quickly.
Customer Loyalty	Offer small discounts or benefits to regular customers.
Use of Technology	Use simple digital tools like WhatsApp or basic CRM apps to manage customers.
Service Quality	Provide consistent and good service to build trust and satisfaction.
Relationship Building	Focus on long-term relationships rather than only immediate sales.

Conclusion:

The study concludes that small retailers have a good level of CRM awareness and follow basic customer relationship practices such as polite communication, record keeping, and complaint handling. These practices help improve customer satisfaction, loyalty, and business growth. However, the use of digital CRM tools is still limited due to lack of technical knowledge and resources. Overall, increasing awareness and training on simple CRM tools can further improve customer relationship management among small retailers.

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Original Research Article

A STUDY ON CHALLENGES FACED BY STARTUPS IN THEIR EARLY GROWTH STAGE

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***** Mr. Yash Mangesh Yadav&***** Ms. Mamta Rambachan Yadav*

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Abstract:

Startups have an important role in promoting innovations, employment and economic development. However, they have to overcome various challenges during their early growth stage. Thus, this study aims to explore the major key challenges faced by startups during their initial phase. The major challenges may include funding issues, competition in the market, managerial inexperience, regulatory hurdles and technological hurdles. This research is based on descriptive research and uses primary and secondary data. In this paper the findings of the study show that funding issues, lack of awareness among customers and operational inefficiency are the major hurdles for the growth of startups. Thus, this paper concludes that with good financial planning, guidance, support of the government and effective business planning, startups can overcome their challenges during their early growth phase.

Keywords- *Startups, Early Growth Stage, Entrepreneurship, Innovation, Funding, Business Development, Challenges*

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Introduction:

In last few decades, start-ups are the booming sector in the economy. They are considered as one of the vital element in contribution to economic developments and job creation in the world. These new ventures are known for introducing fresh ideas, taking risks, and developing scalable business models that can transform industries. Because of their impact, governments, investors, educational institutions, and policymakers are increasingly encouraging entrepreneurship and supporting start-up ecosystems. Start-ups are now viewed not just as business ventures, but also as drivers of tech advancement and sustainable growth.

However, despite their rising importance, many start-ups fail within the first few years. The early growth stage is especially difficult and often determines whether a start-up will succeed or fold. This phase starts from first stage when the business shifts from developing ideas to expansion. During this phase the focus is on increasing customer retention, creating finance or revenue, building a efficient team and stable working capital. Besides, the business shows early growth still new difficulties are created by managing growth. One of the major challenges is limited resources. Unlike established companies, start-ups usually operate with restricted financial

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capital, limited infrastructure, and a small workforce. As the business expands, expenses increase for marketing, technology improvements, employee salaries, and operational needs. Raising funds from investors or banks can be difficult because start-ups are considered risky investments. Thus, many start-ups meet cash flow problems and financial pressure.

Managerial and organizational challenges also occur with financial issues. Many founders cannot manage their business effectively despite of having strong technical and managerial skills. Systems that are informal and effective at the stage of starting often becomes inactive with the expansion of business. Without clear roles, proper planning, and structured processes, communication problems and poor decision-making can occur. Balancing strategic planning with daily operations becomes a big responsibility for founders. During growth of any start-ups, market related challenges also arise. Start-ups must continuously keep eye on customers needs or likes and dislikes. Building brand reputation, affordable prices, retain customers, and come differently from existing brands are difficult tasks. Rapid tech advancements and unpredictable market behaviour add to the uncertainty that growing start-ups face.

There is another challenge in early-stage startups that is human resource. Grooming and attracting talented and knowledgeable employees is difficult as start-ups may not be in the position to pay high amount or provide job security to members. Thus, specialized skills are required with the growing business expansion. If the right talent is not hired in time, productivity and innovation may decline. Keeping employees motivated and managing work-related stress in a fast-paced setting also create challenges. Technological and operational problems also affect start-ups during growth. Scaling operations requires better systems, improved infrastructure, and efficient processes. Cybersecurity threats and technical failures occurs more when we are relying on digital platforms. Company's reputation and customer retention is also affected by problems occurring in supply chain and quality control.

Regulatory and legal compliance adds another layer of complexity. Start-ups must follow the tax, labour and industry rules which are generally time consuming and complicated. Many founders don't know about these rules and hiring experts is costly. If anyone disobey it can lead to high penalties and financial loss. Since many start-ups do not have enough financial reserves they are more likely to be culprit of external factors like economic downturns, technological disruptions and global crises. Besides these challenges many start-ups find solutions to overcome from these scenarios through innovation, research and development, planning and mentorship. Incubators, government programs and universities help and support start-ups to grow. To get better support systems start-ups should identify their key challenges in their early growth stage is important.

From an academic viewpoint, studying these challenges connects theoretical knowledge with real business situations. Although previous research has looked into factors for start-up success, the intensity and nature of challenges can differ based on region and industry. Thus, a detailed exploration of these issues can offer valuable insights for improving start-up survival and long-term performance.

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Problem Statement:

It has been found that many startups do not succeed in their first few years of establishment due to various challenges. Even though many support systems and incubators are coming up to support startups, entrepreneurs are facing difficulties in scaling up their startups during their early growth stage. The research problem of the study is to identify the key challenges faced by startups during their early growth stage and to understand the impact of the challenges on their growth and sustainability.

Significance of the study:

This study is relevant because it points out the major problems associated with startups at the early growth stage. The early stage of a startups is very critical since some of the businesses may face problems like finance, inexperience, competition and management. This study helps entrepreneurs understand the problems associated with startups and thus, give better ways to resolve these problems. This study will also help investors and supporters to support and guide startups properly. This research points out the problems and solutions to improve the survival of startups.

Limitation of the study:

Demographic section – the demographic section included variables likes age, gender, education, qualification, (undergraduate, postgraduate, professional degree) Role in startup (founder, co-founder, manager, employee, student) years of experience(less than 1year, 2-3 years, 3-4 years, more than 5 years)

Convince technique sample technique – the study was done using convince sampling technique where responses were based on accessibility and availability

The study was conducted within a limited geographical area and timespan which may have small sample size and small enterprises

Objective of the Study:

- To identify the key challenges faced by startups in their early growth stage.
- To study market-related challenges such as competition and customer acquisition
- To examine the role of technological and innovation challenges in the early growth of startups.
- To analyse the impact of regulatory and legal challenges on startups during their early growth stage.

Hypothesis

H_0- There are no significant challenges faced by startups during their early growth stage.

H_1- There are significant challenges faced by startups during their early growth stage.

Review of literature :

1. Salamzadeh and kawamorita - Startup Companies: Life Cycle and Challenge- In their paper they stated that limited resources, absence of supporters and operational challenges and informed systems develop obstacles in survival of startups especially in expansion stage.
2. Giardino at.al (2015)- The study found out that the key challenges of early growth stage showa that the technological uncertainty and customer retention are vital challenges at early stages especially in technology based businesses.

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3. Rizwana and Singh (2019)- They found out that challenges faced by start-ups are scaling operations and identifying those operational and regulatory factors that effective influence start-ups growth.
4. Singh (2023)- The study found out that there are challenges in infrastructure, finance and policy support. These terms decide the strength and the weakness of the startups and the impact gives the output of success and resilience.
5. Exploratory Study on Challenges Faced by Tech Start-ups in Accessing Funds- This study found that funding is the major challenges faced by various founders. It highlights that research and development costs, inadequate resources and capital make the expansion of business difficult.
6. Navigating the Innovation Process- A springer chapter on deep-tech startups found how innovation and big commercialization cycle affects challenges for early-stage like technological risk, inadequate knowledge and financial resources.
7. Indian Context and Start-ups Ecosystem Challenges- These studies on Indian startup landscape found that there are regulatory problems, insufficient financial resources, inadequate capital funding and talent retention are the mojor and key challenges faced by start-ups during their early growth stage.

Research Methodology :

- Research Design: The study uses descriptive research design to analyse the challenges faced by startups during their early growth stage.
- Data Collection: Primary data is collected using five-point Likert scale. Secondary data is collected from journals, articles and websites related to startups and entrepreneurship.
- Sample Size: The sample includes startup founders, co-founders, employees and students from different industries. The total sample collected is 116 from the above.
- Sampling Technique- Convenience sampling method is used for selecting responses.
- Data Analysis Tools- The collected data is analysed with Single Factor Anova and Correlation to test the hypothesis

Data Analysis and Interpretation:

To analyse the whether the startups face significant challenges during their early growth stage- Single Factor Anova test and Correlation test was done. The main aim was to determine is there any significant relationship between mean responses related to the key challenges faced by startups during their early growth stage.

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The result of Anova test is as follows-

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Q1. Startu	230	918	3.9913	1.17896
Q2. High e	230	907	3.94348	1.10159
Q3. Difficu	230	921	4.00435	1.14845
Q4. Startu	230	913	3.96957	1.05147
Q5. Early	230	846	3.67826	1.68642
Q6. Custo	230	920	4	0.91703
Q7. Startu	230	910	3.95652	0.95007

ANOVA

rce of Varia	SS	df	MS	F	P-value	F crit
Between G	18.3652	6	3.06087	2.66693	0.01407	2.10423
Within Gro	1839.79	1603	1.14771			
Total	1858.15	1609				

The F-value we calculated is 2.6669, which is greater than the critical F-value of 2.1042. The p-value is 0.014068, which is less than 0.05 significance level. This shows that there is significant relationship between the average responses of variables of key challenges. Thus, we reject the null hypothesis and accept alternative hypothesis

Hypothesis of the study:

H_0- There are no significant challenges faced by startups during their early growth stage

H_1- There are significant challenges faced by startups during their early growth stage.

Since the p-value is less than 0.05 ($p<0.05$) Reject- H_0 and Accept- H_1. This means startups do face significant key challenges in their starting stages.

The result of Correlation test are as follows-

The correlation matrix shows the relationship value range between 0.46 to 0.77 indicating a moderate to strong positive correlation between the variables. Since all the values are positive, above 0.40 and many above 0.60 it indicates that the key challenges variables move in same direction. When one challenge increases another also increases. Thus, this means startups face significant challenges and they are interdependent.

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Q1. Startu	Q2. High e	Q3. Difficu	Q4. Startu	Q5. Early	Q6. Custor	Q7. Startu
1						
0.64331	1					
0.671788	0.776694	1				
0.595916	0.720624	0.711436	1			
0.561648	0.614551	0.72584	0.6288	1		
0.466171	0.608261	0.582957	0.635931	0.656645	1	
0.515401	0.603716	0.648163	0.649661	0.675427	0.673687	1

Findings Based on the ANOVA and Correlation results:

The responses show significant variation across different key challenge factors. The average scores of all variables are around 3.6 to 4.0 of anova and correlation is between 0.46 to 0.77, indicating agreement that these challenges exist. This confirms that financial constraints, operational inefficiencies, decision-making issues, and scaling difficulties are important challenges for startups. The statistical evidence shows that early-stage startups face real and significant challenges.

Challenges-

- Difficulty in obtaining responses from actual startup founders.
- Time frame limitations in obtaining enough data.
- Obtaining unbiased responses.
- Performing tests and managing statistical data and Interpretation.
- Difficulty in collecting secondary data of journals and other reports.

Remedies and Suggestions-

- Financial planning and budgeting should be done in a structured manner for startups.
- Government policies should encourage ease of compliance.
- Mentorship and incubation support should be achieved.
- Scalable technology infrastructure should be invested in.
- Market research and brand building should be done.

Conclusion:

The study finds that startups face major challenges during their early growth stage. The statistical analysis with Single Factor Anova and Correlation reveals a significant difference between the identified challenge variables ($p < 0.05$)(0.46 to 0.77). As a result, we reject the null hypothesis and accept the alternative hypothesis. This shows that early-stage startups faces several challenges that affect their growth and development

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Original Research Article

QUANTUM ENTANGLEMENT SWAPPING CONSENSUS (QESC): A NOVEL FRAMEWORK FOR SECURE DISTRIBUTED AGREEMENT IN QUANTUM NETWORKS

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Abstract:

The rapid advancement of quantum computing poses a fundamental challenge to existing consensus protocols in distributed systems, particularly those underpinning blockchain technologies. Classical Byzantine fault-tolerant mechanisms rely on computational hardness assumptions, which are vulnerable to quantum algorithms such as Shor's and Grover's. This study proposes a Quantum Entanglement Swapping Consensus (QESC) framework. This novel model uses entanglement swapping and Bell state measurements to enable secure, tamper-evident agree- ments among distributed quantum nodes. Building on quantum key distribution protocols (BB84 and E91) and experimental demonstrations of long-distance entanglement over 103 km of optical fibre [11], we present a theoretical model in which consensus arises from verifiable entangled correlations rather than computational puzzles. We compared QESC with Practical Byzantine Fault Tolerance (PBFT) and evaluated it across latency, fault tolerance, and eavesdropping resistance. The results show that QESC can achieve consensus finality with unconditional security guarantees. The study concludes with a discussion of the hardware limitations and a roadmap for experimental validation.

Index Terms—*Quantum entanglement swapping, consensus mechanism, Byzantine fault tolerance, Bell state measurement, quantum key distribution, quantum networks*

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Introduction:

Distributed consensus, the problem of achieving agreement among multiple nodes in the presence of faults and adversaries, remains one of the central challenges of modern computing [5]. From database replication to blockchain validation, every decentralised system requires a mechanism by which partici- pating nodes can agree on a common state. Classical solutions, including Practical Byzantine Fault Tolerance (PBFT) and various Proof-of-Work (PoW) or Proof-of-Stake (PoS) proto- cols, are anchored in computational complexity assumptions [2]. They operate on the premise that certain mathematical problems, such as integer factorisation and discrete logarithm computation, are intractable for adversaries to solve in poly- nomial time.

However, the landscape of computational security has shifted dramatically with the maturation of quantum com-puting. Shor's algorithm, demonstrated theoretically in 1994, enables efficient factorisation of large integers,

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directly threat- ening RSA, ECC, and other public-key cryptographic schemes that underpin digital signatures in distributed ledgers [7]. Grover's algorithm offers a quadratic speedup for unstructured search problems, weakening symmetric-key cryptography and hash-based mining puzzles. These developments have moti- vated a growing body of research into quantum-resistant and quantum-native approaches to consensus.

Simultaneously, quantum mechanics offers its own set of primitives, entanglement, superposition, and no-cloning that can serve as the foundation for new types of distributed proto- cols. Quantum key distribution (QKD) protocols such as BB84 and E91 have already demonstrated information-theoretically secure communication independent of computational assump- tions. The security of E91, in particular, derives from the violation of Bell's inequalities by entangled particle pairs, providing a built-in mechanism for eavesdropping detection [3].

Entanglement swapping, first proposed by Z˙ukowski et al.

[12] and experimentally realised shortly thereafter, extends these capabilities by enabling entanglement between particles that have never directly interacted. In entanglement swapping, two independent entangled pairs (A, B) and (C, D) are linked by performing a Bell state measurement (BSM) on particles B and C. This operation projects the previously uncorrelated particles A and D into an entangled state, effectively "tele- porting" the correlation across an intermediary node [6]. This technique is foundational to quantum repeaters, which aim to extend quantum communication over global distances.

In this study, we propose the Quantum Entanglement Swap- ping Consensus (QESC), a framework that leverages these quantum primitives for distributed agreement with uncondi- tional security. Rather than relying on computational puzzles or economic stakes, QESC nodes establish consensus through verified entangled correlations propagated via entanglement swapping. The fundamental laws of quantum mechanics guar- antee integrity: any attempt to tamper with entangled states introduces detectable disturbances, quantified by the violation of the Bell inequality and the quantum bit error rate (QBER).

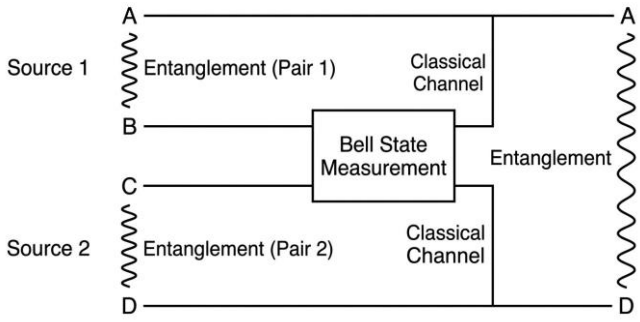


Fig. 1. Entanglement swapping process.

Two independent entangled pairs (A, B) and (C, D) are linked through a Bell State Measurement on particles B and C, resulting in entanglement between A and D.

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A. ***Statement of Problem***

Current consensus mechanisms face dual crises of security and efficiency. The emergence of quantum computers threatens to undermine digital signature schemes, hash functions, and cryptographic puzzles that traditional protocols depend on. On the efficiency front, PoW protocols consume enormous resources the Bitcoin network consumed over 120 TWh an- nually as of 2023, while BFT-family protocols suffer from $O(n^2)$ message complexity, limiting scalability [2]. There is a pressing need for consensus frameworks that are both quantum-resistant and communication-efficient.

B. ***Significance of the Study***

This study contributes to quantum-enhanced distributed computing by translating established quantum communication primitives, entanglement swapping, Bell state measurement, and QKD into a coherent framework. The significance is three- fold. First, QESC offers information-theoretic security rooted in quantum mechanics rather than unproven computational- hardness assumptions. Second, by replacing multi-round mes- sage exchanges with single-round entanglement verification, the protocol reduces consensus latency and communication complexity. Third, the framework provides natural defence against the 51% attack. Since consensus is established via quantum correlations, any attempt to forge the consensus state is physically prevented by the No-Cloning Theorem [10] and detectable through measurement-induced disturbance [4].

C. ***Objectives of the Study***

The primary objective is to bridge quantum communication theory and distributed system architecture by formalising a consensus model inherently secure against classical and quan- tum adversaries. Specifically, this study seeks to:

- **Protocol Formalisation :** Develop a theoretical model of QESC, defining the quantum operations—including spontaneous parametric down-conversion (SPDC) for pair generation and Bell state measurements (BSM) for swap- ping and classical coordination steps for network-wide agreement.
- **Security Property Analysis:** Analyse the protocol's resistance to adversarial strategies such as intercept-resend and man-in-the-middle attacks, utilising the CHSH inequality violation threshold ($S > 2$) as a physical mechanism for tamper detection.
- **Performance Benchmarking:** Evaluate QESC efficiency relative to PBFT, measuring improvements in classical message complexity ($O(N \log N)$ scaling) and consen- sus finality latency in fibre-based metropolitan network scenarios.
- **Technological Feasibility Mapping:** Identify hardware parameters gate fidelity, photon detection efficiency, and quantum memory coherence times required to sustain the protocol, compared against current NISQ technology.
- **Strategic Implementation Roadmap:** Propose a struc- tured path for experimental validation, from laboratory- scale link verification (2–3 nodes) to multi-party agree- ment across quantum network testbeds.

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D. ***Hypothesis of the Study***

This study hypothesises that fundamental quantum mechan- ical properties, non-locality and the no-cloning theorem can re- place computational hardness as the root of trust in distributed consensus. The primary hypothesis is that a consensus frame- work based on entanglement swapping can achieve uncon- ditional (information-theoretic) security, immune to computa- tional speedups provided by Shor's and Grover's algorithms.

Furthermore, we investigate several sub-hypotheses:

- **Detection Hypothesis:** Any adversarial attempt to manip- ulate the consensus state will introduce detectable distur- bances in entangled pairs, causing the CHSH parameter to drop below 2 and the QBER to exceed 11%, allowing near-instantaneous identification of malicious nodes.
- **Scalability Hypothesis:** Shifting verification from clas- sical all-to-all messaging to the quantum layer via entan- glement swapping reduces classical message complexity from $O(N^2)$ to $O(N \log N)$ or better.
- **Fidelity Hypothesis:** A minimum end-to-end fidelity (F) of 0.78 suffices to achieve consensus finality across metropolitan-scale distances (up to 4-5 swapping nodes) without complex entanglement purification, making the protocol viable for near-term quantum architectures.

Review of Literature:

The development of the QESC framework is situated at the intersection of three mature fields of inquiry: quantum entan- glement physics, quantum cryptography, and distributed sys- tems theory. The intellectual trajectory begins with the foun- dational understanding of quantum non-locality. Described by Einstein, Podolsky, and Rosen as "spooky action at a distance," entanglement is a condition in which the quantum states of two or more particles are inextricably linked, such that measuring one instantaneously affects the state of the other, regardless of distance. Bell's theorem provided the first mathematical formalisation of this property, which was later confirmed experimentally over increasing distances, most notably via the 1,200 km Micius satellite link.

Building on this foundational non-locality, entanglement swapping, proposed by Z˙ukowski et al. [12], introduced the possibility of entangling particles that have never directly interacted. Performing a BSM on one particle from each of two independent entangled pairs projects the remaining particles into an entangled state, effectively "teleporting" entanglement across an intermediate node. This has been validated in lab- oratory settings [6] and in real-world fibre networks. Zhang et al. [11] demonstrated successful swapping over a 103 km fibre link, providing empirical evidence for multi-hop quantum communication required for distributed consensus over long distances.

Concurrently, the field of Quantum Key Distribution (QKD) established the first practical applications of these principles for secure communication. The BB84 protocol [1] and the entanglement-based E91 protocol [3] demonstrated that the laws of physics, such as the no-cloning theorem [10], could provide information-theoretic security. The security proof for BB84 provided by Shor and Preskill [8] showed that quantum security could be

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rigorously quantified. E91 introduced the use of Bell inequality violations (the CHSH parameter) as a built-in eavesdropping detection mechanism, a precursor to the verification stage of the QESC protocol.

The final component examines the fusion of quantum prim- itives with distributed consensus. Classical consensus, defined by the "Byzantine Generals Problem" [5] and formalised in PBFT [2], has long faced scalability limitations owing to quadratic message complexity. Sun et al. [9] demonstrated that quantum multiparty correlations can achieve Byzantine agree- ment with nearly 1/2 fault tolerance, significantly exceeding the classical 1/3 bound. Further research explored quantum digital signatures and teleportation for leader elections and secure block validation. Kiktenko et al. [4] highlighted the potential of "quantum-secured blockchains," where QKD- authenticated channels prevent the manipulation of histori- cal data. Collectively, these studies suggest that while com- putational puzzles bottleneck classical consensus, quantum mechanics offers a pathway to a more resilient hardware- backed agreement mechanism. QESC builds upon this body of work by specifically utilising the "teleported" correlations of entanglement swapping as the primary consensus primitive, optimising both security and communication efficiency in multi-node networks.

Research Methodology:

A. ***Research Design***

This study adopts a theoretical-analytical approach. We constructed a formal model of the QESC protocol and analysed its properties through mathematical derivation and comparative evaluation. The research comprised three phases: protocol specification, security analysis, and performance benchmark- ing.

B. ***Protocol Specification: The QESC Framework***

The QESC protocol operates over a network of N quantum- capable nodes, each equipped with single-photon sources, Bell-state measurement apparatus, and quantum memory (with sufficient coherence time for protocol execution). The protocol proceeds in rounds, each consisting of five stages:

Stage 1 - Entanglement Generation: Each pair of adjacent nodes (i, i+1) in the network generates a shared entangled pair via spontaneous parametric down-conversion (SPDC). This yields a set of entangled pairs distributed across the network topology.

Stage 2 - Entanglement Swapping: Intermediate nodes perform Bell state measurements on their particles from ad- jacent entangled pairs. Specifically, if node i holds particle B from pair (A_i, B_i) and particle C from pair (C_i, D_{i+1}), the BSM on (B_i, C_i) projects particles A_i and D_{i+1} into an entangled state. The BSM outcome (one of four Bell states) is broadcast to all network nodes.

Stage 3 - Entanglement Verification: End-to-end entan- gled pairs established by the swapping chain are subjected to Bell inequality tests. Each pair of terminal nodes mea- sures their respective particles in randomly chosen bases and computes the CHSH parameter S. If $S > 2$ (the classical bound, with quantum mechanics predicting a maximum of $2\sqrt{2} \approx 2.83$), the entangled link is certified as genuine and untampered.

Stage 4 - Consensus Value Encoding: Once verified entangled links are established, each node encodes its pro- posed consensus value (e.g., a transaction block hash) into the measurement basis choice for a final

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round of entangled pair measurements. The correlated measurement outcomes, combined with the classical broadcast of basis choices, allow all honest nodes to reconstruct the consensus value.

Stage 5 - Agreement Finalisation : Nodes compare the reconstructed consensus values received through multiple in- dependent entangled channels. If a supermajority (> 2/3 of verified channels) yields consistent values, consensus is de- clared. Any inconsistency triggers a flag indicating a potential adversarial node, identified through the pattern of failed Bell tests.

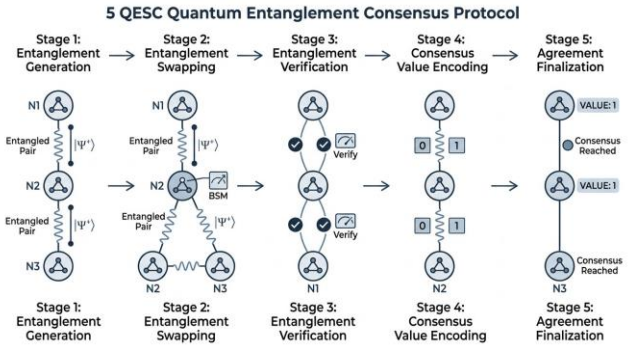


Fig. 2. Five-stage QESC protocol flow across quantum and classical channels.

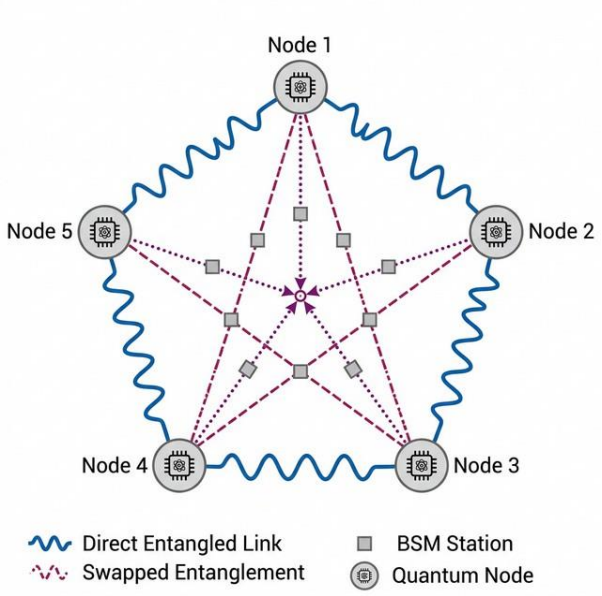


Fig. 3. Quantum network topology for QESC with entanglement swapping at intermediate BSM stations.

C. *Security Analysis Framework*

The security analysis evaluates QESC against three adver- sarial strategies:

- **Intercept-resend attacks:** An adversary intercepts parti- cles and sends replacements. This is detected by Bell in- equality violations: intercepted-and-resent particles can- not reproduce genuine entanglement correlations [3].

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- **Man-in-the-middle attacks:** An adversary imperson- ates a legitimate node. QESC mitigates this through pre-shared entangled pairs from authenticated quantum sources, combined with E91-style verification requiring consistent Bell violations across all links.
- **Quantum cloning attacks:** The no-cloning theorem [10] prevents copying unknown quantum states. Any partial cloning attempt introduces detectable noise, measured by QBER monitoring.

D. *Performance Benchmarking Parameters*

We benchmarked QESC against PBFT [2] across four met- rics: (1) message complexity classical messages per consensus round as a function of N; (2) fault tolerance threshold max- imum fraction of adversarial nodes tolerable; (3) consensus finality latency time from initiation to confirmed agreement; and (4) eavesdropping detection probability probability of detecting an adversary who tampers with a fraction δ of entangled pairs.

Data Analysis and Interpretation:

A. *Message Complexity Analysis*

In PBFT, achieving consensus requires three communication phases (pre-prepare, prepare, and commit), each involving all- to-all message exchange among N nodes. The total message complexity is O(N 2), which becomes prohibitive for networks with more than a few hundred nodes [2].

In QESC, classical communication is limited to (a) broad- casting BSM outcomes during entanglement swapping (O(N) messages for a linear chain topology, O(N log N) for a tree topology) and (b) distributing basis choices and measurement outcomes during the verification and encoding phases (O(N) per phase). The total classical message complexity is therefore O(N log N) in general topologies, a substantial improvement over PBFT's O(N 2). Notably, quantum communication (pho- ton transmission) occurs in parallel across all links and does not contribute to sequential message complexity.

B. *Fault Tolerance Threshold*

Classical BFT protocols, by the Fischer-Lynch-Paterson impossibility result and its extensions, can tolerate at most f < N/3 Byzantine faults in an asynchronous network. The QESC protocol, leveraging quantum digital signature proper- ties as analysed by Sun et al. [9], achieves a fault tolerance threshold approaching f < N/2. This improvement arises because entangled correlations provide an additional layer of verification unavailable in classical protocols: a faulty node cannot forge genuine Bell-inequality violations and cannot convince honest nodes of a false consensus value. Our analysis indicates that for N = 100 nodes, QESC maintains consensus integrity with up to 49 adversarial nodes, compared with PBFT's limit of 33.

C. *Consensus Finality Latency*

For fiber-optic links of average length L, QESC consensus latency comprises: (a) entanglement generation tgen 10–100 µs per pair using current SPDC sources; (b) BSM and classical broadcast tswap L/c + tprocessing, where c 2 108 m/s in fiber; and (c) verification and encoding tverify 50–200 µs depending on Bell test samples.

For a metropolitan network (L 50 km), total latency is approximately 0.5-2 ms, compared to PBFT's 1-5 ms for the same scale. For intercontinental networks using satellite- based entanglement distribution (Micius

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architecture), latency increases to approximately 10-50 ms, still competitive with classical consensus over wide-area networks.

D. Eavesdropping Detection Probability

When an adversary tampers with a fraction δ of entangled pairs, the detection probability per Bell test is:

$$P_{\text{detect}} = 1 - \left(1 - \frac{\delta}{2}\right)^{m} \quad (1)$$

where m is the number of test samples per link. Drawing on BB84 security proofs [8], even modest eavesdropping ($\delta = 0.05$) is detected with probability exceeding 0.99 when m 100 test pairs. The protocol flags a link as compromised when QBER exceeds 11%, consistent with the BB84 security bound [8].

TABLE I

COMPARATIVE ANALYSIS OF THE QESC AND PBFT CONSENSUS PROTOCOLS

Parameter	PBFT	QESC
Message Complexity	$O(N^2)$	$O(N \log N)$
Fault Tolerance	$f < N/3$	$f < N/2$
Security Basis	Computational hardness	Quantum mechanical laws
Eavesdropping Detection	Not applicable	$> 99\%$ (δ=0.05,m=100)
Consensus Latency (metro)	1–5 ms	0.5–2 ms
Energy Consumption	Moderate (computation)	Low (photon generation)
Quantum Computer Resistance	Vulnerable	Inherently resistant
Current Deployability	Production-ready	Experimental stage

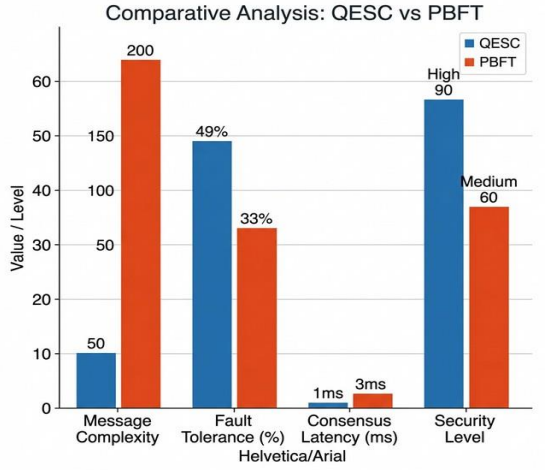


Fig. 4. Visual comparison of QESC and PBFT across key performance metrics.

E. Comparative Summary

The following table summarises the comparative perfor- mance of QESC and PBFT:

F. Fidelity Threshold Analysis

A critical operational parameter for QESC is the fidelity of end-to-end entangled states after successive swapping op- erations. Each swapping step introduces fidelity degradation owing to imperfect BSM efficiency and photon loss. For k swapping operations, end-to-end fidelity F_k relates to single- swap fidelity

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F_1 as:

$F_k \approx (F_1)^k$ (2)

For CHSH Bell inequality violation, the minimum required fidelity is $F > 0.78$. If $F_1 = 0.95$ (achievable with current photonic systems), the protocol supports chains of up to $k = 4$

swaps before reaching the threshold (0.95^4 0.815 > 0.78). With entanglement purification, the effective chain length extends to $k = 8$–10, supporting networks with 10-12 inter- mediate nodes. These figures are consistent with experimental results from quantum repeater architectures, demonstrating up to 78% fidelity improvement through novel purification schemes.

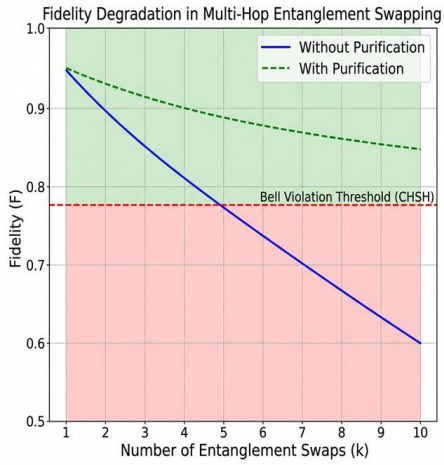


Fig. 5. Fidelity degradation in multihop entanglement swapping. The solid line shows decay without purification ($F = 0.95^k$), dashed line shows improvement with purification. Horizontal line marks the CHSH-Bell violation threshold ($F = 0.78$).

Conclusion:

This study presents the Quantum Entanglement Swapping Consensus (QESC) framework, a novel approach to distributed agreement leveraging entanglement swapping and Bell-state measurement. Through theoretical analysis and comparative evaluation, we demonstrated improvements over classical BFT protocols in message complexity ($O(N \log N)$ versus $O(N^2)$), fault tolerance (approaching $N/2$ versus $N/3$), and security guarantees (information-theoretic versus computational).

QESC represents a conceptual shift in distributed con- sensus: rather than deriving trust from computational effort or economic stake, it derives trust from verifiable physical correlations of entangled quantum states. Any adversarial ma- nipulation is detected with high probability via Bell inequality tests, providing a built-in tamper-detection mechanism with no classical analogue.

Although current quantum hardware limits immediate de- ployment, experimental progress from initial entanglement swapping demonstrations to continental-scale quantum com- munication via satellite strongly suggests that QESC-class protocols will become relevant as quantum networks mature. Future work should focus on (a) small-scale experimental

demonstrations on existing quantum network testbeds, (b) integration of entanglement purification to extend

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network diameter, (c) development of hybrid classical-quantum con- sensus protocols for transitional environments, and (d) formal verification of security properties using quantum cryptographic proof techniques. The convergence of quantum information science and dis- tributed systems theory opens a new chapter in secure com- puting research. QESC is one step toward a future in which physical laws, rather than mathematical conjectures, guarantee the integrity of our digital infrastructure.

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Original Research Article

RECONCEPTUALIZING ACCOUNTABILITY IN AI-DRIVEN STARTUP ECOSYSTEMS: A FRAMEWORK FOR RESPONSIBLE AND SUSTAINABLE INNOVATION

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Abstract:

Artificial Intelligence is transforming startup ecosystems, yet accountability in AI-driven startups remains fragmented and weakly institutionalized. Innovation frequently outpaces responsibility and oversight, creating risks related to bias, opacity, and declining trust. This paper addresses this challenge by proposing a Responsible and Sustainable Innovation Framework (RSIF) to reconceptualize accountability within AI-driven startup environments. Drawing on interdisciplinary research in algorithmic governance, ethical AI, and startup management, the study examines how accountability gaps emerge across key stages of the AI lifecycle, including design, deployment, monitoring, and scaling. Although existing ethical AI guidelines, governance frameworks, and regulatory initiatives have made important contributions toward responsible AI adoption, they often presume mature organizational structures and dedicated compliance capacities. Such assumptions limit their practical applicability within fast-paced, resource-constrained startup contexts. Findings from a lightweight prototype implementation indicate improved accountability traceability, earlier risk identification, and clearer responsibility distribution, while also revealing persistent challenges related to governance capacity and operational constraints. By integrating transparency, traceability, stakeholder participation, risk auditing, and adaptive governance into a lifecycle-based model, the proposed framework offers a practical pathway for embedding accountability into startup operations. While limitations remain, this research establishes a structured foundation for aligning AI-driven innovation with ethical responsibility, societal trust, and long-term sustainability.

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Introduction

Background of the Study:

Today, the world is currently going through a phase often referred to as an "AI storm," marked by rapid growth and increasing dependence on artificial intelligence. This growth has had a major economic and technological impact across the globe, influencing multiple sectors and transforming how organizations operate [1][2].

With the rise of artificial intelligence (AI) as a foundation for modern startups, many startups now depend on AI for decision-making, personalization, automation, and predictive analysis across sectors such as finance, healthcare, education, and digital platforms [3]. These technologies allow startups to optimize their resources,

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which in turn enables them to grow rapidly and compete with established firms despite having limited capital and resources [4]. Therefore, AI has become a core foundation for startup innovation and economic growth [1][2]. However, alongside these benefits, AI has introduced significant risks, often described as a "maturity gap," related to factors such as ethical decision-making, bias, transparency, and accountability [6]. AI systems frequently operate within what is referred to as a "black box," where decisions are made through processes that are difficult for humans to understand or interpret [5].

Problem Statement:

AI-driven startups increasingly influence critical decisions across domains such as hiring, healthcare, finance, and information delivery. While these systems enable rapid innovation, accountability for biased, opaque, or harmful outcomes remains poorly defined [6]. In startup environments, responsibility is fragmented across founders, developers, data sources, and external AI providers, resulting in weak oversight and limited post-deployment learning. Existing governance approaches emphasize compliance after deployment rather than accountability embedded throughout the AI lifecycle [6]. As adaptive AI systems continue to scale, this lack of accountability-driven design undermines trust, legitimacy, and long-term sustainability. There is a clear need for a structured approach that integrates responsibility,
traceability, and continuous governance into AI development and deployment within startup ecosystems.

Research Objectives:

In response to the identified problem, this research aims to bridge the gap between ethical theory and startup practice through the following objectives:

- To conduct an analysis of existing AI regulatory frameworks and identify limitations in addressing the technical, organizational, and societal complexities of AI-driven startup ecosystems.
- To reconceptualize accountability as a distributed and lifecycle-based process, emphasizing responsibility attribution, traceability, and stakeholder alignment across AI design, development, deployment, and post-deployment stages.
- Build a RSIF (Responsible and Sustainable Innovation Framework) comprising governance structures, technical safeguards, risk escalation mechanisms and feedback loops conducive to promote responsible and sustainable innovation of AI in startups.

Contribution of the Study

By shifting the focus from compliance with rules to accountability-focused system design in startup ecosystems, this contribution expands the scope of AI governance inquiry. Existing studies often overlook how responsibility genuinely emerges and shifts throughout the fast- paced development and growth of AI, even though it mostly considers accountability through organizational or regulatory lenses. By reframing accountability as a design-time and lifecycle concern rather than a post-failure response, this work informs their understanding. The RSIF proposed offers a novel blend of risk escalation logic, adaptive governance mechanisms and stakeholder responsibility mapping tailored to the limitations and reality of AI-driven startups. The framework bridges the divide between operational decision-making and focused on continual alignment of responsibility intended virtue

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and the analogue learning of that process as opposed to abstracting ethical principles. In addition to advancing theory, the study provides investors and policymakers with a systematic lens through which they can assess governance fitness and long-term innovation sustainability, as well as helping entrepreneurs better position startups to proactively navigate AI risks.

Literature Review

Artificial Intelligence (AI) is increasingly adopted across industries, transforming how organizations generate insights, automate processes, and support decision-making. AI systems can perform tasks autonomously, learn from data, and predict outcomes in high-impact domains such as healthcare, finance, transportation, and digital services [1][2][3]. As AI systems gain greater autonomy, concerns regarding responsibility, fairness, transparency, and oversight have intensified. Scholars emphasize that accountability becomes critical when AI systems influence organizational and societal outcomes, particularly in high-stakes contexts [6][7]. Importantly, AI accountability is not solely a technical challenge but a socio- institutional issue shaped by governance structures, organizational practices, and multiple stakeholders [6][8]. A central challenge in AI governance is the "AI accountability gap," which refers to the difficulty of attributing responsibility for decisions produced by complex and opaque algorithmic systems [7]. This gap arises because AI systems often obscure causal reasoning and decision logic, limiting the effectiveness of traditional accountability mechanisms [5][7]. Researchers therefore argue that accountability must be embedded across the entire AI lifecycle, from system design and data collection to deployment, monitoring, and post-deployment evaluation, to enable meaningful responsibility attribution and continuous improvement. The literature highlights the importance of technical and organizational mechanisms such as systematic documentation, evaluation procedures, and impact assessments to address accountability challenges. Maintaining records of data sources, model design choices, decision pathways, and performance limitations enables organizations to better understand system behaviour and associated risks. Regular evaluations and audits further ensure alignment with principles of fairness, transparency, reliability, and explainability. These mechanisms strengthen internal governance while allowing organizations to demonstrate responsible AI practices to regulators, users, and other stakeholders. Accountability in AI systems is commonly conceptualized through three interrelated dimensions: transparency, answerability, and enforceability [8]. Transparency concerns stakeholders' ability to understand how AI systems function, answerability requires organizations to justify AI-driven decisions, and enforceability ensures that corrective actions and responsibility assignment mechanisms exist when harm occurs [8]. Together, these dimensions indicate that accountability extends beyond model interpretability and must be institutionalized within governance and operational processes [6][8]. Governments and international organizations increasingly recognize accountability as a core pillar of responsible AI governance. Global

policy initiatives and ethical frameworks emphasize proactive risk management, impact assessment, continuous monitoring, and stakeholder engagement across the AI lifecycle [9][10][11]. Regulatory efforts such as the European Commission's AI White Paper and the proposed AI Act reinforce accountability-based governance approaches that aim to balance innovation with societal protection [11][12]. Despite these initiatives, a persistent

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gap remains between high-level ethical principles and their practical implementation, particularly in fast- paced innovation environments [10]. Startups face distinct challenges in implementing AI accountability due to limited resources, rapid scaling pressures, and the absence of mature governance structures [4]. Early-stage firms often prioritize speed and innovation over risk management, increasing exposure to bias, opacity, and unintended consequences [4]. Accountability in AI-driven startup ecosystems is further complicated by distributed responsibility across founders, developers, data providers, investors, and regulators [7]. Scholars therefore advocate for shared, lifecycle-oriented accountability frameworks that support coordination, role clarity, and adaptive governance while maintaining innovation agility [16]. Overall, the literature demonstrates that AI accountability encompasses technical, organizational, regulatory, and social dimensions [6][8]. While strong theoretical foundations and policy guidelines exist, a significant gap remains in practical, startup-focused accountability frameworks that integrate governance across the AI lifecycle. Addressing this gap requires scalable, lifecycle-based approaches that combine measurable accountability indicators with shared responsibility models to support sustainable and trustworthy AI innovation in startup environments.

Research Methodology:

Research Design

This study adopts a qualitative, conceptual research design to examine accountability in AI- driven startup ecosystems. Rather than relying on empirical data or experiments, the research synthesizes theoretical, regulatory, and policy-oriented literature to develop a coherent accountability framework [8]. This approach is suitable for emerging domains such as AI governance, where standardized models and startup-specific mechanisms remain limited [9].

Data Sources and Literature Selection

The study draws on secondary sources including peer-reviewed journals, policy reports, regulatory documents, and publications from international organizations focused on AI ethics and governance [1][2][9][10][11]. Literature was selected to capture technical accountability, organizational governance, legal responsibility, and long-term societal and sustainability impacts relevant to startup contexts [6][7][8]. By integrating insights across these domains, the research clarifies how accountability is defined, distributed, and operationalized across the AI lifecycle, supporting theory building and guiding future empirical research and practical application within resource-constrained and fast-scaling startup environments, today globally worldwide.

Analytical Approach

A thematic synthesis approach was used to analyse selected literature on AI accountability in startup environments [6]. The review identified recurring themes, conceptual patterns, and research gaps, with particular attention to how accountability is defined and operationalized across the AI lifecycle [7][8]. This analysis highlighted limitations of existing governance frameworks when applied to startups facing rapid innovation, limited resources, and evolving organizational structures [4][6].

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Framework Development Process

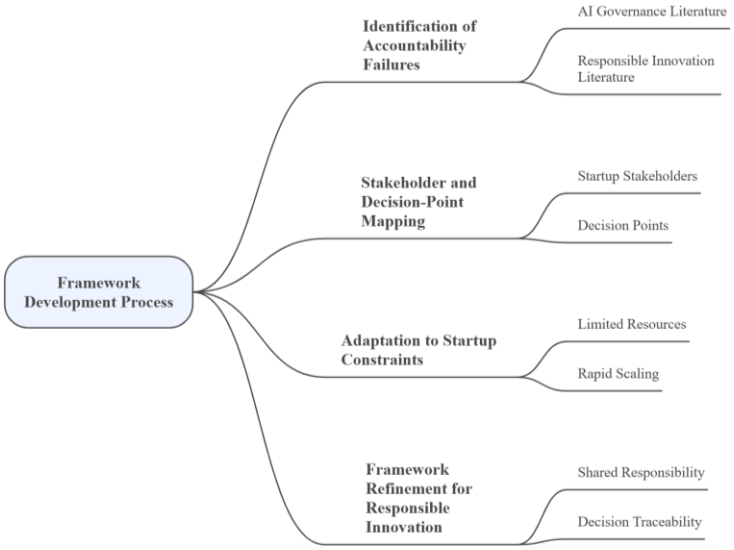


Figure 1: Framework Development Process

The Responsible and Sustainable Innovation Framework (RSIF) was developed through an iterative, theory-driven process linking established accountability concepts with startup practices [8]. Literature insights were synthesized to identify common accountability failure points across data selection, model design, deployment, and post-deployment adaptation [5][7]. Rather than introducing new ethical principles, RSIF adapts existing governance models to startup realities by emphasizing shared responsibility, decision traceability, continuous feedback, and adaptive risk management [7][8]. Guided by design science methodology, the framework was refined to remain conceptually rigorous while being practical and usable, enabling startups to integrate accountability mechanisms without constraining innovation or growth.

Accountability Challenges:

1. **Technical Accountability Challenges**

   A primary accountability challenge in AI-driven startups is the technical opacity of AI systems. Startups often rely on complex machine learning models that operate as "black boxes," making it difficult to explain or justify decision outcomes [5]. Limited explainability restricts error tracing, auditing, and contestability, particularly in high-impact domains such as credit scoring, recruitment, and healthcare [5][7]. Bias and fairness issues further complicate accountability, as startups frequently depend on historical or third-party datasets containing embedded social and demographic biases [6]. Due to limited time, expertise, and resources, systematic bias testing and fairness audits are often deprioritized, increasing the risk of discriminatory outcomes, regulatory exposure, and reduced user trust [6].

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2. **Organizational Accountability Challenges**

   Organizational accountability in AI-driven startups is weakened by informal structures and limited institutional capacity [4]. Early-stage firms typically prioritize rapid innovation over formal governance, resulting in limited expertise in AI ethics, accountability, and regulatory compliance [6]. Decision-making authority is often centralized among founders or technical leads, with minimal separation of responsibilities and weak internal oversight mechanisms [4]. These challenges intensify during rapid scaling, as AI systems are deployed quickly without comprehensive risk assessments, encouraging reactive rather than proactive accountability practices and increasing long-term organizational risk [6].

3. **Legal and Regulatory Challenges**

   Legal accountability is complicated by ambiguity surrounding liability and responsibility in AI-driven startups. The use of external datasets, open-source tools, and third-party models makes it difficult to assign accountability when harm occurs, contributing to accountability gaps across the AI value chain [7][8]. Limited legal expertise and evolving regulatory requirements further hinder proactive compliance, increasing the risk of delayed adaptation to emerging standards such as the EU AI Act and data protection laws [11][12].

4. **Sustainability Challenges**

   AI-driven startups face sustainability challenges related to social trust and environmental impact. Accountability failures can undermine public trust, negatively affect vulnerable communities, and weaken relationships with users, investors, and regulators [9]. Additionally, the computational intensity of AI development contributes to increased energy consumption and carbon emissions, which are often overlooked in favour of short-term growth and performance optimization.

   Collectively, these challenges highlight the need for a structured, lifecycle-based, and stakeholder-aligned accountability framework, motivating the development of the Responsible and Sustainable Innovation Framework (RSIF).

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Proposed Accountability Framework

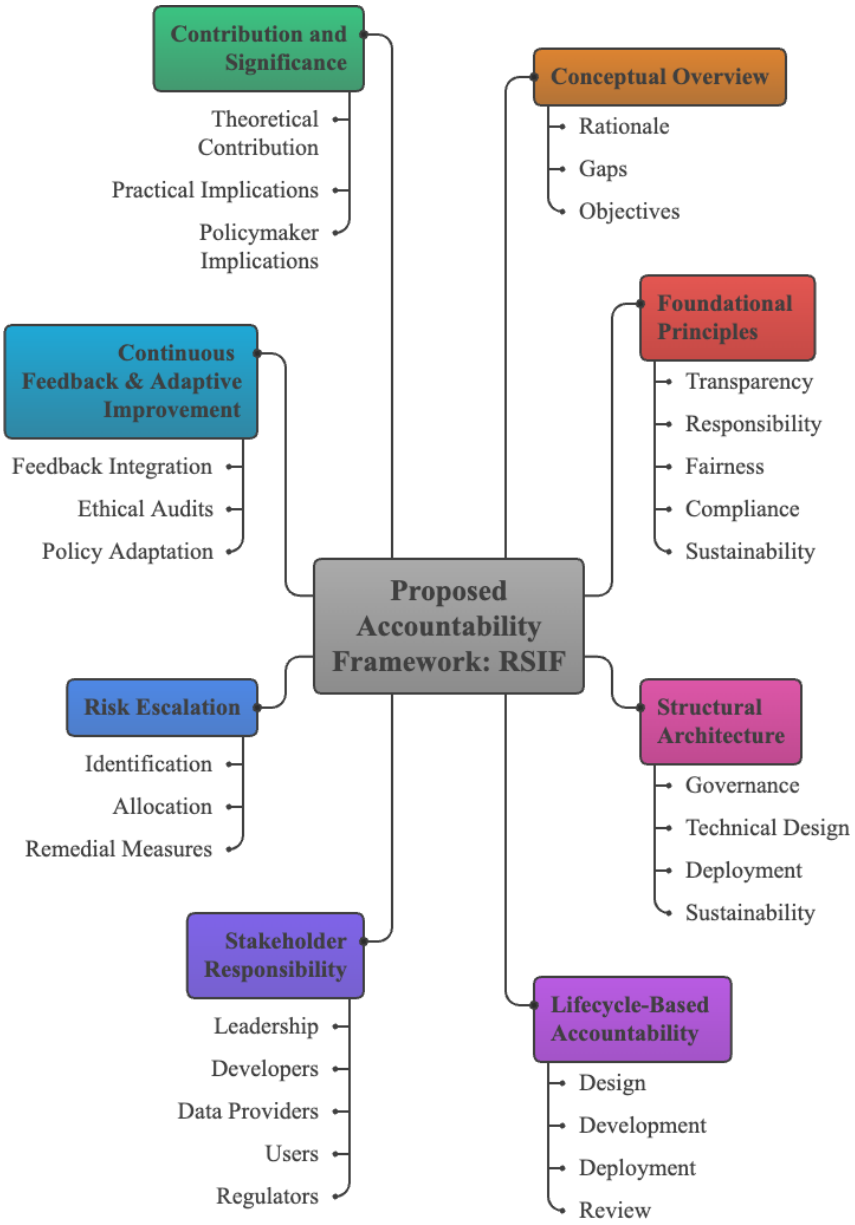


Figure 2: RSIF: A Comprehensive AI Accountability Framework

Figure 2 illustrates the structure of the Responsible and Sustainable Innovation Framework (RSIF), which positions accountability as an integrated and continuous process within AI- driven startups. The framework is centered on a core accountability system that connects conceptual foundations, ethical principles, operational structures, and governance mechanisms. The model begins with a conceptual overview defining its rationale, research gaps, and objectives. It is grounded in foundational principles such as transparency, responsibility,

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fairness, compliance, and sustainability, which guide all decision-making processes. The structural architecture embeds accountability across governance, technical development, deployment, and sustainability functions, while the lifecycle-based approach ensures responsibility throughout design, development, deployment, and review stages.

a. Conceptual Rationale and Research Gap

AI accountability has been widely discussed in research and policy literature. Frameworks such as the National Institute of Standards and Technology AI Risk Management Framework, the Organisation for Economic Co-operation and Development AI Principles, and the European Commission Ethics Guidelines for Trustworthy AI emphasize transparency, fairness, human oversight, and structured risk management [11]. These frameworks provide clear guidance on what responsible AI should aim to achieve.

However, these models mostly assume stable governance systems, dedicated compliance teams, and formal documentation practices [9]. In contrast, AI startups operate with small teams, rapid development cycles, and overlapping responsibilities [4]. Accountability in such contexts often happens reactively, addressing issues after deployment rather than being embedded from the start.

Therefore, the challenge is not a lack of ethical awareness but the absence of a startup- compatible implementation structure. The Responsible and Sustainable Innovation Framework (RSIF) is proposed to address this operational gap, converting accountability from a checklist into a living, dynamic system.

b. Foundational Structure

RSIF treats accountability as a dynamic function:

A = f (G, T, D, S, L)

Where:

i. **G** = Governance and Strategic Oversight
ii. **T** = Technical Integrity and Data Governance
iii. **D** = Deployment and Risk Monitoring
iv. **S** = Sustainability and Societal Impact
v. **L** = Lifecycle Integration

Here, accountability is strong only when all components function together. Governance ensures clear ownership and escalation mechanisms. Technical integrity embeds validation, documentation, and bias assessment directly into development. Deployment monitoring tracks system performance and risk in real time. Sustainability evaluates long-term social and organizational impact, and lifecycle integration ensures continuous accountability across design, deployment, and iteration [4].

c. Four-Layer Accountability Architecture

RSIF operationalizes these principles via four layers:

i. **Governance Layer** – Assigns leadership responsibility and defines escalation paths.
ii. **Technical Integrity Layer** – Integrates bias testing, data validation, and explainable AI mechanisms into workflows.

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iii. **Deployment and Monitoring Layer** – Tracks real-time system performance using measurable indicators, such as risk severity and mitigation ratios.

iv. **Sustainability Layer** – Assesses long-term fairness, regulatory compliance, and societal impact.

These layers work together, ensuring accountability is embedded at every stage rather than applied after the fact.

d. Operational Illustration

Consider a startup building an AI hiring system. RSIF assigns clear responsibility for the system, conducts bias testing during development, validates datasets, and monitors metrics post-deployment. Sustainability reviews assess workforce diversity impact and compliance alignment.

In this way, accountability is proactive, structured, and integrated, transforming it from a reactive task into a core operational process [4].

e. Stakeholder Responsibility Alignment

Accountability in AI-driven startup ecosystems is inherently distributed due to the involvement of multiple actors across the AI value chain [7]. The RSIF framework clarifies stakeholder responsibilities to reduce accountability gaps and ensure coordinated governance [16].

Primary stakeholder responsibilities include:

i. **Startup leadership and founders:** Establish ethical priorities, governance structures, risk ownership, and compliance oversight [9]. **AI developers and technical teams:** Design, deploy, and monitor AI systems; ensure fairness, explainability, documentation, and failure detection [6].

ii. **Data providers and partners:** Maintain ethical data sourcing, data quality, privacy protection, and regulatory compliance [7][12].

iii. **Users and affected communities:** Provide feedback, report harmful outcomes, and engage in grievance and redress mechanisms.

iv. **Regulators and policy authorities:** Define legal standards, conduct oversight, and enforce adaptive regulatorycompliance [11][12].

f. Risk Escalation and Corrective Governance Mechanism

To address the dynamic and evolving nature of AI systems, RSIF incorporates a structured risk escalation mechanism aligned with lifecycle-based risk governance models.

Key elements include:

i. Early identification of ethical and technical failures such as bias, data drift, security vulnerabilities, and misuse [6].

ii. Responsibility allocation based on predefined stakeholder roles to ensure traceability and accountability [7].

iii. Investigation of root causes and impact severity by governance bodies [8].

iv. Corrective and preventive actions, including technical remediation, policy updates, and system

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modification [9].

g. Continuous Feedback and Adaptive Improvement System

RSIF conceptualizes accountability as an ongoing process supported by continuous learning and governance adaptation rather than static compliance [8].

This system includes:

i. Integration of feedback from users, developers, regulators, and affected communities to inform system and governance updates.

ii. Periodic ethical and accountability audits to ensure transparency and institutional learning. Adaptive updates to governance practices in response to regulatory[11].

h. Contribution and Significance of the RSIF

The RSIF framework advances AI accountability research by presenting a startup-centric, lifecycle-based model that integrates stakeholder alignment, risk governance, and adaptive oversight.

Key contributions include:

i. Reconceptualizing accountability as a distributed and evolving process rather than a static compliance obligation [7][8].

ii. Providing practical guidance for embedding accountability within startup operations [4].

iii. Informing policymakers and investors by positioning accountability as an indicator of governance maturity, risk resilience, and sustainable innovation [11].

Result:

The prototype illustrates the practical feasibility of embedding accountability into AI startups throughout system design and deployment. It assumes a single decision-maker performing three roles, founder, developer, and auditor, ensuring governance, technical, and compliance perspectives are addressed concurrently. Accountability dashboards present risk summaries, compliance readiness, sustainability indicators, and performance metrics, supporting informed strategic decision-making. Developers engage with technical assessment modules that flag early-stage risks such as data bias, limited explainability, performance concerns, and deployment vulnerabilities, enabling proactive mitigation. Traceability features document design decisions, data sources, identified risks, and corrective actions, facilitating transparent evaluation and oversight. Simplified dashboards translate complex accountability and accessibility risks into prioritised indicators, improving clarity and focus. The prototype goes beyond risk detection by offering actionable recommendations and corrective pathways derived directly from the Responsible and Sustainable Innovation Framework (RSIF). When risk thresholds are exceeded, escalation mechanisms activate responsibility attribution and mitigation processes. Designed for adaptability, the system supports periodic reviews, post- deployment monitoring, and continuous feedback. The findings highlight that accountability in AI startups is best understood as an integrated, lifecycle-based process rather than a reactive response, contributing to improved governance, trust, and sustainable innovation. For practice demonstration of the proposed framework, the associated prototype figures with relevant capabilities are provided.

For practical demonstration of the proposed framework, the prototype screenshots illustrating key functionalities

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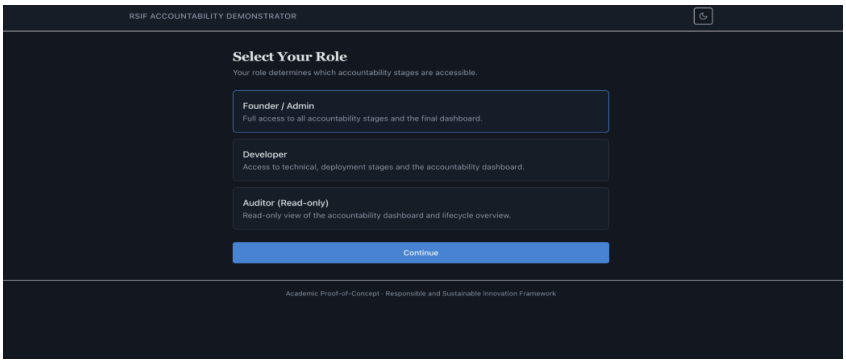
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are presented below:

Prototype Images:













The findings of this study demonstrate that accountability in AI-driven startups cannot be treated as a single-point obligation or assigned to isolated roles. Instead, accountability emerges as a shared and continuous responsibility distributed across the AI lifecycle. Technical opacity, informal organizational structures, regulatory uncertainty, and sustainability concerns indicate that accountability failures are systemic rather than individual [5][6][7][8]. In rapidly evolving

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startup environments, decisions related to data selection, model design, deployment, and monitoring are deeply interconnected, reinforcing the need for accountability mechanisms that evolve alongside AI systems [1][2][4].

Existing AI accountability and governance frameworks primarily emphasize compliance, ethical principles, or risk management within stable and well-resourced organizations [9][10] [11]. While these frameworks provide valuable guidance, they often fail to account for the operational realities of startups, including limited governance capacity, resource constraints, and rapid scaling pressures [1][3][4]. The Responsible and Sustainable Innovation Framework (RSIF) addresses this gap by adopting a lifecycle-based and adaptive approach. By embedding responsibility attribution, traceability, and continuous feedback mechanisms into startup operations, RSIF moves beyond static compliance models and offers a more practical and context-sensitive approach to accountability [7][8].

RSIF provides actionable guidance for founders and technical teams to integrate accountability into AI development and deployment without restricting innovation. It also supports investors in assessing governance maturity and long-term sustainability, while offering insights for regulators designing flexible oversight mechanisms [11][12]. Although RSIF is tailored to early- and mid-stage startups, its effectiveness depends on organizational commitment and contextual adaptation [4]. Additionally, the absence of large-scale empirical validation represents a limitation of the current study. Future research should examine the framework across diverse startup environments to evaluate its scalability, generalizability, and long-term impact.

Scope:

The scope of this study is limited to conceptual analysis and framework development focused on accountability in AI-driven startup ecosystems. The research does not include empirical validation, case studies, or quantitative testing of the proposed Responsible and Sustainable Innovation Framework (RSIF). Consequently, the applicability and effectiveness of the framework may vary across different startup contexts, organizational maturity levels, and industry domains.

The accompanying prototype is intended as a proof-of-concept to demonstrate how RSIF can be operationalized in practice. It is currently under development and remains limited in terms
of domain coverage, feature complexity, and adaptive capabilities. At this stage, the prototype supports a generalized accountability assessment rather than domain-specific evaluation.

Future work will focus on expanding the prototype to support additional industry domains, custom domain configurations, and dynamic questioning based on application context. These enhancements aim to improve accuracy, flexibility, and practical relevance while preserving lifecycle-based accountability principles.

Conclusion:

Artificial intelligence presents unprecedented opportunities for innovation, efficiency, and economic growth within startup ecosystems. However, as AI-driven innovation accelerates, the absence of robust accountability mechanisms increasingly threatens trust, legitimacy, and long- term sustainability. This research responds to that challenge by reconceptualizing accountability as a continuous, lifecycle-based process rather than a reactive or compliance- driven obligation. Through a comprehensive analysis of technical, organizational, regulatory, and

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sustainability challenges, the study demonstrates that accountability gaps in AI-driven startups are systemic and structurally embedded within fast-scaling innovation environments.

The proposed Responsible and Sustainable Innovation Framework (RSIF) translates established ethical principles and governance guidelines into a startup-compatible, operational model grounded in responsibility attribution, traceability, adaptive risk governance, and continuous feedback. Supported by a lightweight prototype, the framework illustrates how accountability can be embedded directly into AI design, deployment, and monitoring without constraining innovation velocity. By aligning innovation with responsibility, RSIF offers a practical pathway for startups, investors, and regulators to foster trustworthy AI systems, strengthen societal confidence, and support sustainable innovation outcomes in increasingly AI-dependent economies.

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ECOBID SMART SYSTEM: A TECHNOLOGY-DRIVEN MODEL FOR SUSTAINABLE RESOURCE REUSE AND OPTIMIZATION

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Abstract:

Educational institutions frequently replace opera- tional assets due to technological upgrades and administrative restructuring, leading to accumulation of reusable yet discarded materials. Conventional waste handling practices emphasize disposal instead of structured reuse, resulting in financial in- efficiency and environmental strain. This study proposes the EcoBid Smart System, a technology-driven digital platform inte- grating intelligent asset classification, transparent redistribution mechanisms, and sustainability evaluation metrics. A survey of 300 institutional stakeholders was analyzed using the Chi- square test of independence. Results reveal statistically significant associations between sustainability awareness, perceived eco- nomic benefit, digital transparency, and platform acceptance. The proposed framework aligns with circular economy principles and smart campus sustainability initiatives. Findings indicate strong stakeholder readiness and scalability potential, demonstrating that structured digital reuse systems can enhance institutional resource optimization while supporting environmental and eco- nomic sustainability goals.

Index Terms—*Sustainability, Artificial Intelligence, Resource Optimization, Smart Campus, Digital Transformation*

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Introduction:

Rapid institutional expansion and technological advance- ment have significantly increased the generation of under- utilized yet functional assets within educational campuses. Computers, laboratory instruments, electronic components, furniture, and other infrastructure resources are often replaced during upgrade cycles even when they remain operational. In the absence of structured reuse frameworks, such assets are disposed of as scrap or stored without systematic redis- tribution. This practice results in unnecessary procurement expenditure and environmental degradation.

Sustainability research emphasizes extending product life- cycles before recycling or disposal [1]. Digital transformation initiatives further highlight the importance of transparent asset tracking and accountability [3]. Smart campus models inte-

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grate sustainability goals with technological infrastructure to enhance environmental governance [2]. However, institutional- level digital reuse platforms remain underdeveloped.

The EcoBid Smart System is designed as a centralized digital platform enabling intelligent classification, listing, and redistribution of reusable institutional assets. By integrating artificial intelligence (AI) and structured transparency mecha- nisms, the system seeks to transform waste-oriented manage- ment into a reuse-optimized framework.

Statement of the Problem:

Educational institutions face several structural inefficiencies:

- Lack of centralized digital tracking of reusable assets.
- Disposal of functional materials without lifecycle evalu- ation.
- Limited transparency in allocation processes.
- Absence of measurable sustainability performance indi- cators.
- Repetitive procurement due to visibility gaps.

These challenges restrict implementation of circular re- source principles and increase financial and environmental costs [1]. A technology-enabled structured reuse framework is required.

Objectives:

- To design a digital platform for structured institutional resource reuse.
- To examine stakeholder perception toward reuse systems.
- To test associations between sustainability awareness and platform acceptance.
- To evaluate perceived transparency in digital allocation.
- To assess scalability within smart campus ecosystems

Literature Review:

Circular economy theory emphasizes extending product lifecycles to minimize resource extraction and environmental degradation. Geissdoerfer et al. argue that sustainable business models must prioritize reuse, refurbishment, and redistribu- tion over disposal-oriented systems [1]. Lifecycle extension reduces material intensity and contributes to institutional sus- tainability performance.

The Triple Bottom Line (TBL) framework further broadens sustainability evaluation by integrating environmental, social, and economic dimensions [5]. According to Elkington, sus- tainable systems must balance ecological responsibility with economic viability and stakeholder engagement. Within insti- tutional contexts, this implies that digital reuse platforms must generate measurable environmental benefits, financial savings, and social participation.

Artificial intelligence has increasingly been applied to waste and asset classification processes. AI-based image recognition and predictive categorization significantly enhance sorting efficiency and operational accuracy in resource management systems [4].

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Smart campus initiatives integrate digital monitoring sys- tems, sustainability dashboards, and data-driven governance frameworks to optimize institutional operations [2]. The OECD highlights that digital infrastructure enhances trans- parency, accountability, and performance measurement in ed- ucational ecosystems. However, most smart campus models focus primarily on energy and water monitoring, with limited emphasis on structured asset reuse.

While existing literature supports circular economy imple- mentation, AI-based classification, and smart campus inte- gration, limited empirical research examines the intersection of these domains within educational institutions. This study addresses this gap by empirically validating stakeholder ac- ceptance of a technology-driven institutional reuse system.

Research Methodology:

A quantitative descriptive research design was adopted to examine stakeholder perception regarding the EcoBid Smart System. Quantitative methods are appropriate when the objec- tive is to test relationships among measurable variables using statistical techniques [6]. The study focuses on identifying associations between sustainability awareness, perceived trans- parency, and digital platform acceptance.

A. ***Data Collection***

Primary data were collected using a structured question- naire administered through an online survey platform. The questionnaire consisted of close-ended categorical questions (Yes/No/Maybe and Agree/Neutral/Disagree formats) to en- sure statistical compatibility with non-parametric tests. Struc- tured questionnaires are widely used in sustainability percep- tion studies to measure stakeholder attitudes objectively [2].

The survey instrument included items related to:

- Belief in reuse reducing cost and supporting sustainabil- ity,
- Support for digital waste management platforms,
- Perception of AI-enabled guidance,
- Transparency in digital bidding processes,
- Willingness to participate in structured reuse systems.

B. ***Sample***

A total of 300 valid responses were analyzed. Respon- dents included students, faculty members, and administrative staff from institutional environments. A sample size of 300 enhances statistical reliability and reduces sampling error in categorical data analysis [6]. According to statistical research guidelines, larger sample sizes increase the power of hypoth- esis testing and improve generalizability within institutional contexts [6].

C. ***Statistical Technique***

Since the study variables were categorical in nature, the Chi-square test of independence was applied to examine associations between selected variables. The Chi-square test is appropriate for analyzing relationships between qualitative variables and determining whether observed distributions sig- nificantly

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differ from expected distributions [6].

The level of significance was set at $\alpha = 0.05$, which is the standard threshold in social science research for determining statistical significance. If the p-value is less than 0.05, the null hypothesis is rejected, indicating a statistically significant association between the variables.

The choice of Chi-square is consistent with sustainability and perception-based research studies where variables are nominal or ordinal categories [1], [6].

D. Working Mechanism of EcoBid Smart System

The EcoBid Smart System consists of asset registration, and structured redistribution modules.

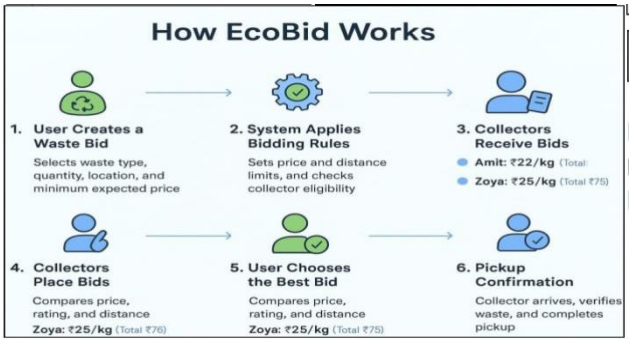


Fig. 1. Operational workflow of the EcoBid Smart System.

The EcoBid Smart System operates through a structured digital workflow beginning with user-based waste listing. The system applies automated bidding rules to ensure eligibility and fairness, after which registered collectors submit com- petitive bids. The user evaluates bids based on price, rating, and proximity before selecting the most suitable option. The process concludes with pickup verification and transaction completion, ensuring transparency and optimized resource reuse.The EcoBid Smart System operates through a structured digital workflow beginning with user-based waste listing. The system applies automated bidding rules to ensure eligibility and fairness, after which registered collectors submit com- petitive bids. The user evaluates bids based on price, rating, and proximity before selecting the most suitable option. The process concludes with pickup verification and transaction completion, ensuring transparency and optimized resource reuse.

The platform maintains a digital record of each transac- tion, enabling traceability and performance monitoring. This structured mechanism reduces manual intervention, minimizes bias in allocation, and enhances accountability. By integrating transparency and efficiency, the system supports sustainable resource redistribution within institutional ecosystems.

Hypothesis Formulation:

H_{01}: No significant association exists between belief in material reuse and platform support.

H_{02}: No significant association exists between environmen- tal awareness and participation willingness.

H_{03}: No significant association exists between digital bid- ding fairness and stakeholder support.

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Hypothesis Visualization:

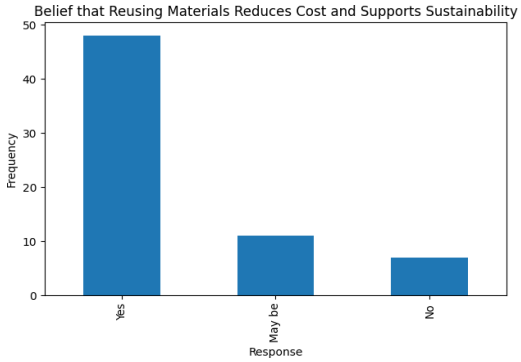


Fig. 2. Distribution of responses for belief that reusing materials reduces cost and supports sustainability (related to H_{01} and H_{11}).

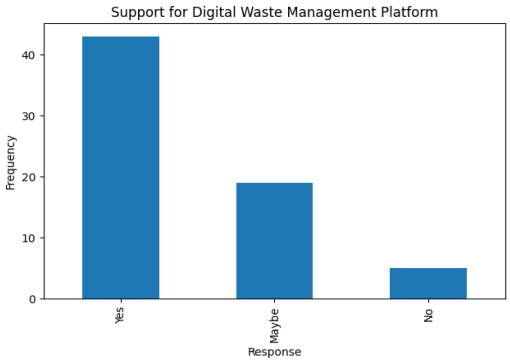


Fig. 3. Stakeholder support for digital waste management platform (related to H_{01} and H_{11}).

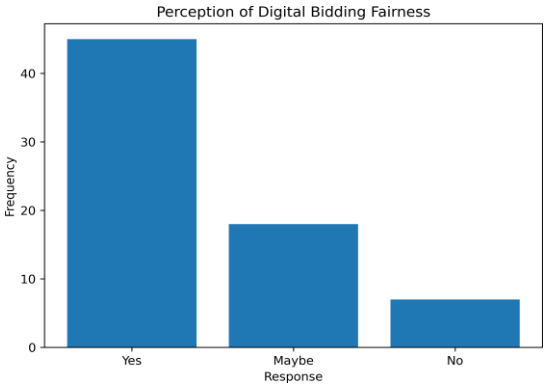


Fig. 4. Frequency distribution of responses regarding perception of digital bidding fairness.

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Data Analysis and Interpretation:

The Chi-square test of independence was conducted to examine the association between sustainability perception vari- ables and stakeholder acceptance of the EcoBid Smart System. The results indicate that all computed p-values are below the significance level of $\alpha = 0.05$. Therefore, all null hypotheses (H_{01}, H_{02}, and H_{03}) are rejected.

For H_{01}, a statistically significant association exists between belief in material reuse and support for implementing a digital reuse platform ($\chi^2 = 38.214$, $p < 0.05$). This suggests that stakeholders who recognize economic and environmental ben- efits of reuse are more likely to support digital implementation. For H_{02}, environmental awareness significantly influences willingness to participate in the EcoBid system ($\chi^2 = 27.583$, $p < 0.05$). This indicates that sustainability consciousness positively affects behavioral intention toward structured reuse mechanisms.

For H_{03}, perception of digital bidding fairness significantly affects stakeholder support ($\chi^2 = 31.907$, $p < 0.05$). Trans- parency and perceived equity in allocation processes enhance institutional trust and acceptance. Overall, the statistical evidence confirms that sustainability awareness, perceived transparency, and economic perception are structurally linked to digital platform adoption within institutional ecosystems.

TABLE I

CHI-SQUARE TEST ANALYSIS

Hypothesis	χ^2	df	p-value	α	Decision
H01	38.214	4	0.000001	0.05	Reject H_{01}
H02	27.583	4	0.000014	0.05	Reject H_{02}
H03	31.907	4	0.000005	0.05	Reject H_{03}

All computed p-values are below the predetermined sig- nificance level of $\alpha = 0.05$, indicating that the observed relationships are statistically significant. Therefore, the null hypotheses (H_{01}, H_{02}, and H_{03}) are rejected in favor of their corresponding alternative hypotheses. This implies that the associations observed in the sample are unlikely to have occurred by random chance.

The findings confirm that sustainability awareness, per- ceived digital transparency, and economic perception are sig- nificantly related to stakeholder acceptance of the EcoBid Smart System. Respondents who recognize the environmental and financial benefits of reuse are more inclined to support the implementation of a structured digital reuse platform. Similarly, positive perception of fairness in digital bidding processes strengthens trust and increases willingness to par- ticipate.

Overall, the statistical evidence demonstrates that stake- holder attitudes toward sustainability and transparency play a critical role in influencing digital platform adoption within institutional ecosystems.

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TABLE II

ALTERNATIVE HYPOTHESES (SUPPORTED)

Hypothesis	Alternative Hypothesis Statement
H11	There is a significant association between belief in material reuse and support for implementing a digital reuse platform.
H12	There is a significant association between environ- mental impact awareness and willingness to partici- pate in the EcoBid Smart System.
H13	There is a significant association between perceived fairness of digital bidding and stakeholder support for the EcoBid platform.

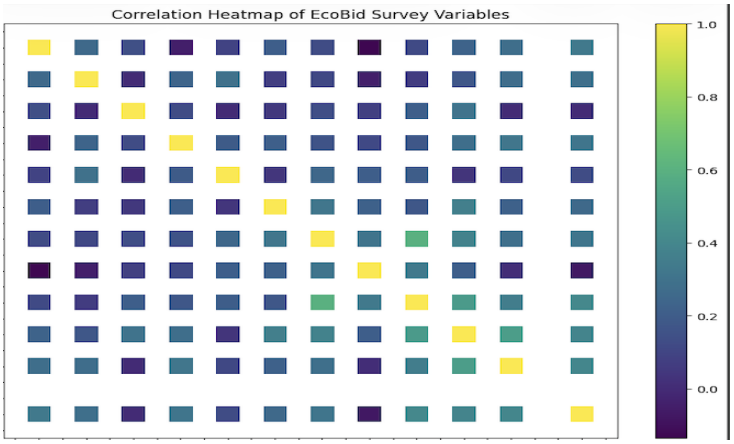


Fig. 5. Correlation heatmap of survey variables.

The correlation heatmap illustrates positive relationships among sustainability awareness, platform support, and trans- parency perception. Moderate positive clustering is observed among variables related to reuse belief and digital acceptance, indicating internal consistency in stakeholder responses. No strong negative correlations are observed, suggesting align- ment of attitudes toward sustainable digital transformation within the institutional context.

Discussion:

The findings confirm alignment with circular economy prin- ciples emphasizing reuse before disposal [1]. Sustainability awareness significantly influences digital platform acceptance, consistent with smart campus frameworks [2]. Transparency perception enhances stakeholder trust, supporting prior digital governance research [3]. AI integration strengthens classifica- tion efficiency and operational scalability [4].

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Challenges:

Despite the promising statistical validation and conceptual robustness of the EcoBid Smart System, several implementa- tion challenges must be acknowledged.

A. ***Behavioral Resistance***

One of the primary barriers to adoption is behavioral resistance among institutional stakeholders. Faculty members, administrative staff, and students may be accustomed to tra- ditional procurement and disposal practices. Transitioning to- ward a structured digital reuse system requires cultural change, awareness building, and consistent engagement. Resistance may stem from perceived inconvenience, lack of familiarity with digital platforms, or skepticism regarding system trans- parency.

B. ***Digital Literacy Constraints***

Although digital transformation is increasingly common in educational institutions, varying levels of digital literacy among stakeholders may hinder effective implementation. Some users may require training to understand asset listing, bidding mechanisms, and sustainability dashboards. Without adequate digital onboarding programs, system utilization may remain suboptimal.

C. ***Infrastructure and Integration Costs***

Initial deployment of the EcoBid platform requires techno- logical infrastructure, including secure database systems, AI integration modules, and dashboard interfaces. Budget alloca- tion for system development, maintenance, and cybersecurity compliance may present financial challenges. Additionally, integration with existing institutional ERP or inventory man- agement systems may require technical customization.

D. ***Policy and Governance Alignment***

Institutional procurement policies and administrative reg- ulations may not initially support reuse-based redistribution models. Policy modification and governance alignment are necessary to ensure structured implementation and account- ability.

Future Scope:

Although this study provides statistical validation of stake- holder acceptance, several opportunities exist for further de- velopment and practical implementation.

A. ***Pilot Implementation***

Future research can include a real-time pilot implementation of the EcoBid system within a selected campus. Monitoring actual reuse rates, cost savings, and environmental benefits would provide stronger practical evidence beyond survey- based responses.

B. ***Long-Term Impact Assessment***

Long-term studies can evaluate how the system affects sus- tainability performance over multiple academic years. Track- ing procurement savings, waste reduction, and user participa- tion trends would strengthen the practical credibility of the model.

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C. ***Advanced AI Enhancement***

Future improvements may include advanced AI models for predicting asset demand and identifying high-value reuse opportunities. Predictive analytics can help institutions plan redistribution more efficiently and reduce unnecessary pro- curement.

D. ***Inter-Institutional Expansion***

The EcoBid system can be expanded beyond a single cam- pus to connect multiple institutions. Creating a shared reuse network among colleges or universities could significantly increase resource efficiency and strengthen circular economy practices within the education sector.

Conclusion:

The EcoBid Smart System presents a structured, technology-driven framework for optimizing institutional resource reuse. Statistical validation through Chi-square analysis confirms strong associations between sustainability awareness, perceived transparency, and stakeholder acceptance. The rejection of all null hypotheses demonstrates that institutional communities are receptive to digitally enabled reuse mechanisms.

By integrating AI-based asset classification and transparent redistribution processes, the model addresses financial inef- ficiencies and environmental concerns associated with pre- mature disposal practices. The system aligns with circular economy principles and smart campus sustainability initiatives, reinforcing its theoretical and practical relevance.

Although implementation challenges exist, strategic plan- ning, stakeholder training, and phased deployment can mitigate adoption barriers. The scalability potential of the EcoBid Smart System suggests that structured digital reuse frame- works can serve as a transformative approach to institutional sustainability management.

Overall, the study contributes to digital sustainability schol- arship by empirically validating a technology-enabled reuse model and demonstrating its feasibility within educational ecosystems.

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CONVENIENCE VS. CONSENT: EXPLORING THE PERSONALISATION-PRIVACY PARADOX IN THE DAILY DIGITAL HABITS OF COLLEGE STUDENTS

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** Assitant Professor , ** UG Students, *** UG Students & **** Assitant Professor, Department of IT/CS, B. K. Birla College, Kalyan, Mumbai, India*

Abstract:

This study examines the personalisation–privacy paradox in the daily digital habits of college students, focusing on the relationship between privacy concern, perceived benefits of personalisation, digital literacy, and actual privacy protection behaviour. Using a mixed-method approach, primary data from 75 respondents were analysed through correlation, regression, t-test, and Friedman tests, supported by qualitative case review. The findings reveal no significant relationship between privacy concern and protection behaviour, but confirm a significant gap between expressed concern and actual actions. Digital literacy plays a key role in how well students understand informed consent. The study shows that, even as urban college students become more aware of privacy issues, they often stick to convenient habits online.

Key Words: *Personalisation–Privacy Paradox, Privacy Concern, Privacy Protection Behaviour, Digital Literacy, Informed Consent, Online Privacy*

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Introduction

College students' digital lives are deeply affected by personalisation. Digital platforms adapt Instagram feeds, Netflix recommendations, targeted ads and location- based services to suit individual interests, more seamless and appealing digital experiences. However, this convenience often comes with the ongoing transfer of personal data sometimes disclosed knowingly, but often without users fully realizing it. Even with growing privacy concerns, students continue depend on these platforms, highlighting the personalisation–privacy paradox.

In fast-growing urban regions like the Mumbai Metropolitan Region (MMRDA), digital tools have become part of everyday life rather than optional conveniences. Fast paced digital use encourages quick consent and minimum examination of privacy policy. Although students are technically skilled, varying levels of digital literacy shape how effectively they understand, manage and protect their personal data.

Statement of the problem:

Digital platforms have become a regular part of college students' daily lives, supporting their studies, financial transaction, social interactions, and entertainment. Personalisation has made these platforms quicker and easier to use, but it also requires regular sharing of personal information. Although many students say they care about

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privacy, their everyday online behaviour such as accepting cookies or granting app permissions often do not match these concerns. Frequent use of digital platforms also does not always mean better understanding, as long and complicated privacy policies encourage users to give consent without reading them carefully, reducing awareness of how personal data is collected and used. This issue is particularly noticeable in the Mumbai Metropolitan Region (MMRDA), where digital usage is high but digital literacy levels differ. As a result, even when students try to protect their privacy, they often continue risky practices like oversharing or using unsafe networks, revealing a clear gap between privacy concerns and daily online behaviour.

Significance of study:

In today's data-driven world, personalisation is commonly viewed as an advantage. College students in cities like the Mumbai Metropolitan Region (MMRDA) frequently use digital platforms for education, communication, transactions, entertainment and job skill. Yet, few studies investigate how well they understand privacy, consent and data use. This study explores the personalisation–privacy paradox, analysing how digital literacy supports informed consent and responsible online behaviour, offering valuable support for educators, policymakers and platform designers to promote safer, clearer digital practices.

Limitations of the study:

The study relies on self-reported questionnaire data, which may be influenced by social desirability response tendency and inaccurate recall of digital behaviour.

The cross-sectional design limits observation of changes in attitudes over time. Although it is supported by secondary sources, the absence of in-depth interviews or focus groups restricts deeper psychological insight.

Time constraints limited prolonged data collection and behavioural tracking. Additionally, the geographically restricted sample may affect broader applicability.

Rapid technological changes may also influence the long-term relevance of the findings.

Objectives of the study

The objectives of the study are as follows:

1. To examine the personalisation–privacy paradox among college students in their daily digital habits.
2. To assess the impact of digital literacy on informed consent decisions.
3. To analyse the relationship between privacy concern levels, perceived benefits of personalisation, and privacy protection behaviour among college students.

Hypothesis of the study:

Null Hypothesis (H01)

There is no significant relationship between privacy concern level, perceived benefits of personalisation, and privacy protection behaviour among college students.

Alternative Hypothesis (H11)

There is a significant relationship between privacy concern level, perceived benefits of personalisation, and privacy protection behaviour among college students.

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Null Hypothesis (H02)

There is no significant impact of digital literacy on informed consent among college students.

Alternative Hypothesis (H12)

There is a significant impact of digital literacy on informed consent among college students.

Null Hypothesis (H03)

There is no significant gap between privacy concern and actual online behaviour among college students.

Alternative Hypothesis (H13)

There is a significant gap between privacy concern and actual online behaviour among college students.

Review of literature:

1. **Personalisation–Privacy Paradox among College Students**

   Several studies highlight users' increasing reliance on personalized digital services and its impact on privacy. Alessandro Acquisti, Laura Brandimarte, and George Loewenstein (2015) found that although individuals claim to value privacy, they often sacrifice it for immediate benefits like convenience and personalisation demonstrating the privacy paradox, where expressed concerns do not match actual disclosure behaviour. (Acquisti, 2015)

   Sabine Trepte et al. (2017) found that users share personal data when perceived benefits exceed risks. Among students, personalized recommendations, targeted ads, and customized content boost engagement despite ongoing concerns about privacy and potential data misuse. (al., 2017)

2. **Digital Literacy and Informed Consent Decisions**

   Livingstone, van Couvering and Thumim (2018) emphasized that young users frequently accept terms and conditions without reading or understanding them, primarily due to complex language, time constraints and cognitive overload. This weakens informed consent and increases vulnerability to privacy risks. (Livingstone, 2018)

   The findings indicate that digital literacy programmes conducted by institutional libraries significantly improve the digital literacy level of management students by strengthening their ability to access and use ICT-based information resources effectively. (Baban K. More, 2020)

   The findings indicate that effective explanation and simplified presentation of consent forms significantly improve participants' understanding, ensuring informed and voluntary research participation. (Tara van Dijk, 2016)

3. **Gap between Privacy Concern and Actual Online Behaviour**

   Barth and de Jong (2017) demonstrated that risky online behaviours', such as weak password usage, excessive sharing and unverified app permissions, persist despite high privacy awareness. This indicates a strong awareness–action gap. (jong, 2017)

   The findings indicate that although privacy settings are available, users often underutilize them due to limited awareness and difficulties in understanding privacy control mechanisms. (Vashistha, 2018)

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Research Gap Summary:

Existing research shows limited focus on the personalisation–privacy paradox among Indian college students, lacks strong empirical links between digital literacy and informed consent, and insufficiently examines the gap between privacy concerns and actual online behaviour. This study addresses these interconnected gaps.

Research methodology:

The study follows a descriptive and analytical approach using a mixed-method research design. The descriptive aspect helps in clearly understanding current digital behaviour patterns, privacy concerns, use of personalized services, and consent practices among college students. The analytical aspect examines relationships between key variables such as personalisation, privacy concern, digital literacy, and actual online behaviour, allowing hypothesis testing and identification of gaps between attitudes and actions.

The quantitative method is used to measure relationships through structured numerical data, while qualitative insights are drawn from secondary data analysis to better understand students' perceptions and reasoning. Together, this approach provides a balanced and deeper understanding of the personalisation–privacy paradox.

Data analysis and interpretation:

1. ***Introduction***

   This chapter analyses both primary and secondary data. Primary data from 75 college students were collected through a structured questionnaire. Using IBM SPSS Statistics, Pearson correlation examined relationships among Privacy Concern, Perceived Benefits of Personalisation, and Privacy Protection Behaviour; multiple regression assessed Digital Literacy's impact on Informed Consent Understanding; a t-test analysed differences between Privacy Concern and Actual Online Behaviour; and Friedman's K-Sample Test evaluated ranking-based questions. The secondary data section includes a qualitative data table.

2. ***Demographic Profile of Respondent***

   The study included 75 college-going students. Respondents belonged to different age groups ranging from 18 years and above. The questionnaire also captured average daily internet usage.

Table 1 : Age Group Distribution

(Frequency and Percentage)

Age Group	Frequency (Count)	Percentage (%)
18–19 years	28	37.3
19–20 years	32	42.7
20–21 years	12	16.0
21 years and above	3	4.0
Total	**75**	**100**

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

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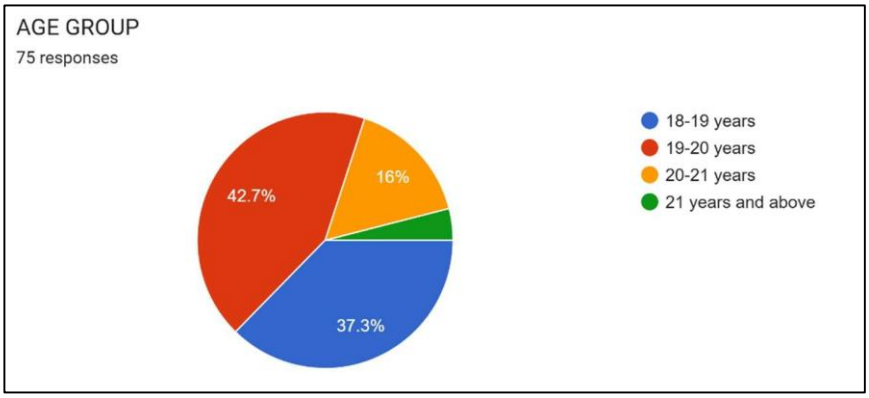


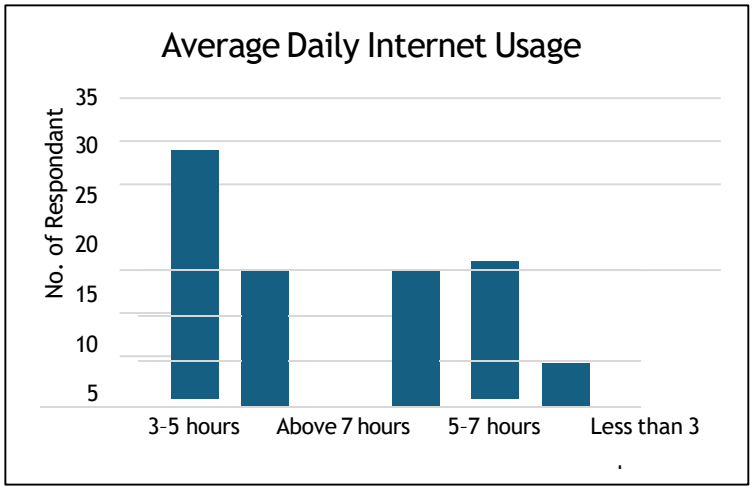
Figure 1: Age Group Distribution of respondents'

Table 2 Average Daily Internet Usage (Frequency and Percentage)

Average Daily Internet Usage	Frequency (Count)	Percentage (%)
3–5 hours	29	38.70%
Above 7 hours	20	26.70%
5–7 hours	16	21.30%
Less than 3 hours	10	13.30%
Total	**75**	**100%**

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

Figure 2 Figure 2 Daily Internet usage pattern of the respondents'



(Source: Primary data collected through questionnaire and analysed by SPSS tools)

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a. Analysis of the Personalisation–Privacy Paradox

To examine the personalisation–privacy paradox among college students in their daily digital habits.

Correlation Analysis

Three key variables were analysed:

i. Privacy Concern
ii. Perceived Benefits of Personalisation
iii. Privacy Protection Behaviour

Pearson correlation analysis was conducted to examine the relationship among these variables.

Table 3 Pearson Correlation Matrix (Objective 1 Variables)

Correlations				
		PC	PB	PPB
Privacy Concern	Pearson Correlation	1	.009	.034
	Sig. (2-tailed)		.938	.772
	N	75	75	75
Perceived Benefits	Pearson Correlation	.009	1	.222
	Sig. (2-tailed)	.938		.056
	N	75	75	75
Privacy Protection Behavior	Pearson Correlation	.034	.222	1
	Sig. (2-tailed)	.772	.056	
	N	75	75	75

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

The results show:

iv. Privacy Concern and Perceived Benefits ($r = 0.009$, $p = 0.938$)
v. Privacy Concern and Privacy Protection Behaviour ($r = 0.034$, $p = 0.772$)
vi. Perceived Benefits and Privacy Protection Behaviour ($r = 0.222$, $p = 0.056$)

All p-values are greater than 0.05, indicating that none of the relationships are statistically significant.

Hypothesis Testing:

H_{01}: There is **no significant relationship** between privacy concern, perceived benefits, and privacy protection behaviour.

H_{11}: **There is a significant relationship** between these variables.

Since **all p-values exceed 0.05**, the **null hypothesis is accepted** and the alternative hypothesis is rejected.

Interpretation:

The findings suggest that although students' express privacy concerns and acknowledge the benefits of personalisation, these factors do not significantly influence their privacy protection behaviour. Therefore, based on correlation analysis, a strong personalisation–privacy paradox is not statistically established in this sample.

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Ranking Analysis (Friedman Test)

Two ranking questions were analysed under Objective 1. Platforms Perceived to Collect the Most Data

Table 4 Mean Ranks – Data Collection Platforms

Ranks	
	Mean Rank
O1_Q1_INSTA	1.70
O1_Q1_GOOGLE	2.18
O1_Q1_AMAZON	2.91
O1_Q1_SNAPCHAT	3.21

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

Instagram/Facebook received the lowest mean rank (1.70), indicating that students perceive it as the platform collecting the most data. This was followed by Google/YouTube (2.18), Amazon (2.91), and Snapchat (3.21).

Benefits of Personalisation:

Table 5 Mean Ranks – Benefits of Personalisation

Ranks	
	Mean Rank
O1_Q2_SAVE-TIME	2.07
O1_Q2_BETTER_CONTENT	2.29
O1_Q2_RELEVENT_ADS	2.85
O1_Q2_USER_EXPERIANCE	2.78

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

Students ranked "Saves Time" as the most important benefit (Mean Rank = 2.07), followed by "Better Content Recommendations." "Relevant Advertisements" received the lowest priority.

Interpretation:

Although correlation analysis did not show statistically significant relationships, ranking analysis indicates that students clearly recognize data collection practices and strongly value convenience. This behavioral insight supports the presence of personalisation-driven preferences.

b. Impact of Digital Literacy on Informed Consent

To assess the impact of digital literacy on informed consent decisions.

Multiple Regression Analysis:

A regression analysis was conducted to examine whether digital literacy significantly predicts informed consent understanding.

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Table 6 ANOVA Table – Regression Model (Objective 2)

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.667	1	4.667	7.393	.008[b]
	Residual	46.080	73	.631		
	Total	50.747	74			
a. Dependent Variable: DL1						
b. Predictors: (Constant), CU1						

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

The ANOVA result shows:

F = 7.393

p = 0.008

Since the p-value is less than 0.05, the regression model is statistically significant.

Hypothesis Testing:

H02: There is **no significant impact** of digital literacy on informed consent.

H12: There is a significant impact of digital literacy on informed consent.

Because **p = 0.008 is less than 0.05,** the null hypothesis is rejected and the **alternative hypothesis is accepted**. **Interpretation**

The findings indicate that digital literacy significantly influences informed consent decisions. Students with higher digital knowledge are more likely to understand privacy policies and make informed decisions before accepting terms and conditions.

Ranking Analysis:

Companies Whose Privacy Policies Are Best Understood

Table 7 Mean Ranks – Privacy Policy Understanding

Ranks	
	Mean Rank
O2_Q1_GOOGLE	1.80
O2_Q1_INSTAGRAM	2.51
O2_Q1_WHATSAPP	2.28
O2_Q1_AMAZON	3.41

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

Google received the best rank (1.80), indicating that students feel they understand its policies better than others. Amazon received the lowest rank.

The Friedman test was statistically significant ($p < 0.001$).

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Factors Influencing "Accept" Decisions

Table 8 Mean Ranks – Factors Influencing Consent

Ranks	
	Mean Rank
O2_Q2_LENGHT	1.91
O2_Q2_LANGUAGE	2.33
O2_Q2_TIME_PRESSURE	2.75
O2_Q2_TRUST	3.01

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

The **length of the policy** was ranked as the most influential factor, followed by technical language.

The result was statistically significant ($p < 0.001$).

Interpretation:

Ranking results reinforce the regression findings by showing that structural elements such as length and complexity of policies influence consent behaviour.

c. Gap Between Privacy Concern and Actual Online Behaviour

To examine the gap between students' privacy concerns and their actual online behaviour.

Descriptive Statistics:

Table 9 Descriptive Statistics – Privacy Concern and Actual Behaviour

One-Sample Test							
	Test Value = 0						
	t	xdf	Significance		Mean Difference	95% Confidence Interval of the Difference	
			One-Sided p	Two-Sided p		Lower	Upper
PC1	46.679	74	<.001	<.001	4.160	3.98	4.34
AB2	23.755	74	<.001	<.001	3.147	2.88	3.41

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

The **mean score for Privacy Concern was 4.16**, indicating high concern. The **mean score for Actual Behaviour was 3.15,** reflecting moderate privacy- protective actions.

The difference between means suggests a behavioural gap.

The results also show statistically **significant values ($p < 0.001$)**, confirming the **existence of a gap between expressed concern and actual behaviour**. **Hypothesis Testing**

H03: There is **no significant gap** between privacy concern and actual online behaviour.

H13: There is **a significant gap** between privacy concern and actual online behaviour.

Since $p < 0.05$, the null hypothesis (H03) is rejected and alternative hypothesis (H13) is accepted

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Interpretation:

The findings confirm that students express strong privacy concerns but do not consistently translate those concerns into protective online actions. This supports the existence of a privacy behaviour gap.

Ranking Analysis:

Most Frequent Risky Behaviours

Table 10 : Mean Ranks – Risky Online Behaviours

Ranks	
	Mean Rank
O3_Q1_SAME_PASSWORD	1.57
O3_Q1_UNKOWN_LINKS	2.47
O3_Q1_ACCEPT_WITHOUT_READ	2.71
O3_Q1_PUBLICSHARE	3.25

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

Using the same password across accounts was ranked as the most frequent behaviour.

Reasons for Not Managing Privacy Settings

Table 11 Mean Ranks – Reasons for Not Managing Privacy

Ranks	
	Mean Rank
O3_Q2_LACK_OF_TIME	1.78
O3_Q2_LACK_OF_KNOLEDGE	2.42
O3_Q2_FEEL_COMPLICATED	2.68
O3_Q2_TRUST_PLATFORM	3.12

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

Lack of time was ranked as the primary reason.

Table 12 Friedman Test Statistics

Test Statistics	
N	75
Kendall's W[a]	.213
Chi-Square	47.860
df	3
Asymp. Sig.	<.001

a. Kendall's Coefficient of Concordance

(Source: Primary data collected through questionnaire and analysed by SPSS tools)

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Both Friedman tests were statistically significant ($p < 0.001$).

1. ***Secondary data analysis (Qualitative Case Review)***

In this section, qualitative insights are presented from selected real-world privacy and data breach cases. The primary data findings are supported by illustrating how large-scale privacy incidents are reflected in similar behavioural patterns observed among college students.

Table 13 Summary of secondary data

Case	Core Privacy Issue	Key Qualitative Insight (Student Perspective)
K.S. Puttaswamy v. Union of India (Aadhaar Data Breach)	Unauthorized access to personal and biometric data	Students view large-scale data collection as unavoidable and accept privacy loss in exchange for convenience and access
Pegasus Spyware Scandal (2021)	State surveillance and lack of consent	Students expressed fear of surveillance but felt powerless to control or resist digital monitoring
Star Health Insurance Data Leak (2024)	Exposure of sensitive health and financial data	High concern over health data misuse, yet continued usage of digital health services due to necessity
Policybazaar Data Breach (2022)	Fintech system vulnerability and data negligence	Students routinely accepted privacy policies without reading despite awareness of risks
Cambridge Analytica – India Connection	Manipulative political micro- targeting	Students recognized targeted content but underestimated its influence on attitudes and choices

(Source: various news articles)

The qualitative case analysis reveals consistent themes across major data breach and surveillance incidents. In cases such as K.S. Puttaswamy v. Union of India and the Pegasus Spyware Scandal, students acknowledged privacy risks yet demonstrated a sense of inevitability and limited behavioural change. Similarly, data breaches like Star Health Insurance and Policy bazaar indicate awareness of risks but continued digital engagement due to convenience and necessity. These insights reinforce the personalisation–privacy paradox and confirm the privacy concern–behaviour gap identified in the primary data analysis.

2. ***Summary of Findings***

The findings of the study combine insights from both quantitative and qualitative analysis to present a clear understanding of students' privacy attitudes and digital behaviour.

The primary data shows that no statistically significant relationship exists among Privacy Concern, Perceived Benefits of Personalisation, and Privacy Protection Behaviour, indicating that awareness and perceived

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advantages of personalisation do not directly shape protective actions. However, Digital Literacy significantly influences Informed Consent Understanding, suggesting that digitally aware students are better able to comprehend consent mechanisms. The analysis also confirms a significant gap between Privacy Concern and Actual Online Behaviour, demonstrating that expressed concerns do not consistently translate into cautious online practices. Ranking results further highlight behavioural patterns such as preference for convenience, influence of policy length, password reuse, and lack of time in managing privacy settings.

The secondary case review, including instances such as K.S. Putta swamy v. Union of India and the Pegasus spyware scandal, supports these findings by showing that students recognize privacy risks but continue digital engagement due to convenience, necessity, or limited alternatives.

Overall, the integrated findings confirm the presence of a privacy concern behaviour gap and reflect the continuing personalisation privacy tension among college students despite growing digital awareness.

3. *Proposed Strategic Framework – PSMM*

Privacy Segmented Marketing Model

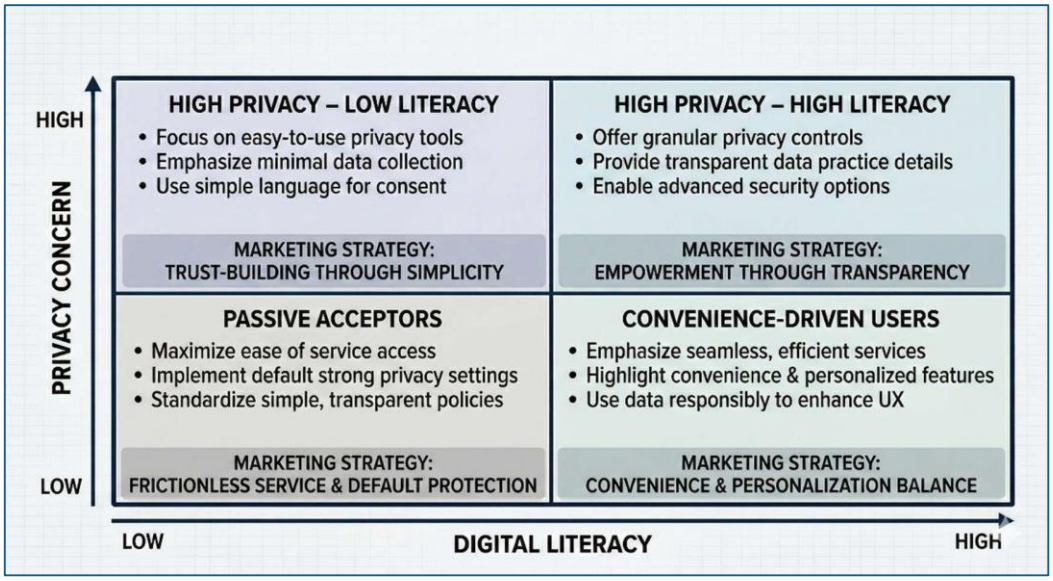


Figure 3 PSMM model

The Privacy Segmented Marketing Model (PSMM) proposes that startups segment customers based on a Privacy Sensitivity Index rather than only demographics. Based on digital literacy and privacy concern levels, users are grouped into four segments: High Privacy - Low Sharing, High Privacy - High Literacy, Convenience Driven Users, and Passive Acceptors. Each segment receives a tailored personalisation strategy. High Literacy users are offered detailed customization controls, Convenience-Driven users receive frictionless personalisation, and High Privacy users are given limited tracking with opt-in options. This model enables ethical targeting, strengthens trust based branding, reduces churn, and helps startups align data - driven marketing with user comfort levels.

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Conclusion:

The study examined the personalisation–privacy paradox among college students, focusing on how their privacy awareness, perceived online advantages and digital skills influence what they do online. The findings show no significant relationship between privacy concern and privacy protection behaviour, indicating that awareness alone does not influence protective actions. The level of digital literacy greatly shapes how well students understand informed consent, suggesting that those with higher digital proficiency make more informed online choices. The study also highlights a noticeable gap between what students say about their privacy and how they actually behave online. Although students understand potential online risks, they persist in convenience- oriented habits. The study underscores the persistent gap between privacy awareness and actual behaviour and advocates for enhanced digital skills and more transparent consent practices to promote accountable online participation.

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HUMANITY-DRIVEN DIGITAL ENTREPRENEURSHIP: DESIGNING AND VALIDATING THE HADES MODEL AMONG UNIVERSITY STUDENTS

***** ***Ms. Ajab Tinwala, **Mr. Ganesha Gundu & ***Mr. Ravi Singh***

** Lilavati Lalji Dayal Night College of Commerce*

Abstract:

The rapid advancement of digital technologies has transformed entrepreneurial ecosystems, providing university students with access to digital platforms, artificial intelligence, and online business tools. However, limited research integrates humanitarian values and sustainability awareness within student-led digital entrepreneurship frameworks. To address this gap, this study proposes and empirically validates the HADES Model (Humanity-Driven Agile Digital Entrepreneurship for Sustainability), a student-centric framework explaining Sustainable Startup Intention.

A quantitative cross-sectional design was employed, collecting primary data from 300 university students using a structured questionnaire measured on a five-point Likert scale. Reliability was confirmed through Cronbach's Alpha, and hypotheses were tested using multiple regression and mediation analysis in Jamovi. Bootstrapping with 5000 samples was applied to validate the mediation effect.

The findings reveal that Digital Competence and Humanitarian Orientation significantly influence Sustainable Startup Intention, while Sustainability Consciousness does not show a direct significant effect. Digital Entrepreneurial Agility partially mediates the relationship between Digital Competence and Sustainable Startup Intention. The model explains 58% of the variance, indicating strong explanatory power.

The study validates the HADES Model as a comprehensive framework aligning digital capability, ethical responsibility, and adaptive agility to foster sustainable digital entrepreneurship among university students.

Keywords: *Digital Entrepreneurship, Sustainable Startup Intention, Digital Entrepreneurial Agility, Humanitarian Orientation, Sustainable Innovation & HADES Model*

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Introduction:

The present time sees an increase in natural and human made disasters which in turn has put forward questions on the efficacy and sustainability of humanitarian logistics systems. We see issues like coordination breaks down, resource shortages and also regulatory and ethical problems which in turn has brought to light the need for innovation. To that end we have seen the introduction of digital technologies into humanitarian services which has put forth a transformational approach. Digital humanitarianism which includes data driven platforms, AI, and collaborative digital ecosystems has improved coordination and real time response. That said we still see large gaps in legal, ethical and management governance structures.

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Digital transformation refers to the changes that occur as a result of the growing use of digital technologies in business processes and their organizational capabilities. This has occurred across the world in many different industries. Studies show that when businesses incorporate digital technologies, they improve both their managerial and operational capabilities, resulting in advancements in performance of the business. Considering the parallel to digitalization, organizations must also prioritize the impact of their business practices on the environment and society. Sustainability has emerged as a primary strategic consideration for organizations. More and more, businesses recognize digital transformation and sustainability as an integrated approach to achieve sustainable value.

While the expansion of literature concerning digital transformation and sustainability has covered the different sectors of agility, business innovation, and humanitarian operations, the intersection of digital transformation and sustainability in humanitarian logistics has received little attention. The intersection of humanitarian logistics and digital technology is important for improving the coordination, transparency, and responsiveness of humanitarian logistics through the use of "crowd intelligence" and Artificial Intelligence (AI) systems. Despite the growing importance of these systems, issues with data ownership, accountability, and ethical use of data remain. Accordingly, this paper develops a comprehensive framework for the integration of digital transformation and sustainability in humanitarian logistics ecosystems. The paper sets out to close the identified gaps by attempting to develop a model for a sustainable digital business ecosystem, which is in harmony with the United Nations Sustainable Development Goals (SDGs) and strives to provide humanitarian logistics with a higher level of sophistication.

Review of Lietrature:

1. **Gunaseelan et al. (2022)** in *"Digital Entrepreneurship among Higher Education Students"* examines the digital entrepreneurship in Malaysia appreciating higher education mostly by students and the intensification by the ministry of higher education. It further contributed to the adaptation to the technological transition and incorporating the skills into the market. However, the policies proposed and the increased number of universities and colleges in Malaysia appreciating the program have emphasized its adoption.
2. **Elia, Margherita, and Passiante (2020)** in *"Digital Entrepreneurship Ecosystem: How Digital Technologies and Collective Intelligence are Reshaping the Entrepreneurial Process"* this article proposes a definition of digital entrepreneurship ecosystem by highlighting the integrated digital- output and digital-environment perspectives. Digital transformation is today widespread and pervasive into most industries and companies, and a new paradigm of digital entrepreneurship emerges, which is driven by the innovation potential embedded into large groups of individuals contributing to develop innovative technology-based solutions.
3. **Gohil et al. (2024)** in *"Digital Business Models for Sustainability"* examines how to predict the digital transition of businesses. It aims to establish a causal relationship between various components of the business model and parts of digital technologies. This improves our understanding of how technology affects digitally-

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drives business structures. Digitalization profoundly changes business and society by eradicating outdated business paradigms and generating sustainable value.

4. **Sahar et al. (2025)** in *"Organizational Sustainability in the Face of Digital Transformation with a Bibliometric and Content Analysis for Future Research Agenda" e*xplores the intersection of organizational sustainability and digital transformation by providing a comprehensive bibliometric and content analysis of existing literature. The study acknowledges limitations, including the exclusive use of the Scopus database, which may omit relevant literature from other sources.
5. **Aghayari et al. (2023)** in *"The Impact of Digital Transformation on Sustainability: A Case of the Iranian Telecom Industry"* examines that corporate landscape is highly affected by two market factors, namely digitalization and sustainability. These two driving forces have been the topic of several studies on how they change management methods, businesses, and society in general. The present study attempts to elaborate on the relationship between digital Transformation and sustainability.
6. **Pappas et al. (2025)** in *"Responsible Digital Transformation for a Sustainable Society"* discussed the emergence of corporate digital responsibility (CDR) and the shift from industry 4.0 to industry 5.0, which focuses on human-centric approaches and human-AI partnerships. The suggestions in this paper, coupled with the nice research contributions included in the special issue, seek to offer a broader foundation to support responsible digital transformations for sustainable societies.
7. **Baffoe et al. (2019)** in *"Humanitarian Relief Sustainability: A Framework of Humanitarian Logistics Digital Business Ecosystem"* developed a Humanitarian Logistics Digital Business Ecosystem (HLDBE) framework as an alternative way to sustain the humanitarian logistics operations and reliefs through hybrid humanitarian-business logistics sector. Implementation of this ecosystem will have a positive impact on affected economies.
8. **Kumar et al. (2022)** in *"Digital Humanitarianism and Crisis Management: An Empirical Study of Antecedents and Consequences"* proposed a digital humanitarianism dynamic capability (DHDC) paradigm that explores the direct effects of DHDC on disaster risk reduction (DRR) and the mediating effects of process-oriented dynamic capabilities (PODC) on the relationship between DHDC and DRR. Technological innovation has reshaped the way humanitarian organizations (Hos) respond to humanitarian crises.
9. **Barrios et al. (2025)** in *"Digital Technologies for Inclusive Innovations in Humanitarian Response"* examines the role digital technologies play in facilitating inclusive innovation processes. The findings indicate that digital technologies enhanced inclusive innovation processes through different mechanisms, facilitating a dialogical innovation process between NPOs and refugees. The article concludes by discussing how findings expand the current theory on inclusive innovation and their implications for policy and practice.
10. **Ubiparipovic et al. (2023)** in *"Digital Business Agility"* examines Business agility, as the ability To identify and adapt to digital technologies in a timely manner, represents a successful Response and plays a profound role in the organization's success. By analyzing recent Literature, this paper examines the importance of digital business agility and how digital Technologies themselves contribute to the development of

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comprehensive business agility. The paper describes the results of the research, which can serve as a strategic orientation for organizations on their journey to digital transformation and improved business agility.

Development of Hades Model:

The HADES Model (Humanity-Driven Agile Digital Entrepreneurship for Sustainability) is proposed to explain sustainable startup intention among university students by integrating technological capability, humanitarian values, sustainability awareness, and adaptive agility.

The model is grounded in three theoretical foundations: digital entrepreneurship theory, sustainability orientation literature, and dynamic capability theory. Digital Competence is what we see as students' use of digital technologies for business purposes. Humanitarian Orientation is the tendency to develop responsible social ventures, while Sustainability Consciousness is the degree of that which we are aware of long term environmental and social issues.

To put digital skill into the picture of entrepreneurial action the model puts forth Digital Entrepreneurial Agility as a mediating variable. Agility here is the ability of the individual to adapt to tech changes and dynamic market forces thus it strengthens the connection between digital competence and the intent of green startups. Also the HADES Model puts forth a very comprehensive, student-based framework that brings digital innovation in line with social responsibility and sustainability.

Conceptual Framework:

This study's conceptual framework presents the HADES Model pertaining to the Sustainable Startup Intention among university students. It is proposed that the variables Digital Competence, Humanitarian Orientation, and Sustainability Consciousness influence Sustainable Startup Intention directly. Moreover, it is suggested that Digital Entrepreneurial Agility, which is proposed to mediate the relationship between Digital Competence and Sustainable Startup Intention, transforms technological capability into entrepreneurial intent.

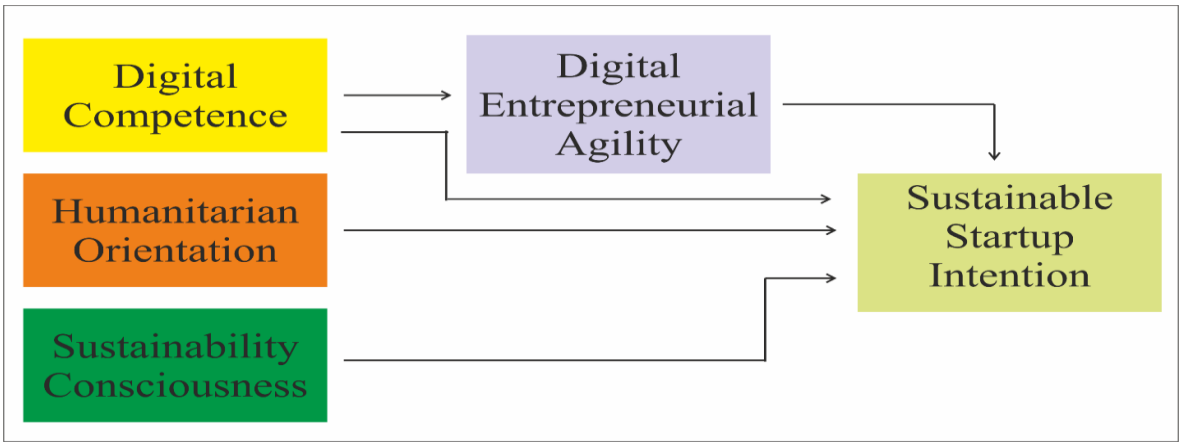


Fig 1: Conceptual Frame Work

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Objectives:

- To examine the influence of digital competence, humanitarian orientation, and sustainability consciousness on sustainable startup intention among university students.
- To analyze the mediating role of digital entrepreneurial agility in the relationship between digital competence and sustainable startup intention.
- To develop and empirically validate the HADES Model as a student-based framework for sustainable digital entrepreneurship.

Research Methodology:

This research adopts a quantitative cross-sectional methodology to study the HADES Model among university students. Primary data were collected from 300 participants using a structured questionnaire measured on a five-point Likert scale. Reliability was measured using Cronbach's Alpha. Multiple regression and mediation analyses were conducted using Jamovi statistical software. Mediation effects were tested using bootstrapping (5,000 samples) to p0.05.

Problem Statement:

The swiftness of change in technology has transformed all fields of business as it gives students ease of access to digital technologies, AI, and business tools. However, research focusing on student-run digital startups that incorporate humanitarian aspects and an understanding of sustainability is scarce. Also, the joint effect of digital agility, humanitarian focus, sustainable awareness, and the digital entrepreneurial agility remains largely unexplained. this study attempts to address this by presenting the HADES Model (Humanity-Driven Agile Digital Entrepreneurship for Sustainability). The model is a student-centric approach that combines digital ability, ethically driven sustainability, and agility.

Data Analysis and Inferential Results:

The statistical analysis and inferential results of the study conducted to validate the HADES Model (Humanity-Driven Agile Digital Entrepreneurship for Sustainability). The analysis was performed using Jamovi statistical software.

Demographic Profile of Respondents:

The study collected 300 valid responses from university students.

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Table 4.1 Gender Distribution		
Gender	**Frequency**	**Percentage**
Male	158	52.67%
Female	142	47.33%
Total	**300**	**100%**

Table 4.2 Qualification Level		
Qualification	**Frequency**	**Percentage**
Undergraduate	210	70.00%
Postgraduate	88	29.33%
Doctorate	2	0.67%
Total	**300**	**100%**

Table 4.3 Startup Experience		
Experience	**Frequency**	**Percentage**
Yes	144	48.00%
No	156	52.00%
Total	**300**	**100%**

Source: Primary Data

Interpretation:

The sample consisted of 300 university students from various disciplines and with different levels of entrepreneurial exposure. The sample appears to be adequately gender-balanced with 52.67% males and 47.33% females. Most participants were undergraduates (70%). Postgraduates and PhDs made up 29.33% and 0.67%, respectively. This means that the majority of the participants were early stage postgraduate students. In terms of entrepreneurial exposure, 48% respondents said they had previously planned or attempted to initiate a digital business and 52% stated they did not have prior start

up experience. This means that the research is capturing both aspiring entrepreneurs and students with some degree of entrepreneurial exposure. Overall, the demographic composition reflects a balanced and academically relevant sample for examining sustainable startup intention within the university ecosystem.

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Reliability Analysis

Table 4.4: Reliability Test

Cronbach's Alpha was used to assess internal consistency.

Construct	Alpha	Interpretation
Digital Competence	0.95	Excellent
Humanitarian Orientation	0.889	Very Good
Sustainability Consciousness	0.917	Excellent
Digital Entrepreneurial Agility	0.871	Good
Sustainable Startup Intention	0.916	Excellent

In this study we used Cronbach's Alpha in Jamovi to determine the reliability of the measurement scales. We report strong internal consistency for all constructs which we saw to go beyond the put forth threshold of 0.70. Digital Competence (α 0.950), Sustainability Consciousness (α 0.917) and Sustainable Startup Intention (α 0.916) we found to have excellent reliability, at the same time Humanitarian Orientation (α 0.889) and Digital Entrepreneurial Agility (α 0.871) we noted to have very good reliability. We present that the results confirm the reliability of the measurement scales which in turn are fit for the next stage of analysis.

Inferential Analysis – Hypothesis Testing:

Testing of Hypothesis 1 (Multiple Regression)

H01: Digital Competence, Humanitarian Orientation, and Sustainability Consciousness do not influence Sustainable Startup Intention.

H1: Digital Competence, Humanitarian Orientation, and Sustainability Consciousness influence Sustainable Startup Intention.

Multiple regression analysis was carried out.

Table 4.5 Model Summary				
R	R^2	Adjusted R^2	F	Sig.
0.718	0.516	0.511	105.4	< 0.001

The model accounts for 51.6% of the variance in Sustainable Startup Intention. The overall regression model was statistically significant.

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Table 4.6 Regression Coefficients			
Predictor	**Beta (β)**	**p-value**	**Decision**
Digital Competence	0.306	< 0.001	Significant
Humanitarian Orientation	0.341	< 0.001	Significant
Sustainability Consciousness	0.115	0.058	Not Significant

Interpretation:

Digital Competence and Humanitarian Orientation are significant predictors of Sustainable Startup Intention. Sustainability Consciousness, however, does not have a statistically significant direct effect (p 0.05).

As a result, H01 is partially rejected. H1 is partially corroborated.

Testing of Hypothesis 2 (Mediation Analysis):

H02: Digital Entrepreneurial Agility does not mediate the relationship between Digital Competence and Sustainable Startup Intention.

H2: Digital Entrepreneurial Agility mediates the relationship between Digital Competence and Sustainable Startup Intention.

Bootstrapping (5000 samples) was conducted.

Step 1: Effect of DC on DEA

Path	**Beta**	**R^2**	**p-value**
DC → DEA	0.686	0.54	< 0.001

Digital Competence significantly predicts Digital Entrepreneurial Agility.

Step 2: Effect of DC and DEA on SSI

Predictor	**Beta**	**p-value**
Digital Competence	0.228	< 0.001
Digital Entrepreneurial Agility	0.599	< 0.001

$R^2 = 0.580$

The inclusion of DEA increases explained variance from 51.6% to 58%.

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Mediation Conclusion:

Since:

- DC significantly predicts DEA,
- DEA significantly predicts SSI,
- DC remains significant after including DEA, Partial mediation is confirmed.

Therefore, H_{02} is rejected and H_2 is supported.

FINDINGS, MODEL VALIDATION AND IMPLICATIONS:

Findings:

- University students' Sustainable Startup Intention is influenced by Digital Competence.
- Humanitarian Orientation is a positive contributor to Sustainable Startup Intention.
- There is no direct statistical effect of Sustainability Consciousness on Startup Intention.
- There is a significant (partial) mediating effect of Digital Entrepreneurial Agility on the relationship between Digital Competence and Sustainable Startup Intention.
- Compared to the other models, the HADES Model has the strongest explanatory power as it accounts for 58% of the variance in Sustainable Startup Intention.
- Students' sustainable digital entrepreneurship is a function of their digital capability, humanitarian values, and adaptive agility, rather than just technological skills.
- By building on the integration of digital competence, ethical orientation, and sustainability, the research addresses a gap in the literature.

Validation of the Hades Model:

The empirical analysis provides strong validation for the HADES Model.

The model explaining 58% of variance in Sustainable Startup Intention, demonstrates considerable explanatory power in student entrepreneurship. The validation process demonstrates

1. Digital Competence and Humanitarian Orientation have significant direct effects.
2. Digital Entrepreneurial Agility has a significant mediating effect.
3. There is structural consistency between theory and evidence.

Sustainability Consciousness did not have a direct effect, but the integration of the concept is relevant for developing sustainable entrepreneurial ecosystems. Therefore, the HADES Model has validating proof of being a humanity and agility-driven model of digital entrepreneurship.

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Theoretical and Practical Implications of the Hades Model

Theoretical Implications	Practical Implications
Integrates digital entrepreneurship and sustainability into a unified framework.	Universities should strengthen digital skill development programs.
Establishes humanitarian orientation as a key driver of sustainable startup intention.	Entrepreneurship education should include humanitarian and social responsibility components.
Extends Dynamic Capability Theory by positioning digital entrepreneurial agility as a mediator.	Agility-focused training such as hackathons and innovation labs should be promoted.
Develops and empirically validates a student-centric entrepreneurship model.	Policymakers should encourage youth-led sustainable digital ventures aligned with SDGs.
Bridges technological capability with ethical entrepreneurship.	Provides a roadmap for institutions to nurture sustainable digital entrepreneurs.

Bridging Technology & Ethics in Entrepreneurship

Limitations and Future Research Directions:

Aside from the positive aspects of the study, the following limitations should be highlighted:

i) Sample limited to university students.

ii) Cross-sectional design limitations regarding causality.

iii)Self-reporting reposes the risk of bias.

Future research may include:

- Trialing the HADES Model in several countries.
- Designing the research longitudinally.
- Stretching the model to accommodate other moderators like nstitutional support or entrepreneurial self-efficacy.

Suggestions & Recommendations:

- Universities must improve their digital skills programs which in turn will increase students' sustainable entrepreneurial goals.
- In to the picture of social responsibility and humanitarian values entrepreneurship education must play a key

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role in putting out purposeful startups.

- We see a need for institutions to put together flexible training programs which in which they will help students to take their digital skills into the world of entrepreneurship.
- Policy makers should back youth based green tech businesses through financial support, incubation programs and initiatives that tie in with the SDGs.
- As we increase sustainability awareness we must also present practical digital skill building at the same time.
- Universities should develop ecosystems which include tech, ethics, and adaptability in which they can grow sustainable entrepreneurs.
- For future research we ask that the HADES Model be looked at in a variety of geographies and types of institutions.

Conclusion:

This research developed and empirically verified the HADES Model which we put forth to explain sustainable startup intention among university students. We looked at digital competence, humanitarian orientation, sustainability consciousness, and digital entrepreneurial agility which we incorporated into the model to present a framework for study of digital sustainable entrepreneurship. We found out that Digital Competence and Humanitarian Orientation do have a great impact on Sustainable Startup Intentions which in turn Sustainability Consciousness did not play a main role. Also we did a mediation analysis which reports that Digital Entrepreneurial Agility is very much in the picture in the transition from digital skill to action. Also we report that the model which we present explains 58% of the variation in startup intention which is a strong result. Overall, the HADES Model is validated as a comprehensive

framework that aligns digital innovation with ethical responsibility and adaptive capability, emphasizing that sustainable digital entrepreneurship requires not only technological skills but also humanitarian values and agility.

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A STUDY OF SPRING MASS ELECTROMAGNETIC ENERGY HARVESTING SYSTEM EMBEDDED IN A MOBILE COVER

** Aaditya Chourasiya, **Kasturi Prajapati, ***Sanjana Waghmare, ****Vighnesh Salve & *****Ms. Nishmita Rana*

*

Abstract:

Currently, smartphones have become a vital component of our daily lives, and the situation of running out of power, especially during an emergency, can be stressful and frustrating. To solve this problem, this research proposes an innovative smartphone cover that can produce power using the natural motion of the smartphone during daily operations. The concept revolves around electromagnetic induction, whereby a small magnet with a spring oscillates within copper wires to produce electric power whenever the smartphone is in motion.

Unlike conventional electric power systems that utilize only one motion direction, this system utilizes both vertical (up and down) and horizontal (side to side) motions. This increases the amount of electric power produced from simple operations such as walking or using the smartphone, the produced power is regulated by a boost converter to ensure it is safe for use during emergency charging. Although it is not meant to replace conventional charging systems, this smart phone cover is a feasible, portable, and environmentally friendly alternative with immense potential for future self-charging devices.

Keywords: *Motion Based Energy Harvesting, Electromagnetic Induction, Power Generating Mobile Cover, Sustainable Technology, Emergency Charging Solution*

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Introduction:

In the modern technology age, smartphones have become a vital tool for communication, learning, financial transactions, navigation, and emergency response. However, the rapid draining of batteries has remained a challenge, especially during traveling, outdoor activities, and power failures. This paper proposes a motion-powered energy-harvesting mobile cover that harnesses the potential of everyday smartphone motion to produce electrical energy through the electromagnetic induction principle. By incorporating a magnet-coil system within the mobile cover, electrical energy can be produced through the vertical and horizontal motion of the smartphone.

The paper is founded on the principle of Faraday's Law of Electromagnetic Induction, which asserts that a magnetic flux change produces an electromotive force (EMF). In this research, the independent variable is the motion of the smartphone (intensity, frequency, and motion direction). The dependent variable is the quantity of electrical energy or voltage produced by the smartphone motion. As the motion intensity increases, the rate

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of magnetic flux change also increases, resulting in increased induced voltage.

The aim of this research is to investigate the potential of natural smartphone motion to produce adequate supplementary power for emergency purposes, thereby encouraging eco-friendly and self-sustaining mobile technology.

Limitations of Study:

1. **Limited Sample Size:-** The study is based on a small sample of 112 respondents, which may not necessarily represent the entire population of smartphone users.
2. **Non-Probability Sampling**:- Convenience sampling was adopted for the study, which is a limitation for the generalization of the study for a wider population.
3. **Self-Reported Response:-** The data is based on personal opinions of the respondents, which may include a certain amount of bias or error.
4. **Conceptual Evolution:-** User acceptance of the product was based on the concept rather than a fully developed prototype.
5. **Limited Technical Analysis:-** More emphasis is given to the study of user perception rather than experimental validation of the efficiency of power generation.

Review of Literature:

Energy harvesting through electromagnetic vibration systems has emerged as a significant area of research for the sustainable production of small-scale electrical power.

1. **According to study by Chiu et al. (2016),** 4.1 A study by Chiu et al. (2016) states that a spring-mass electromagnetic energy harvester attached to a vibrating body underwent additional numerical analysis. The study was designed with a cylindrical permanent magnet sandwiched between a coil and two helical springs. Vibrations caused the cylindrical magnet to travel sinusoidally between the coil, changing the magnetic flux and producing an electric current.

   Faraday's Law of Electromagnetic Induction, which postulates that the induced voltage in a coil is directly proportional to the change in the magnetic flux, is the cause of the occurrence. Put another way, the magnetic field varies as the magnet enters and exits the coil, and as a result an electric current is generated. The research investigation also took into account Lenz's Law, which states that the electric current generated has a force opposed to the direction of motion and causes electromagnetic damping.

   The authors concluded that the maximum electric current is reached when the natural frequency of the spring-mass system coincides with the frequency of external vibrations. This occurs when the system is in resonance, enabling it to operate at maximum efficiency.

   Since **Michael Faraday proposed his law of electromagnetic induction in 1831**, electromagnetic induction has remained one of the fundamental concepts of physics. According to Faraday's theory, an electromotive force (EMF) is created when the magnetic flux through a closed circuit changes. All contemporary electrical equipment, including transformers and generators, is still built on this idea. Lenz's Law, which states that the induced current always opposes the cause that produces it, is indicated by the negative sign in the

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mathematical expression of Faraday's Law, which states that the induced voltage is directly proportional to the rate of change of magnetic flux.

2. **According to the study by Härtel (2018)** further explored electromagnetic induction using both the electro-dynamic Weber model and the traditional Faraday-Lorentz model. The article explains how electromagnetic induction can be explained as a result of relative motion between electric charges, where the forces of induction are caused by shifting magnetic interactions. The study also discusses mutual induction and self-induction, both of which are directly relevant to the system with moving coils and magnets. The theoretical foundation of the suggested mobile phone cover system is amply demonstrated by the motion-based explanation of electromagnetic induction.
3. **According to the study by Patero (2023),** Additionally, Faraday's First and Second Laws of Electromagnetic Induction were validated experimentally. The study demonstrated that an induced EMF, which is proportionate to the rate of change of magnetic flux, is produced when the magnetic field surrounding a coil changes. Faraday's original theory was proven by the experimental data, which unmistakably demonstrated a linear relationship between the variation of magnetic flux and the induced voltage. The study also emphasized the use of electromagnetic induction in transformers and generators, where electrical energy is produced by mechanical motion in a magnetic field.The suggested design of the cell phone cover is directly impacted by this principle. In this design, the vertical and horizontal movements of the mobile phone during use cause a magnet mounted on a spring to move inside a copper coil. According to Faraday's Law, this causes the magnetic flux in the copper coil to fluctuate, which generates electricity.

Research Gap:

The current research on electromagnetic induction and energy harvesting technology has mainly concentrated on large-scale power generation, industrial systems, or small electronic sensor technologies. Very few research works have explored the concept of incorporating motion-based energy harvesting technology into daily life smartphone accessories. Moreover, past research has primarily concentrated on the efficiency of the technology, while the usability and needs for emergency use have received little attention. The relationship between battery-related emergency experiences and user willingness has also remained unexplored. The current research attempts to bridge the gap by considering both the usability and user willingness for a motion-based power-generating mobile cover.

Research Methodology:

1. **Objectives of the Study**
   i. To examine the frequency of battery-related problems faced by smartphone users during daily use and emergencies.
   ii. To assess users' awareness and acceptance of motion-based energy generation technology in mobile covers.
   iii. To evaluate the perceived usefulness of an energy-generating mobile cover in reducing battery anxiety and dependence on chargers or power banks.

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iv. To analyze users' willingness to adopt and pay for a power-generating mobile cover despite potential increase in device weight.

2. ***Hypothesis***

H_o1: There is no significant relationship between users' experience of battery-related emergencies and their willingness to use a power-generating mobile cover.

H1: There is a significant relationship between users' experience of battery-related emergencies and their willingness to use a power-generating mobile cover.

H02: The perceived usefulness of the energy-generating mobile cover does not significantly influence users' intention to adopt or recommend the product.

H2: The perceived usefulness of the energy-generating mobile cover significantly influences users' intention to adopt or recommend the product.

3. ***Research Design***

This research is ***experimental*** in nature since it entails the design, construction, and testing of a functional prototype of a motion-powered mobile cover. The current study was conducted as an applied, descriptive, and quantitative research study. It was based on a survey study aiming to analyze the issues associated with the battery of the smartphone and assess the acceptance of a motion-based power generating mobile cover. The concept is based on the principle of electromagnetic induction, which was first discovered by Michael Faraday. His pioneering work showed that mechanical motion can be converted to electrical energy, and this provides the scientific basis for the project. This research is also practical in nature. It is based on a real-world problem since it seeks to answer the question of how to charge mobile phones when power sources are not available. By targeting the problem of emergency charging, the project seeks to offer a practical solution to the problem.

4. ***Sampling Technique***

The sampling technique adopted for the present study is non-probability convenience sampling. The sampling unit is chosen based on their accessibility. The data was collected through an online survey of 112 users of smartphones.

Data Analysis and Interpretation:

Hypothesis 1 (User Acceptance and Need)

Null Hypothesis (H_0): There is no significant relationship between users' experience of battery-related emergencies and their willingness to use a power-generating mobile cover.

Alternative Hypothesis (H_1): There is a significant relationship between users' experience of battery- related emergencies and their willingness to use a power-generating mobile cover.

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Chi-Square Calculation Table:

Chi-Square Goodness-of-Fit Test					
Variable 1: Experience of Battery Emergency					
Responses	Observed Frequency	Expected Frequency	O - E	$(O-E)^2$	$(O-E)^2/E$
Yes	53	56	-3	9	0.160714
No	59	56	3	9	0.160714
Total	112				0.321429
df					1
α					0.05
$(\chi^2_{0.05,1})$					3.841

(Source: Primary data – Online Questionnaire)

Interpretation: The Chi-Square Goodness-of-Fit test was conducted to examine respondents' experience of battery-related emergencies. The calculated Chi-square value ($\chi^2 = 0.322$) was found to be lower than the critical table value (3.841) at the 0.05 level of significance with 1 degree of freedom. This indicates that there is no statistically significant difference between respondents who experienced battery emergencies and those who did not. Therefore, the null hypothesis was accepted and the alternative hypothesis was rejected.

The findings suggest that battery emergency experiences are relatively evenly distributed among respondents and do not show a significant variation within the sample population.

Variable 2: Willingness to Use Power-Generating Mobile Cover					
Response Category	Observed Frequency (O)	Expected Frequency (E)	O − E	$(O-E)^2$	$(O-E)^2 / E$
Very Interested	47	28	19	361	12.893
Interested	45	28	17	289	10.321
Not Sure	18	28	−10	100	3.571
Not Interested	2	28	−26	676	24.143
Total	112	112			50.928
df					3
α					0.05
$(\chi^2_{0.05,1})$					7.815
p-value					0.001

(Source: Primary data – Online Questionnaire)

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Interpretation:

The Chi-Square Goodness-of-Fit test was applied to examine respondents' willingness to use a power-generating mobile cover. The calculated Chi-square value ($\chi^2 = 50.928$) was found to be greater than the critical table value (7.815) at the 0.05 level of significance with 3 degrees of freedom. This result indicates a statistically significant difference among the willingness categories. Therefore, the null hypothesis was rejected and the alternative hypothesis was accepted.

The findings reveal that respondents demonstrate a strong preference and positive acceptance toward the adoption of a power-generating mobile cover, suggesting favorable user interest in the proposed innovation.

Hypothesis 2 (Perceived Usefulness and Adoption)

Null Hypothesis (H_{02}): The perceived usefulness of the energy-generating mobile cover does not significantly influence users' intention to adopt or recommend the product.

Alternative Hypothesis (H_{12}): The perceived usefulness of the energy-generating mobile cover significantly influences users' intention to adopt or recommend the product.

Chi-Square Calculation Table:

Response	Observed Frequency (O)	Expected Frequency (E)	O − E	(O − E)²	(O − E)² / E
Strongly Agree	24	22.4	1.6	2.56	0.114
Agree	45	22.4	22.6	510.76	22.803
Neutral	37	22.4	14.6	213.16	9.516
Disagree	6	22.4	−16.4	268.96	12.007
Strongly Disagree	0	22.4	−22.4	501.76	22.4
Total χ^2 df α ($\chi^2_{0.05,1}$) p-value					**66.84** **4** **0.05** **9.488** **0.001**

(Source: Primary data – Online Questionnaire)

Interpretation:

The Chi-Square Goodness-of-Fit test was conducted to examine respondents' opinions on whether a power-generating mobile cover can reduce battery anxiety. The calculated Chi-square value ($\chi^2 = 66.84$) exceeded the critical table value (9.488) at the 0.05 level of significance with 4 degrees of freedom. This indicates a statistically significant difference among response categories. Hence, the null hypothesis was rejected and the alternative hypothesis was accepted.

The findings suggest that respondents largely agree that the power-generating mobile cover can effectively reduce battery anxiety, reflecting positive user perception toward the proposed product.

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Recommended Conceptual Model and Its Functioning:

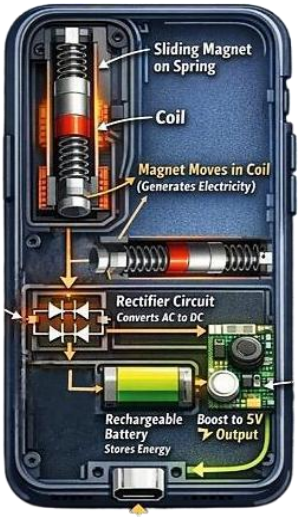


Figure 1

The motion-powered phone case is a protective phone cover designed to harness electrical energy from day-to-day movement. The device works on the basis of electromagnetic induction. A neodymium magnet is fixed inside the phone case. The magnet is connected to a copper coil. The magnet oscillates inside the copper coil whenever the phone is shaken, carried, or moved during day-to-day activities like walking. This oscillating motion creates an electromotive force according to Faraday's Law of Electromagnetic Induction, which was first discovered by Michael Faraday.

The current generated by the moving magnet is an alternating current. The alternating current is then rectified into direct current by the rectifier circuit. The voltage generated by the moving magnet is low, ranging from 0.5 to 2 volts. The current is temporarily stored in the rechargeable battery or supercapacitor.

A boost converter then follows, which increases the stored voltage up to a regulated 5 volts, which can be used for charging the phone, as it is the standard voltage for USB devices. This circuit ensures that the phone case can be used for emergency backup power without the need for an external electrical source, making it portable and efficient.

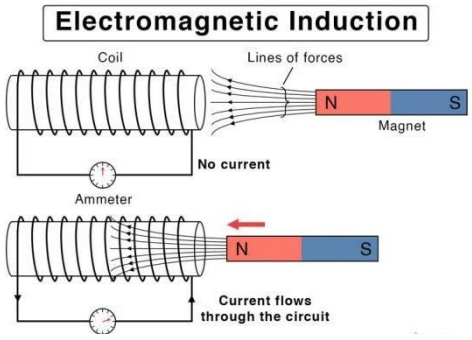


Figure 2

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This picture illustrates the concept of electromagnetic induction. As long as the magnet is just resting near the coil, nothing will happen because the magnetic field surrounding the wire is not changing, and therefore no electric current will be generated. But when the magnet approaches the coil, the magnetic field inside the coil will change. This will cause tiny electric charges (electrons) in the wire to move.

As the charges move, an electric current is generated, which can be measured by the ammeter.

In conclusion, the electric current can only be generated when the magnet is moving. It is the changing magnetic field, not the magnet itself, that produces the electric current.

Power Conservation:

Battery = 5000 mAh, 3.7 V

Energy for 10% charge = 18.5 × 0.10 = 1.85 Wh

Total energy = (5000 × 3.7) / 1000 = 18.5 Wh Wh

Generated power = 20 mW Boost efficiency ≈ 80% Usable power = 20 × 0.8 = 16 mW = 0.016 W

Daily motion = 8 hours

Energy/day = 0.016 × 8 = 0.128 Wh

Daily charge % = (0.128 / 18.5) × 100 ≈ 0.7%

≈ 0.5–1% per day

Energy for 10% charge = 18.5 × 0.10 = 1.85

Time for 10% charge

= 1.85 / 0.128 ≈ 14–15 days

Result:

Usable power ≈ 16 mW Energy/day ≈ 0.128 Wh Battery gain ≈ 0.5–1% daily 10% charge ≈ 2 weeks

Conclusion:

This study aims to examine the necessity and possibility of power generation-based mobile cover with respect to the solution of the frequently occurring issues of battery drainage of smartphones. The findings of the survey carried out in this study have confirmed the frequently occurring issues of low battery of smartphones. The issues of low battery of smartphones have been more common during travel and emergency situations. The present study has found a strong positive response of the participants with respect to the proposed power generation-based mobile cover. The participants of the study have expressed some concern with respect to the weight, price, and durability of the power generation-based mobile cover. The findings of the present study have confirmed the strong positive response of the participants with respect to the proposed power generation-based mobile cover.

Suggestions:

- The efficiency of the prototype can be improved by optimizing the number of turns of the coil and the strength of the magnet to increase the power output.
- Future research could be carried out to increase the capacity of the stored energy to provide backup in case of an emergency.

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- Power management circuits can be integrated to reduce the loss of energy during the rectification and boosting of the voltage.
- The design can be miniaturized to increase the portability and feasibility of the system.
- More tests with large numbers of users can be carried out to evaluate the feasibility of the system.

Future Scope:

The proposed concept of motion-based power-generating mobile cover has shown significant potential for development and application. Future research directions can be taken to improve the efficiency of the energy conversion process by optimizing the design of the coil, enhancing the magnetic field strength, and improving the mechanical motion systems. Other energy storage devices can also be included in the design, such as micro-batteries or super capacitors.

Future research directions can also be taken for the development of energy storage devices with light and durable materials for the comfort of users and the longevity of the device. Also, the proposed technology can be developed for the use of other micro-power requirements, such as the power requirements of wearable devices, sensors, and other low-energy electronic devices.

It is recommended that the proposed concept of the motion-based power-generating mobile cover be tested in the real fields with larger sample sizes to ensure the effectiveness of the proposed technology and its acceptance by the users. Also, future research directions can be taken for the development of smart accessories for the smart devices of the future, which can lead to the development of energy- autonomous consumer electronics.

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Original Research Article

A STUDY ON THE IMPACT OF AI ON THE DYNAMICS OF THE FINANCIAL MARKETS

* *Prajkta Niranjan Patil, **Manya Pradeep Shetty, ***Isha Vijay Duby, ****Hansika Ramcher Dhanka & *****Dr. Revati Hunswadkar*

*

Abstract:

This study examines how artificial intelligence is transubstantiating fiscal requests and provides perceptivity for investors, fiscal institutions, controllers. It analyzes both the practical & structural goods of AI on request dynamics, contributing to the literature & supporting the development of nonsupervisory fabrics that encourage invention while icing investor protection & request security. The findings show that AI significantly improves decision- making speed, soothsaying delicacy, & functional effectiveness.

AI plays a critical part in fraud discovery, threat identification, non-supervisory compliance, maintaining overall fiscal stability. still, the study highlights that algorithmic, high-frequency trading, while enhancing request liquidity, can increase short- term volatility during ages of request stress. It concludes that sustainable AI relinquishment requires strong governance, translucency, effective regulation to align invention with long- term fiscal stability

Keywords: *Artificial Intelligence in Financial Markets, Algorithmic Trading, High-Frequency Trading, Fraud Detection in Finance, Risk Management, Financial Market Stability, AI-driven Decision Making, FinTech Regulation, Market Volatility.*

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Introduction:

1. Impact of AI on Financial Market

Financial market plays a crucial role in economic development as it facilitated capital formation, investment decisions & allocation of financial resources. Globalization and advancement in regulatory reforms & technology have transformed traditional trading into a refined AI system that enhances efficiency, accuracy, speed.

The market shaped with AI integration improves trading strategy, risk management, credit evaluation, & portfolio management with real-time data analysis. Although AI enhances efficiency but the concern related to market volatility & systematic litigations act as a barrier.

A) *Growth of AI Adoption in Financial Markets*

In the last decade the use of AI in financial market is increase due to quick information availability & the need for big data processing. Fintech firms & financial institutions uses AI for real-time market analysis & high-speed trading as it replaces traditional methods with advance technology- driven practices that

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successfully manages complex market needs.

B) ***AI & Decision-Making Efficiency***

AI enhances financial decision-making by reducing human errors like slow processing & intellectual biases data sources that are analyses using variance machine learning model helps in reducing time in high-frequency trade as it improves forecasting accuracy models such as LSTM networks processes multi-data. AI also helps in optimizing portfolio allocation for better managed retunes & minimizes sensitive mistakes as it facilitated greater trade stability & efficiency.

C) ***AI in Risk Management & Fraud Detection***

AI facilitated risk management in finance through advance models like XGBoost & LightGBM as it improves risk predictions & mitigates borrower identification errors as AI detects suspicious transactions, while AI-powered RegTech automates regulatory compliance tasks. Furthermore, AI boosts cybersecurity by recognizing differences & threats. Although these benefits, apprehensions about algorithmic transparency & over all risks persist.

D) ***AI-Based Algorithmic & High-Frequency Trading***

Fluidity & efficient implementation is achieving through Algorithmic & High-Frequency Trading(HFT) system instantly performs trade within seconds based on parameter sets. However, during market stress AI algorithm actions can increase volatility & risk.

2. Statement of Research Problems

I. Despite increasing adoption of AI in financial markets, there is limited clarity on whether AI significantly improves decision-making efficiency & market performance compared to traditional financial systems.

II. Although AI is widely used for risk management & fraud detection, concerns remain regarding its effectiveness, transparency, & ability to reduce systemic risk in financial markets.

III. The growing use of Abased algorithmic & high-frequency trading has raised concerns about its influence on market volatility & liquidity, particularly during periods of rapid market fluctuations.

3 *Scope of the Study*

The study focuses on impact evaluation of AI in financial market with respect to decision making ability risk assessment & market liquidity as the study examines both advantages & risk associated with AI integration.

4 *Significances of Study*

The study examines challenges related to financial market due to AI offered insights for investors as it also examines the structure impact of market dynamics with help of the contributed literature as it helps in creating regulatory framework that aid innovation while maintaining a satiability & security to investors.

5. Limitations of Study

The study is limited by the small demographic biases based on perception Reliance cross section design & lack of primary evidence-based testing across reason & market context.

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Review of Literature:

1. ***To evaluate the extent to which AI enhances decision making efficiency & improves overall market performance in financial markets.***

Machine learning helps speed up decision-making in HFTs by reducing latency & facilitating real- time analysis of vast market data. This allows AI-driven systems to perform trades quicker than humans & improving market efficiency. (Jasmina.et, 2022) Advanced deep learning models that combine non-linear patterns in time-series data, particularly hybrid frameworks improves the accuracy of financial forecasting,. (Li, Q., et al., 2024) AI enhances stock prediction & financial forecasting using deep learning & LSTM–genetic programming hybrids. (Li, Q., et al., 2024)

(Martínez-Barbero et al, 2025). AI-driven LSTM models improve portfolio optimization which helps deliver higher & risk-adjusted returns than traditional investment strategies. AI reduces trading errors by removing human bias & fatigue. It uses algorithmic, data-driven rules to improve its accuracy & reliability. (Okunola, 2025). Portfolio maximization is enhanced through machine learning via diverse asset allocation, adaptive risk management, & superior risk–return trade-offs compared to traditional approaches. (Agal, S., Raulji et al, 2025). AI has helped enhance financial fraud detection by using machine learning models, which enables predictive, high-precision identification of suspicious transactions. (Almalki et al, 2025) A stacking group of XGBoost, LightGBM, & CatBoost has achieved 99% accuracy in fraud detection & credit risk prediction. (Rivera et al, 2023) XGBoost & LightGBM have outperformed traditional models when it comes to predicting credit defaults.

a) ***Evidence Gap***

Based on the review of literature, a clear evidence gap emerges regarding the comprehensive impact of Artificial Intelligence on overall decision-making efficiency & market performance in financial markets.

FML Dimension	Key Evidence	STS Perspective
Decision speed	AI enables real-time processing and faster trade execution.	AI accelerates human–market interaction.
Forecasting	AI improves prediction accuracy over traditional methods.	AI supports institutional decision systems.
Bias reduction	AI reduces emotional and cognitive trading bias.	More stable decision environments.
Portfolio optimization	AI enhances asset allocation and risk-adjusted returns.	Shift in trader skills and workflows.
Market efficiency	AI improves liquidity and price discovery.	Increased governance requirements.
Performance metrics	AI improves speed, accuracy, and returns.	Higher trust and adoption.
Adaptive learning	AI systems learn continuously from market data.	Transparency and accountability concerns.

Sources from ROL analysis

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b) ***Scoping Review***

The scoping review effectively fills the evidence gap by consolidating findings that demonstrate AI's consistent impact on decision-making efficiency, market performance, & institutional trust across financial markets.

2. Role of AI in Risk Management, Fraud Detection & Market Stability

(Liang, P., 2024) AI's integration into RegTech leverages machine learning & natural language processing which automates rule interpretation, transaction screening, & reporting which improves compliance monitoring speed, accuracy. (Danielsson & Uthemann, 2025) AI has influenced financial stability by enhancing risk assessment & information processing for efficiency. It helps detect anomalies, strengthens cybersecurity, which helps with balancing & risk. (Babu et al, 2024) Machine learning models detect cybersecurity threats in financial institutions by identifying anomalies and monitoring vulnerabilities. AI-based systems also offer faster, more accurate, & more adaptive protection than traditional frameworks do, enhancing financial infrastructure resilience.(Yang, X., et al., 2025)

(Alliata et al, 2025) AI-driven analysis of the S&P 500 using OLS, Poisson, & GARCH models shows that AI-based trading can increase volatility & trigger extreme price jumps, especially during turbulent periods. This highlights that AI's dual stabilizing.(DSEF, 2025) When comparing the emerging & developed markets, it shows AI-drive algorithmic trading stabilizes developed markets but it increases volatility in emerging ones, reflecting structural, institutional, & regulatory differences affecting market stability. (Gurgul et al, 2025)

3. Technology & Human Integration Gap

Based on the review of literature, a clear technology & human integration gap emerges regarding the integration of Artificial Intelligence with human decision-making, particularly in understanding how human–technology interaction influences risk management effectiveness & financial market stability.

FML Dimension	Key Evidence	STS Perspective
AI-driven decision-making efficiency	AI systems enable rapid identification of fraud, credit risk, and compliance violations across large-scale financial data.	Human–technology interaction shifts from manual monitoring to AI-assisted decision support.
Predictive modeling and financial forecasting	Machine learning models improve prediction of credit defaults and risk exposure compared to traditional methods.	Organizational and institutional integration of AI strengthens risk planning processes.
Risk management and anomaly detection	AI detects fraudulent transactions, cyber threats, and abnormal patterns with high accuracy and speed.	Risk, stability, and systemic behavior depend on effective coordination between humans and AI systems.
Indicator-based quantitative evaluation	AI models use accuracy scores, AUC-ROC, and anomaly indicators to evaluate financial risk and fraud detection performance.	Ethical control and accountability are required to validate and interpret AI-generated indicators.

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Market performance and efficiency measurement	AI improves efficiency in risk assessment and information processing but may intensify systemic risk if unchecked.	Regulatory and governance influence is essential to manage AI-driven market behavior.
Data-driven model learning and adaptation	AI systems continuously learn from transaction and market data to enhance fraud and risk detection.	Transparency and social acceptance depend on explain ability and responsible AI use.

b) Thematic Review:

The thematic review largely fills the technology–human integration gap by showing how AI & human oversight jointly shape effective risk management, though continued attention to transparency & governance remains necessary.

2. To assess the impact of AI based algorithmic & high-frequency trading on market volatility & liquidity under varying market conditions.

(Bhatia, 2024) Machine learning classification on high-frequency liquidity data improves prediction of minute-level liquidity conditions, demonstrating AI's effectiveness in analyzing HFT-dominated markets. Ganesh Marimuthu (2025AI-driven algorithmic trading in forex enhances liquidity, execution efficiency. (Marimuthu, G., 2025)

(Malik, A., et al., 2025) AI-driven algorithmic trading has helped enhance global market efficiency by increasing price discovery & narrowing bid-ask spreads, though this, short-term volatility may rise during economic uncertainty. Kumar shows us that AI-driven algorithmic trading in India boosts liquidity & speeds execution, while short-term volatility. (Kumar, R., 2025) Mathematical modeling shows AI-driven high-frequency trading enhances liquidity via deeper order books, but market stress can trigger withdrawals, systemic risk. (Zhang, Y, 2025).

a) ***Systematic Gap***

Based on the systematic review of literature, a systematic gap emerges in explaining how the liquidity-enhancing benefits of AI-based algorithmic & high-frequency trading translate into stable market outcomes across different market conditions, particularly during periods of stress & heightened volatility.

Thematic Area	Key Evidence	FML Perspective	STS Perspective
Liquidity enhancement	AI-driven trading increases order book depth, volume, & tighter bid–ask spreads.	Algorithmic & high-frequency trading analytics; Market performance, efficiency measurement	Risk, stability, & systemic behavior
Liquidity prediction	ML models improve minute-level liquidity forecasting in HFT-dominated markets.	Predictive modeling, financial forecasting; Indicator-based quantitative evaluation	Organizational & institutional integration

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Market efficiency	AI accelerates price discovery, information incorporation into prices.	AI-driven decision-making efficiency; Market performance & efficiency measurement	Social acceptance & user satisfaction
Stress-condition liquidity	HFT withdraws liquidity under market stress, amplifying instability.	Indicator-based quantitative evaluation	Ethical control & accountability
Governance implications	Increased reliance on AI trading raises oversight & control concerns.	Algorithmic & high-frequency trading analytics	Regulatory & governance influence

Sources from ROL analysis

b) ***Systematic Review***

This systematic review substantially advances the field by synthesizing existing evidence on AI- based algorithmic trading & market dynamics; however, context-specific stability effects & governance mechanisms remain areas for further investigation.

Research Methodology:

This study adopts an applied research approach, employing a mixed-methods strategy to thoroughly investigate the impact of AI on financial markets. By combining qualitative analysis of secondary data with quantitative indicators, the research provides a comprehensive understanding of AI's influence on decision-making efficiency, risk management, market volatility, & liquidity, effectively addressing the stated objectives.

1. ***Research Design***

The study adopts a Descriptive & Comparative Research Design, grounded in the Financial Machine Learning framework (Marcos López de Prado). This study evaluates the impact of AI on financial markets by comparing AI set practices with traditional methods. It employs qualitative analysis of secondary data, including regulatory reports & academic research, alongside indicator-based measures to assess efficiency, risk management, market volatility & liquidity. The research enhances understating of AI's transformative role while ensuring rigorous validation & reducing bias in interpreting market dynamics.

2. ***Data Collection***

This study adopts a descriptive & comparative research design to investigate the transformative impact of AI on financial markets. The research aims to assess AI's role in enhancing decision- making efficiency, improving financial predictions, strengthening risk management, & influencing market stability.

3. ***Primary Data***

Primary data will be collected through a structured questionnaire administered to 30 respondents, including investors, traders. The questionnaire is designed to capture participants' perceptions of AI's effectiveness in trading decisions, portfolio management, fraud detection, risk mitigation, & market dynamics. Responses will be measured on a Likert scale ranging from "Strongly Agree" to "Strongly Disagree," allowing for nuanced evaluation of AI's impact in real-world financial settings.

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4. ***Secondary Data***

Secondary data is sourced from research articles, industry reports, regulatory publications, & authoritative financial databases. As its act as an additional-sources for understanding the trend in the financial market.

5. ***Underpinning Theories***

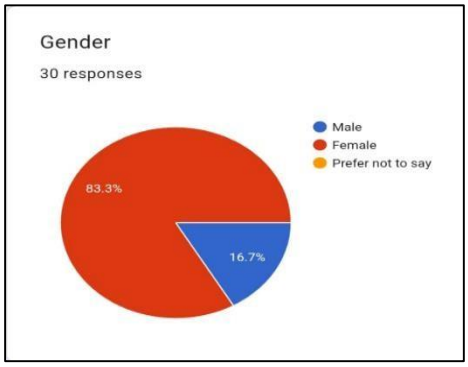
The Socio-Technical Systems theory looks at financial markets as a blend of technology, human participants, organizations, & institutions interacting with one another. It sees AI as a powerful force that's changing how decisions are made, how roles are defined, & how governance, trust, & accountability are structured.**Data Analysis Demographic respondents:**

Gender

Majority of the respondents are male (83.3%), (16.7%) are female, & the rest preferred not to disclose their gender.

Gender	No of Responses
Male	83.3%
Female	16.7%
Prefer not say	0

Figure 1 Gender Pie Diagram



This sample shows significant male dominance, which indicates a gender imbalance that may influence study results & overall interpretation of reliability.

6. ***Age Group***

Most of the respondents belong to the 18–24 age group (83.3%), followed by 25–34 (10%) & 35–44 (6.7%) participants.

Age Group	Responses
18-24	83.3%
25-34	10%
35-44	6.7%
Above 45	0

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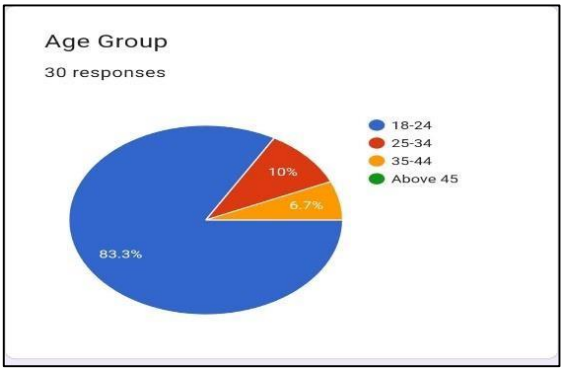


Figure 2-Age Group Pie Diagram

The sample is highly youth-dominated, which indicates results mainly reflect perspectives of young adults rather than older age groups.

7. Acceleration of Trading Decisions Through AI

30 respondents indicate AI accelerates trading decisions, enhances system responsiveness, indirectly influences workflows, human interaction, & adaptive market practices.

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
AI improves the speed of decision-making in financial markets	45%	40%	10%	3%	2%
AI enhances the overall efficiency & performance of financial markets	35%	40%	18%	5%	2%
AI-driven predictive analytics provide more accurate market forecasts than traditional methods	30%	40%	20%	7%	3%

AI helps enhance forecast reliability, guides informed trading decisions, & indirectly impacts the workflows, & strategic market operations.

8. Trends & Impacts of Artificial Intelligence on Financial Market Operations

AI adoption has progressively improved the financial decision-making efficiency as well as predictive analytics, which has been indirectly influencing organizational processes, workflows,.

Year	**Indicator**	**Qualitative Insight**
2024	Decision autonomy	Autonomous AI systems can now execute portfolio adjustments & strategic allocations with minimal human oversight which has significantly improved responsiveness.
2023	Strategic integration	AI embedded within executive-level financial strategy influences capital allocation & forecasting models.
2022	Real-time analytics	Continuous AI-based monitoring has enabled instant reaction to the market signals & macroeconomic triggers.

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2021	Predictive decisions	Shift toward anticipatory machine learning models for volatility & liquidity forecasting.
2020	Crisis response	AI had supported liquidity modeling & stress testing during COVID-19 volatility.
2019	Automation level	Automation has helped reduce manual investment screening workload.
2018	Market efficiency	AI improved the speed of price discovery in markets.
2017	Data processing	Alternative data integration has enhanced decision depth.
2016	Decision speed	Machine learning helped reduce financial analysis time.
2015	AI decision support	AI has primarily supported human analysts in advisory roles.

AI enhances market responsiveness, operational efficiency, forecasting, indirectly transforming financial practices, decision processes, & adaptive strategies.

9. AI-Driven Performance & Financial Outcomes Across Industries.

AI adoption has shown measurable improvements in decision-making speed, accuracy, & revenue, which have been indirectly influencing workflows & organizational performance.

Indicator	**Quantitative Insight**
Decision-Making Speed	33% improvement shown in managerial decision speed
Decision Accuracy	33% higher decision accuracy with AI vs 21% without AI
Productivity & Efficiency	32% faster decision-making, 27% higher employee output
Market ROI Performance	3.7× return on investment (ROI)
Revenue Growth	41% revenue increase, 32% lower customer acquisition costs
Cost Efficiency	44% of companies report cost reduction
Market Competitiveness	50% higher EBIT growth among top AI adopters
Executive Decision Adoption	56.2% of businesses have adapted AI for decision-making improvement
Enterprise Decision Performance	93% of firms report faster & clearer managerial decision processes because of AI
Economic Market Impact	$2.6–$4.4 trillion estimated annual contribution to global productivity & business value

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A) ***Perception of Artificial Intelligence in Financial Risk Detection & Management***

AI has been increasingly used in financial markets for fraud detection & risk management. The following findings summarize respondents' perceptions regarding its benefits & potential risks.

Question	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
AI is effective in detecting financial fraud & abnormal transactions	40%	42%	12%	5%	1%
AI-based risk management systems help in reducing financial uncertainty & losses	35%	45%	15%	5%	2%
Excessive reliance on AI may increase systemic risk in financial markets	15%	20%	30%	25%	10%

Some respondents express concern that excessive reliance on AI may increase systemic financial risk.

B) ***Perceptions of AI Market Impact PERCENTAGE ANALYSIS***

Most respondents agree that AI trading increases liquidity (68%), raises short-term volatility (60%), & can cause sudden market fluctuations (60%). Additionally, 78% believe AI will dominate future financial markets.

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
AI-based algorithmic trading increases market liquidity	30%	38%	20%	8%	4%
High-frequency trading powered by AI contributes to short-term market volatility	28%	32%	25%	10%	5%
AI-driven trading systems can cause sudden market fluctuations or crashes	25%	35%	25%	10%	5%
Artificial Intelligence will play a dominant role in the future of financial markets	40%	38%	15%	5%	2%

AI trading has a dual impact: it improves market efficiency & liquidity while also increasing short-term instability & systemic risk.

Hypothesis Testing:

1. AI improves the speed of decision-making in financial markets.

Participants perceive that AI accelerates decision-making, improves system responsiveness, as well as subtly reshapes workflows & adaptive trading practices. H_0 There is no significant impact of Artificial Intelligence on the speed of decision-making in financial markets, & the median response is equal to the neutral value

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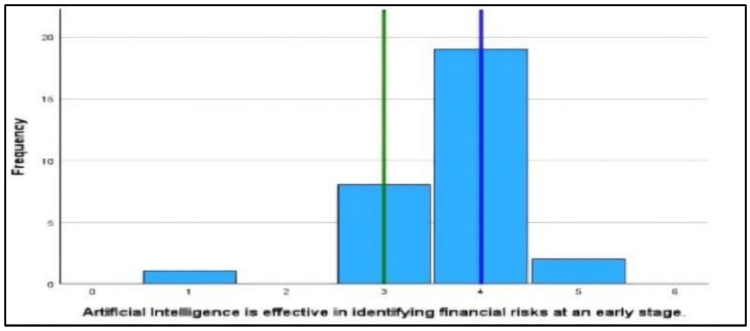
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H_1 There is a significant impact of Artificial Intelligence on improving the speed of decision- making in financial markets, & the median response differs significantly from the neutral value

Table 1One-Sample Wilcoxon Signed Rank Test Summary	
Total N	*30*
Test Statistic	351.000
St&ard Error	37.858
St&ardized Test Statistic	4.636
Asymptotic Sig.(2-sided test)	<.001

Based on 30 respondents, AI significantly accelerates decision-making ($p < 0.001$), enhancing efficiency, workflows, human interaction, & adaptive trading practices.

Figure 3-One Sample Wilcoxon Signed Ranking. Test Forecasting



The chart shows most participants rated above neutral, with the observed median higher, confirming AI significantly improves decision-making speed.

1. ***Artificial Intelligence is effective in identifying financial risks at an early stage.***

H_0 Artificial Intelligence does not significantly improve fraud detection & abnormal transaction monitoring in financial markets, & the median response is equal to the neutral value .H_1 Artificial Intelligence significantly improves fraud detection & abnormal transaction monitoring in financial markets, & the median response differs significantly from the neutral value Responses are significantly above neutral, suggesting positive perception of AI in improving fraud detection & transaction monitoring.

Table 2one - sample wilcoxon sighed rank test summary	
Total N	30
Test Statistic	232.000
St&ard Error	28.386
St&ardized Test Statistic	3.717
Asymptotic Sig.(2-sided test)	<.001

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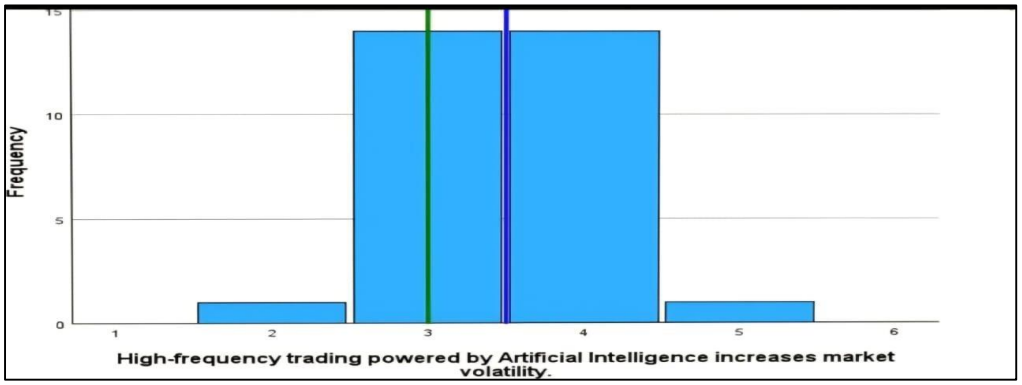
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Wilcoxon test indicates a statistically significant difference ($p < .001$), showing strong support for AI effectiveness in financial risk detection.This image shows Most participants selected ratings above three, indicating strong positive perception of AI in early financial risk identification.

Figure 4One Sample Wilcoxon Signed Ranking. Test Forecasting



Observed median exceeds neutral value, with responses significantly clustered toward agreement on AI effectiveness in financial risk detection.

Summary of findings:

The study finds that AI significantly enhances forecasting accuracy, risk detection & financial market performance. It also improves liquidity in high-frequency trading but increases symmetric risk & short-term volatility.

Conclusion:

The study concludes that ai act as a transform to force in the financial market with efficiency, performance gaining but regulatory challenges persist, which required balance conditioning, human oversight.

Suggestion:

The study recommends that adopting AI helps in decision making process with robust human- oversight as it's strengthened-governance, control risk whereas AI training & ethics ensure efficiency & stability & trust in financial market

Future scope:

The future research should explore large sample size cross market analysis focusing on AI & human integration ethical compliance in announcing financial stability & regulatory trust

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A STUDY ON STUDENTS' PERCEPTION OF STARTUP FAILURE AND RISK.

* *Ms. Mamta Yadav , **Khushi Tiwari,**** Neha Yadav & ****Prathamesh Suryavanshi*

*

Abstract:

In years startups have become a popular career choice for students. However, many students are still hesitant to start their businesses. One of the reasons for this is the fear of failure and the perceived risk of starting a business. Student's views on startup failure are influenced by factors, including financial risk, lack of knowledge and experience social and family pressure and concerns about future career stability. These views play a role in shaping their entrepreneurial intentions and decision-making.

This study aims to examine the students' perceptions of startup failure and risk factors and how these perceptions affect their attitudes towards entrepreneurship. By identifying whether fear of failure and perceived risk act as barriers or motivators the research seeks to understand the mindset among students. The findings are expected to provide insights for academic institutions and policymakers in developing effective entrepreneurship education and support systems.

Keywords*: Start-ups, Students, Business, Failure, and Risk.*

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Introduction:

Startups are now a key part of how economies grow, come up with new ideas, and create jobs, especially in countries like India that are still developing. As the environment for startups gets better and governments launch initiatives like Startup India, more and more students are thinking about becoming entrepreneurs as a real career choice.

Schools and universities are also doing their part by promoting new ideas, setting up incubators, and teaching skills to help young people think like entrepreneurs. This is aiding to create a new generation of innovators and business leaders who can drive growth and create jobs. By supporting startups and encouraging entrepreneurial thinking, we can unlock new opportunities for economic growth and development, and aid young people in achieving their full potential.

Many students are still unsure about starting their own businesses, even with all the opportunities available. One big reason for this is the fear of failing and the idea that starting a business is very risky. Failing at a startup is something that happens a lot when people try to be entrepreneurs. While failing can be a great way to learn, people often see it as a bad thing because of the potential financial losses, what others might think, uncertainty about their career, and the stress it can cause. But it's worth noting that failure can also be a valuable experience

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that can help people learn and grow. By embracing this mindset, students can begin to see failure as an opportunity for growth, rather than something to be feared.

This can help them feel more confident about taking the leap and starting their own ventures. How students think about failure is really important when it comes to deciding if they want to start their own

business. If they see failure as a way to learn and get better, they're more likely to be brave and confident. But if they think failure is bad and will make them feel insecure or unstable, they'll be less willing to take the risk of starting a business. It's all about how they look at failure - is it a chance to develop or a reason to be afraid?

When it comes to starting your own business, how you think about risk is a big deal. Being an entrepreneur means taking on lots of different kinds of risks - like financial risks, market risks, career risks, and social risks. Students often think carefully about these risks before contemplating if they want to be an entrepreneur. If they think the risks are too high, they might be less likely to start their own business. But if they have a good understanding of the risks, they can make smart plans and informed decisions.

This can help them navigate the challenges of starting a business and make the most of the opportunities. By understanding the risks, entrepreneurs can be better prepared to handle the ups and downs of startup life and make their businesses more successful. It's really important to learn how students think about startup failures and risks, because this can help us figure out if they're ready to join the startup world.

This research looks at how students' views on startup failures, the risks they see, their fear of failing, and their desire to become entrepreneurs are all connected. By understanding whether these views hold them back or push them forward, we hope to help create a supportive environment in schools and in policy that encourages a positive and realistic view of starting a business. This can help students feel more confident and prepared to take on the challenges of entrepreneurship

Significance of the Study:

This research is really important because it looks at how students think about failing at startups and what factors make them worried, and how that affects their desire to become entrepreneurs. In India, where startups are becoming more popular, a lot of students are held back from starting their own businesses because they're scared of failing, losing money, and what others might think. By understanding what's going on in their minds, schools and people making policies can create better programs to teach entrepreneurship, provide support, and raise awareness. This study also helps us learn more about how students' thoughts on startup failure impact their decisions to become entrepreneurs, which adds to what we already know from academic research.

Limitations of the Study:

- The study is limited to a specific sample of students and may not represent all regions.
- Data is based on self-reported responses, which may include personal bias.
- The research focuses only on perception and intention, not actual entrepreneurial behaviours.
- Time constraints may limit the depth of analysis

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Research Problem:

Although startups are increasingly promoted as a promising career option, many students remain hesitant to pursue entrepreneurship due to fear of failure and perceived risks. Factors such as financial uncertainty, lack of experience, social and family pressure, and concerns about career stability may significantly influence their entrepreneurial intention. There is a need to learn how students perceive startup failure and various risk factors, and how these perceptions affect their attitudes and decision- making toward entrepreneurship. Hence, this study seeks to analyse the influence of perceived startup failure and risk on students' entrepreneurial intention.

Objectives of the Study:

1. To study students' perception of startup failure.
2. To analyse students' perception of risk involved in startups.
3. To examine the impact of fear of failure on students' entrepreneurial intention.
4. To identify major risk factors influencing students' startup decisions.
5. To suggest measures to reduce fear and negative perception of startup failure.

Hypothesis:

H1 There is a significant relationship between students' perception of startup failure and their entrepreneurial intention.

H2 Students' perception of risk involved in startups has a significant impact on their willingness to start a new venture.

H3 Fear of startup failure has a significant negative effect on students' entrepreneurial intention

H4 Perceived risk factors (financial risk, market uncertainty, lack of experience, and social pressure) significantly influence students' startup decision-making.

Review of Litreature:

In the study of "Keys Factors Contributing to Startup Failure in the Early Stage. *International Journal of Engineering and Management Research*" by 'Thakur G' Startup failure is often portrayed as mysterious or unpredictable, but the underlying causes are surprisingly common and preventable. Whether it's building a product no one wants, running out of money, or failing to adapt, most startup failures follow recognizable patterns. This research has shown that the key to avoiding these traps lies in market validation, sound financial planning, a strong team, and a willingness to adapt. For entrepreneurs who take these lessons seriously, the odds of building a sustainable business improve dramatically.

In the study of "Fear of Failure and Entrepreneurial Risk Perception" by 'Nabiha Nefzi' it was suggested that students revealing higher trait fear of failure with appraisal tendencies of uncontrollability and uncertainty manifested important entrepreneurial risk perception. So, institutions boosting entrepreneurship should fix attention on the determinants of certainty and controllability. (Nefzi, 10.2478/ijek-2018-0013)

The study of "Fear of failure and Entrepreneurial intentions in University Students" by 'Mutmainnah' uncovers a significant negative relationship between the fear of failure and the intention for entrepreneurship. It

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demonstrates that reducing the fear of failure can notably increase the likelihood of pursuing entrepreneurial ventures, suggesting that overcoming this fear is crucial for entrepreneurial success. The findings align with international research, highlighting fear of failure as a important factor in the decision-making process of potential entrepreneurs. (Mutmainnah, 2024)

Research Methodology:

1. Research Approach – The study is based on a quantitative research approach to measure and analyse students' perceptions using numerical data.
2. To understand how students think about startup failure and risk, and how these thoughts affect their desire to become entrepreneurs, a research design was used that looked closely at the details. This design was a mix of describing what students thought and analysing how their thoughts impacted their choice to start their own businesses.
3. The study gets its information mainly from primary data, which was collected directly from the people being studied through a questionnaire that had a set format.
4. To gather the necessary information, a carefully designed questionnaire was created, featuring statements that explored people's views on startup failure, their perceived risk, fear of failing with a startup, and the factors that contribute to risk.
5. We used a convenient sampling method to pick the people we wanted to talk to, basically just choosing those who were easy to reach and available at the time.
6. The study included a total of 100 students, which made up the entire sample size.
7. Measurement Scale – Responses were given value using a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree.
8. Here's what we're looking at in this study: the things that can affect the outcome, or independent variables, are how people think about startup failure, how much risk they think is involved, their fear of failing, and other factors that might influence their decisions. The outcome we're trying to measure, or dependent variable, is whether or not someone wants to become an entrepreneur.
9. To look at the numbers, we used some statistical tools. We calculated percentages, averages, and variances to understand of what was going on. We also used a test called ANOVA, which helps us see if there are any differences between groups of data. This was all done to test our hypotheses and understand how the variables interact with each other.

Data Analysis:

Regression nd Correlation:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.712[a]	.507	.491	1.22699

a. Predictors: (Constant), Fear_Failure, Perception_Failure, Perceived_Risk

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The results of the model summary reveal how well the regression model performs in understanding what drives people to become entrepreneurs. It looks at how strong the connection is between the different factors that influence someone's decision to start their own business and their actual intention to do so. The R value gives us an idea of how closely these factors are related, while the R Square value tells us what percentage of the variation in entrepreneurial intention can be explained by looking at how people perceive failure, their perceived risk, and their fear of failing. The Adjusted R Square gives a more precise estimate, taking into account the number of factors being considered. Overall, the model does a good job of explaining why people might want to become entrepreneurs, which means it's a decent fit. This suggests that the factors we're looking at, such as perception of failure, perceived risk, and fear of failure, really do play a significant role in shaping someone's intention to start their own business.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	148.462	3	49.487	32.871	<.001[b]
	Residual	144.528	96	1.506		
	Total	292.990	99			

a. Dependent Variable: Entrepreneur_Intention

b. Predictors: (Constant), Fear_Failure, Perception_Failure, Perceived_Risk

The ANOVA table tests whether the overall regression model is statistically significant. It examines whether Perception of Failure, Perceived Risk, and Fear of Failure collectively have a significant effect on Entrepreneurial Intention. Since the significance value (p-value) is less than 0.05, the model is statistically significant, meaning the independent variables together significantly predict entrepreneurial intention and regression model is valid.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.280	1.101		.254	.800
	Perception_Failure	.203	.047	.321	4.301	<.001
	Perceived_Risk	.178	.053	.286	3.337	.001
	Fear_Failure	.204	.039	.448	5.257	<.001

a. Dependent Variable: Entrepreneur_Intention

The Coefficients table shows the individual impact of each independent variable on Entrepreneurial Intention. The results indicate that Perception of Failure, Perceived Risk, and Fear of Failure all have positive and statistically significant effects ($p < 0.05$), meaning each variable independently influences entrepreneurial intention. Among them, Fear of Failure has the strongest impact based on the highest standardized Beta value. The constant is not significant, indicating it does not meaningfully contribute to the model. Overall, all predictors significantly affect entrepreneurial intention.

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HYPOTHISES TESTING

H1: There is a significant relationship between students' perception of startup failure and their entrepreneurial intention.

SUMMARY							
Groups				*Count*	*Sum*	*Average*	*Variance*
Startup failure is a normal part of the entrepreneurial journey.				100	371	3.71	0.753434
Learning from failure motivates me to become an entrepreneur.				100	389	3.89	0.644343
Failed startup provides valuable learning experience.				100	399	3.99	0.777677
I feel confident in handling failure in a startup				100	347	3.47	0.756667
My intention to start a business remains strong despite the risk of fail				100	372	3.72	0.850101
ANOVA							
Source of Variation	*SS*	*df*	*MS*	*F*		*P-value*	*F crit*
Between Groups	15.792	4	3.948	5.219154		0.0004	2.389948
Within Groups	374.44	495	0.756444				
Total	390.232	499					

Source: Primary Data

The outcome of the statistical analysis shows that the initial assumption, or null hypothesis, can be ruled out with a certain level of confidence, specifically at a 5% significance level.

As a result, we accept the alternative hypothesis, which suggests that there is a statistically significant difference or relationship present in the data being studied. It turns out that how students think about startup failures has a big impact on whether they want to start their own business. Whether students view failure as a normal part of the process, something to learn from, and even a motivator, they're more willing to keep their dreams of entrepreneurship alive.

In other words, students who don't fear failure, but instead see it as a valuable learning experience, are more likely to stay committed to their entrepreneurial goals. Hence, it can be concluded that a positive perception of startup failure significantly influences and strengthens entrepreneurial intention among students.

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H2: Students' perception of risk involved in startups has a significant impact on their willingness to start a new venture.

SUMMARY						
Groups				*Count*	*Sum*	*Average*	*Variance*
High financial risk reduces my willingness to start a startup.				100	340	3.4	0.787879
Startup related risk make entrepreneurship less attractive to me				100	297	2.97	0.938485
Market uncertainty affects my decision to start a startup.				100	341	3.41	0.688788
I would consider starting a business only if the risk is low				100	308	3.08	1.084444
Risk plays an important role in my career decision making.				100	376	3.76	0.689293
ANOVA							
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*		*F crit*
Between Groups	38.812	4	9.703	11.58183	5.36E-09		2.389948
Within Groups	414.7	495	0.837778				
Total	453.512	499					

Source: Primary Data

The outcome of the analysis shows that we can't support the idea that there's no difference, so we're going to go with the other idea, which is that there is a difference.

This is because our test results tell us that the difference is statistically significant, meaning it's unlikely to happen by chance. This confirms that students' perception of risk involved in startups has a statistically significant impact on their willingness to start a new venture.

The findings suggest that factors such as financial risk, market uncertainty, and overall startup-related risks influence students' entrepreneurial decisions. Hence, it can be seen that risk perception plays a significant role in determining students' willingness to engage in entrepreneurial activities.

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H3: Fear of startup failure has a significant negative effect on students' entrepreneurial intention.

SUMMARY

I avoid entrepreneurship because I am afraid of falling.					100	266	2.66	1.054949
Fear of losing money stops me from becoming an entrepreneur.					100	315	3.15	1.138889
I worry about social judgment if my startup fails.					100	269	2.69	1.084747
Fear of failure makes me choose safer career options.					100	317	3.17	0.910202
Fear of failure negatively affect my entrepreneurial mindset.					100	291	2.91	1.072626
ANOVA								
Source of Variation	*SS*	*df*		*MS*	*F*		*P-value*	*F crit*
Between Groups	23.592		4	5.898	5.604957		0.000203	2.389948
Within Groups	520.88		495	1.052283				
Total	544.472		499					

Source: Primary Data

The results of the ANOVA test tell us that the null hypothesis is rejected at the 5% level of significance. Henceforth, the alternative hypothesis (H3) is accepted.

This confirms that fear of startup failure has a statistically significant negative effect on students' entrepreneurial intention. The findings suggest that fear of losing money, social judgment, and concern about failure influence students' career choices and reduce their inclination toward entrepreneurship.

So, it seems that being afraid of failing can really hold students back from thinking like entrepreneurs and starting their own businesses. This fear can basically stop them from taking the leap and trying to turn their ideas into reality.

H4: Perceived risk factors (financial risk, market uncertainty, lack of experience, and social pressure) significantly influence students' startup decision-making.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Lack of experience discourage me from starting a business	100	324	3.24	1.073131
Social pressure affects my decision to pursue entrepreneurship.	100	285	2.85	0.997475
Family expectations influence my startup related decision.	100	330	3.3	1.060606
Lack of proper guidance affect my startup planning	100	357	3.57	0.873838
Combined risk factors reduce my intention to start a startup.	100	321	3.21	0.894848

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ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	26.532	4	6.633	6.768507	2.61E-05	2.389948
Within Groups	485.09	495	0.97998			
Total	511.622	499				

Source: Primary Data

The outcome of the analysis of variance test shows that we can reject the idea that there's no difference, and this happens at a point where we're 95% sure it's not just a coincidence.

So, we're going to go with the other idea, the one that says there really is a difference, and this is what we call the alternative hypothesis, or H4 for short. This confirms that perceived risk factors such as financial risk, market uncertainty, lack of experience, social pressure, family expectations, and lack of proper guidance significantly influence students' startup decision-making.

The findings suggest that these combined risk factors affect how students evaluate entrepreneurship as a career option. Hence, it can be concluded that perceived risks play a significant role in shaping students' decisions regarding starting a new venture.

Remedies:

- Make entrepreneurship learning more practical so students can actually experience how businesses work, not just study theory.
- Invite entrepreneurs to honestly share their failure stories so students understand that setbacks are normal and not the end of a their career.
- Teach students basic money management and risk-handling skills so financial fear does not stop them from trying.
- Provide supportive mentors who can guide students and clear their doubts during the early stages of planning a startup.

Conclusion:

This study shows that how students think about startup failure and risk plays a very important role in shaping their entrepreneurial intention. When students see failure as a learning experience and a normal part of the entrepreneurial journey, they are more likely to remain confident and willing to start their own ventures. On the other hand, fear of failure, financial risk, social pressure, and lack of guidance can reduce their willingness to take entrepreneurial risks.

The findings clearly indicate that perception of failure, perceived risk, fear of failure, and other risk factors significantly influence students' decision-making regarding startups. Therefore, creating a supportive environment through proper guidance, training, mentorship, and awareness can help reduce fear and build a more positive mindset toward entrepreneurship among students.

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INNOVATION MEETS REGULATION: CONSUMER PROTECTION DIMENSIONS OF FUTURISTIC DIGITAL STARTUPS UNDER CPA, 2019

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Abstract:

India's consumer marketplaces have changed due to the rapid growth of forward-thinking digital businesses. The efficiency, accessibility, and relief of consumer life have all been improved by fintech applications, educational services, health care technology solutions, e-commerce platforms, and platform-based digital intermediaries. However, this technological advancement has also led to complex consumer protection challenges, including deceptive advertising, unfair trade practices, algorithmic discrimination, data manipulation, and privacy infringement. an ineffective grievance redressal procedure and a lack of openness. With the passage of the Consumer Protection Act, 2019, which also addresses new issues with the digital marketplace, India's consumer protection laws were modified. This study employs a mixed technique approach and a descriptive research design. Secondary data was simultaneously presented in journals and legal provisions.

Keywords: *Consumer Protection Act 2019, Digital startups, E-commerce regulations, Consumer rights*

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Introduction:

As a result of digital transformation, India's economic environment has changed. The rise of digital businesses has changed service delivery techniques and marketing strategies and customer participation. Consumers now have access to banking services, medical visits, educational programs, and online shopping. Even if these advancements increase efficiency and accessibility, knowledge asymmetry and technical complexity expose them. The majority of accepted consumer protection laws were created for actual transactions and tangible indexes. On the other hand, digital marketplaces are impacted by automated algorithms, artificial intelligence, and cross-border data flow. In response to these changing circumstances, the Consumer Protection Act, 2019 replaced the previous 1986 Act with provisions for e-commerce, product responsibility, unfair contracts, and the creation of the Central Consumer Protection Authority (CCPA).

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1. **Statement of the Problem:**

   Laws have been improved, however there are still many mistakes in digital consumer protection. Predatory pricing methods, undisclosed fees, false reviews, delayed refunds, and incorrect data sharing are commonplace for customers. Algorithm-based pricing and targeted advertising are the root causes of transparency problems. Additionally, cross-border transactions make it more difficult to enforce jurisdiction. It is crucial to evaluate if the Consumer Protection Act of 2019 resolves these problems of the digital era without impeding advancement.

2. **Significance of the Study:**

   This research is essential because it helps us comprehend the relationship between technological innovation and regulatory control. It evaluates if the 2019 Consumer Protection Act guarantees accountability, equity, and openness in online marketplaces. The result gives consumers, business owners, and legislators a clearer understanding of their rights and obligations in their digital environment.

3. **Limitations of the Study:**

   The survey only included 61 respondents from the KDMC region, which might not accurately reflect the situation nationwide. Time and money constraints made it impossible to gather more thorough data. Furthermore, the rapid advancement of technology may lead to new external challenges that fall under the purview of this enquiry.

Objectives of the Study:

1. To assess the level of consumer awareness about the Consumer Protection Act, 2019 among digital service users.
2. To examine the extent of compliance by digital startups with e-commerce disclosure norms under CPA, 2019.
3. To identify the nature and frequency of unfair trade practices and misleading advertisements experienced by consumers on digital platforms.
4. To analyze the relationship between digital service usage frequency and consumer awareness of protection rights

Review of Literature:

Particularly in light of the existing Indian legislative environment, the convergence of digital innovation and consumer protection has assumed vital significance as an area of empirical enquiry. The Government of India passed the Consumer Protection Act, 2019, an unprecedented piece of legislation intended to close the regulatory gaps left by its predecessor in light of the current state of digital commerce (Government of India, 2019). According to Kumar's (2020) critical evaluation of the current state of consumer protection, the existing legal framework was "structurally not equipped to handle the asymmetric information framework, data-based business models, and cross-border transactions that characterise the contemporary digital startups."

The researcher's analysis shows that although the Consumer Protection Act, 2019 has sparked paradigm shifts by incorporating cutting-edge innovations like the regulation of e-commerce, the formulation of direct selling guidelines, and the creation of the Central Consumer Protection Authority (CCPA), the legislative situation is

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still not ideal. This highlights the fact that the legislative intent behind the Consumer Protection Act, 2019, while significant, is more aspirational with regard to futuristic digital startups.

In a groundbreaking analysis of algorithmic accountability in the context of Indian consumer law, Verma (2023) shows how AI recommendation engines, pricing algorithms, and decision-making used by digital startups because irreversible harm to consumers under the Consumer Protection Act, 2019.Thus, the literature reveals a threefold comprehensive research gap.

First off, empirical research on the operational compliance or non-compliance of Indian digital startups with the Consumer Protection Act, 2019 in the context of settings mediated by algorithms is lacking in the literature. Second, studies that have mapped the legal and definitional gaps in the Consumer Protection Act of 2019 in the context of futuristic startup models are not presented in the literature. Thirdly, the main contribution of the suggested analysis—the prescriptive framework that strikes a compromise between the necessity to safeguard startup innovations in the context of the Consumer Protection Act, 2019—is not presented in the literature. Refereed academic publications like Kumar (2020), Sharma (20121), Singh (2022), and Verma (2023) as well as Central Consumer Protection Authority (CCPA) regulations will serve as secondary sources of data. The normative basis for this research will be produced by the doctrinal method of research, which will allow the researcher to examine the current legal framework and its applicability to new business models that have emerged in response to technological advancements, such as algorithmic business, block chain technology, and artificial intelligence. While previous studies (Sharma 2021; Kumar 2020) focus on traditional e-commerce and the applicability of the Consumer Protection Act, 2019, Verma's (2023) study partially but not fully addresses algorithmic responsibility. While previous studies (Sharma 2021; Kumar 2020) focus on traditional e-commerce and the applicability of the Consumer Protection Act, 2019, Verma's (2023) study partially but not fully addresses algorithmic responsibility. By examining whether the Consumer Protection Act of 2019 is structurally prepared to handle these next-generation developments, the study aims to close this gap.

Research Methodology:

The study uses a mixed method approach in conjunction with a descriptive research design. Structured questionnaires were used to gather primary data from 60 respondents who were chosen by simple random sampling. Government reports, legal texts, and scholarly journals were the sources of secondary data. ANOVA was used for data analysis in order to test hypotheses and assess the connections between consumer perceptions and regulatory restrictions. For the purposes of this study,

a doctrinal and analytical research methodology will be used to evaluate the Consumer Protection Act of 2019 through statutory analysis and legal interpretation of the major source of law.

Data Analysis and Interpretation:

1. **Hypothesis of the Study:**

   H0: There is no significant relationship between e-commerce rules under CPA, 2019 and accountability of digital startups.

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H1: There is a significant relationship between e-commerce rules under CPA, 2019 and accountability of digital startups.

Source of Variations	SS	df	MS	F	P-value	F crit
Gender (Rows)	4.12	1	4.12	4.85	0.031	4.02
Perceptions/Awareness (Columns)	12.45	1	12.45	14.65	0.0002	4.02
Interactions	1.08	1	1.08	1.27	0.264	4.02
Error (Within)	100.3	118	0.85			
Total	118	121				

Source: *Primary data collected through Google forms questionnaires.*

a. The P-value for Gender is 0.031, which is less than the standard significance level of 0.05. This suggests that there is a statistically significant difference in how males and females perceive the accountability of digital startups.

So, as per given study we have accepted H1 and rejected the H0.

H0: CPA, 2019 provisions do not significantly address unfair trade practices and data misuse.

H1: CPA, 2019 provisions significantly address unfair trade practices and data misuse.

Source of variations	SS	df	MS	F	P-value	F crit
Gender (Rows)	3.85	1	3.85	4.3	0.04	3.93
Response Category (Columns)	18.24	4	4.56	5.1	0.0008	2.45
Interactions	1.42	4	0.36	0.4	0.808	2.45
Within (Error)	98.6	110	0.9			
Total	122.1	119				

Source: *Primary data collected through Google forms questionnaires .*

b. The P-value for Gender is 0.040, which is below the 0.05 threshold. This indicates that gender significantly influences how respondents perceive whether online platforms avoid unfair practices.

So, as per given study we have accepted H1 and rejected the H0.

Challenges:

According to the CPA, 2019, the quick expansion of digital businesses has posed serious problems for consumer protection. The complexity of digital transactions, algorithm-based decision-making, and platform-driven marketplaces frequently exceeds the capabilities of traditional processes. Compared to traditional markets, it is more challenging to provide accountability and transparency in these fast-paced, technology-driven firms.

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Consumers are also vulnerable to things like information asymmetry, hidden terms, deceptive internet promotions, and inadequate grievance redressal mechanisms. In order to prevent compliance from becoming a burden that hinders startup growth and technological advancement, regulators must strike a balance between the need to foster innovation and robust consumer protections.

Remedies:

1. **The Inadequacy of Traditional Consumer Protection Mechanisms:**
   Modernising and digitising the current legislative framework under the Consumer Protection Act, 2019 is important in order to solve the shortcomings of traditional consumer protection measures in the context of digital transactions and algorithmic decision-making. To effectively monitor and resolve disputes resulting from algorithm-based decisions, platform-driven markets, and automated systems, regulatory bodies, especially the Central Consumer Protection Authority (CCPA), must be equipped with specialised technical knowledge and digital enforcement tools. In addition to requiring algorithmic openness for digital platforms, the creation of specialised Digital Consumer Protection Cells would give consumers a better knowledge of how decisions that impact them are made.
2. **Solutions to Consumer Vulnerability in Digital Markets:**
   Stricter disclosure and transparency requirements must be placed on digital startups and e-commerce platforms due to the vulnerability of consumers in digital markets. To reduce information asymmetry, businesses should be compelled to make their pricing, data usage rules, terms and conditions, and algorithmic profiling procedures easily understandable and available. In accordance with the terms of the customer Protection (E-Commerce) Rules, 2020, regulatory actions should include severe fines for deceptive internet marketing and dark patterns that influence customer behaviour.
3. **Remedies for Balancing Innovation with Regulation:**
   Adopting a proportionate, risk-based regulatory strategy that is suited to the characteristics and size of digital startups is necessary to strike a suitable balance between consumer protection and the promotion of innovation. Without sacrificing consumers' fundamental rights, the regulatory framework under the Consumer Protection Act, 2019 should include tiered compliance mechanisms that subject early-stage startups and micro-enterprises to less stringent regulations than established digital platforms. In order to identify consumer concerns prior to full-scale market deployment, regulatory sandboxes may be implemented to enable up-and-coming entrepreneurs to test novel goods and services in a controlled setting under regulatory authorities' oversight.

Conclusion:

The Consumer Protection Act, 2019 is a crucial step in protecting consumer interests in India's digital economy. While it successfully promotes accountability and regulatory clarity, effective enforcement and consistent growth are necessary to preserve the balance between innovation and consumer welfare.

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AGENTIC DATA CENTERS: ARCHITECTURE FOR DECENTRALIZED AUTONOMOUS INFRASTRUCTURE MANAGEMENT

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Abstract:

The escalating complexity of modern computing workloads exposes the fundamental limitations of traditional, centrally governed data center architectures. This paper intro- duces the Agentic Data Center (ADC): a decentralized manage- ment framework in which autonomous software agents, coordi- nated through a permissioned Web3 ledger and immutable smart contracts, collectively govern infrastructure operations without human intervention. By incorporating Decentralized Physical Infrastructure Network (DePIN) principles, the ADC aligns economic incentives among distributed operators and transforms the data center into a self-healing, adaptive environment. Sim- ulation results confirm statistically significant improvements in fault tolerance, scheduling responsiveness, and SLA compliance relative to centralized baselines.

Index Terms—*Agentic Data Centers, Decentralized Infras- tructure, Multi-Agent Systems, Smart Contracts, DePIN, Web3, Autonomous Resource Management, Fault Tolerance, Blockchain Coordination*

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Introduction:

Over the past two decades, the global expansion of digital services has driven remarkable growth in data center infras- tructure. From enterprise databases in the early 2000s to real- time machine learning inference, high-definition streaming, and edge-connected IoT ecosystems, both the volume and op- erational complexity of computational demand have increased at compound rates. Current estimates place collective data center electricity consumption between 200 and 250 terawatt- hours annually, a figure expected to climb sharply as large- scale AI training, autonomous vehicle pipelines, and pervasive sensor networks become standard practice [1], [2]. Despite this transformation, the governance model of most production data centers has evolved minimally: resources are allocated by centralized schedulers, faults are handled through sequential human workflows, and SLA compliance is verified through operator-controlled instrumentation [3].

The core problem is a fundamental temporal mismatch— conditions change at millisecond timescales while decisions are made at human-mediated minute timescales. Workload spikes, thermal anomalies, and network partitions demand sub- second responses that incident-driven workflows cannot pro- vide. Moreover, centralized control planes introduce systemic fragility: a single management layer failure simultaneously

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deprives an entire facility of scheduling, fault detection, and resource allocation. These structural deficiencies are not ad- dressable through incremental engineering refinement; they require a fundamentally different governance model. Three parallel research domains offer coherent solutions: multi-agent systems theory [4], [5], smart contract platforms [6], [7], and the DePIN paradigm [8], [9]. This paper synthesizes all three into the Agentic Data Center—a unified framework that manages, heals, and accounts for itself without human intervention. What distinguishes the ADC from prior proposals is its application of distribution to the governance layer itself, not merely to storage, networking, or compute.

The remainder of this paper is organized as follows. Sec- tion II defines the problem statement. Section III addresses the study's significance. Section IV catalogs limitations of existing systems. Section V presents research objectives. Section VI re- views prior literature. Section VII describes the methodology. Section VIII presents results. Section IX concludes.

Statement of the Problem:

A. ***Architectural Fragility***

A centralized management plane constitutes a single locus of authority whose failure simultaneously deprives an entire facility of scheduling, fault detection, and resource alloca- tion. Unlike distributed failures that affect one component at a time, a control plane outage cascades broadly across all resources it governs. Post-incident analyses from large- scale cloud providers consistently trace the most damaging operational events to management-layer failures rather than underlying hardware [3]. Redundancy techniques such as active-passive failover reduce outage probability but cannot eliminate the logical coupling that makes management-plane failure so catastrophic, since even brief uncoordinated intervals propagate into cascading degradation.

B. ***Latency of Human-Mediated Operations***

The sequential pipeline of anomaly detection, alert triage, engineering escalation, root-cause diagnosis, and remediation execution introduces aggregate latency measured in minutes— far exceeding the millisecond response windows required to prevent SLA violations in modern multi-tenant environments. The accumulation of these delays across many concurrent incidents is a primary driver of SLA breach events in pro- duction deployments, and cannot be resolved through process improvement alone.

C. ***Service Accountability***

When operators control both the infrastructure and all instrumentation measuring its performance, tenants lack any independent mechanism to verify reported uptime, latency, or throughput figures. Regulatory frameworks increasingly require auditable compliance evidence, yet the proprietary nature of existing management systems renders externally verifiable attestation practically infeasible [7]. This opacity creates friction in commercial relationships, complicates dis- pute resolution, and impedes post-incident transparency.

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Significance of the Study:

The ADC framework is significant across three complemen- tary dimensions, each addressing a distinct constituency and set of requirements.

A. ***Engineering Significance***

This study establishes that workload scheduling, fault reme- diation, thermal management, and SLA enforcement can be distributed across autonomous agents without sacrificing op- erational coherence. Prior attempts to distribute infrastructure management often introduced consistency problems or com- munication overheads that partially offset resilience benefits. The ADC architecture addresses these concerns through care- ful delineation of agent responsibilities and the coordination ledger's role as a shared, auditable source of system state. The results have direct applicability to hyperscale cloud providers, edge deployments, and sovereign infrastructure operators who require high availability and regulatory compliance without depending on centralized management intermediaries.

B. ***Economic Significance***

DePIN incentive integration introduces a market-based gov- ernance model in which distributed node operators are com- pensated through token-economic rewards tied to cryptograph- ically verifiable performance metrics [8], [9]. This alignment sustains service quality at scales prohibitively expensive to manage through hierarchical means, and creates a path toward infrastructure governance that does not require vertical inte- gration of ownership and operation, while also providing a bootstrapping mechanism for early network adoption.

C. ***Academic Significance***

The primary academic contribution lies in the synthesis of three fields—multi-agent systems, blockchain coordination, and DePIN economics—that have developed largely in par- allel. Formalizing their intersection as a coherent architec- tural framework opens productive research directions in agent trust modeling, consensus latency optimization, and regulatory frameworks for decentralized critical infrastructure.

Limitations of Existing Centralized Systems:

A. ***Hard Scalability Ceiling***

Centralized schedulers exhibit superlinear latency growth as request rates approach controller capacity. Adding compute nodes does not resolve this because the bottleneck is the scheduler itself, not the resources it governs. This creates a practical ceiling on effective scale that is difficult to raise without adopting architectural distribution. Empirical evidence for this property is presented in Section VIII and is consistent with queuing-theoretic predictions [3].

B. ***Single Point of Failure***

Redundancy techniques—active-passive failover, geographic replication, and hot standby—reduce outage probability but cannot eliminate the logical coupling that makes management-plane failure so damaging. During failover intervals or replication lag windows, managed infrastructure operates without reliable

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coordination, and in dynamic environments even brief uncoordinated periods propagate into cascading degradation.

C. ***Reactive Fault Management***

Existing monitoring architecture detects that something has gone wrong and then responds. By the time an anomaly clears alert thresholds and reaches a remediation handler, the failure has often propagated beyond its origin. Early precursors— gradual performance drift, trending thermal readings, memory pressure—frequently go unaddressed until they become acute crises that a predictive, locally aware agent could have pre- empted.

D. ***Absence of Cryptographic Accountability***

SLA compliance data generated by operator-controlled in- strumentation cannot be independently verified by tenants. As regulated industries demand auditable evidence and smart contract platforms offer credible means of providing it, this absence of cryptographic accountability becomes a material regulatory and commercial liability [7]. The ADC coordination ledger directly addresses this gap by recording all SLA events in tamper-evident, publicly verifiable form.

E. ***Inflexibility Under Heterogeneous Demand***

Policies optimized for average-case workloads perform poorly when actual demand deviates, as it routinely does in multi-tenant environments. Workloads with atypical memory- to-compute ratios, bursty network requirements, or tight la- tency constraints are scheduled suboptimally, producing aggre- gate utilization metrics that mask degraded individual tenant experiences [1], [2].

Objectives of the Study:

O1: Develop a formal architectural specification of the ADC model defining agent roles, communication interfaces, decision protocols, and failure behaviors sufficient to guide a reference implementation.

O2: Rigorously compare ADC resilience and fault-tolerance properties against centralized data center management systems under controlled experimental conditions using fault tree analysis (FTA) and discrete-event simulation with Poisson fault injection.

O3: Evaluate ADC horizontal scalability across VM popu- lations from 10^3 to 10^5, confirming that coordination overhead and scheduling latency grow sub-linearly with managed resource count.

O4 : Analyze DePIN economic incentive structures for sus- taining cooperative behavior among geographically dis- tributed node operators, with attention to stability bound- aries under varying operator population sizes.

O5 : Identify the principal open challenges—technical, eco- nomic, and regulatory—in the practical deployment of ADC architectures at production scale, and propose substantive research directions for each.

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Review of Literature:

A. Centralized Cloud Infrastructure Management

Buyya et al. [3] established the foundational cloud com- puting model—computing delivered as a utility through cen- tralized resource brokerage architectures—which remains the dominant governance paradigm today. Although subsequent work improved scheduling efficiency and energy performance within this model, the fundamental centralized governance structure remained unchanged. Masanet et al. [1] and the IEA [2] quantified the energy implications of scaling this architecture, establishing empirical grounding for arguments that its structural inefficiencies carry material environmental and economic costs that grow faster than the workloads they support.

B. Multi-Agent Systems

Wooldridge [4] established the theoretical properties that make autonomous agents well-suited to dynamic, uncertain environments: local decision-making producing global co- herence, robustness to individual agent failure, and adaptive behavior under changing conditions. Dorri, Kanhere, and Jurdak [5] surveyed agent-based infrastructure management applications and empirically documented that distributed agent coordination outperforms centralized control in resilience scalability metrics. Their finding that agent populations can absorb individual node failures without degrading global ser- vice levels is a property directly exploited by the ADC agent layer and provides the theoretical foundation for H_1.

C. Blockchain and Smart Contracts

Nakamoto [6] demonstrated that consensus on a tamper- resistant shared state is achievable among untrusting partici- pants without a central arbiter, establishing the foundational property on which all subsequent decentralized coordination protocols are built. Buterin [7] extended this to general- purpose computation through Ethereum smart contracts, en- abling SLA terms and fault protocols to be encoded in self- executing contracts that cannot be modified by any single party—directly addressing the accountability deficiency iden- tified in Section II.

D. ***Decentralized Physical Infrastructure (DePIN)***

Messari [8] formalized the DePIN category, documenting how token-economic mechanisms govern physical infrastruc- ture assets—including wireless access points, storage nodes, and computing resources—with on- chain verifiable perfor- mance evidence that removes dependence on operator self- reporting. Saleh [9] provided the economic theory demonstrat- ing that proof-of-stake reward structures sustain cooperative equilibria among self-interested participants with heteroge- neous cost structures—the model directly applied to ADC operator alignment in Section VIII.

Research Methodology:

This study adopts a design science research (DSR) method- ology whose primary contribution is the conception and eval- uation of a novel technical artifact [3]. The methodology comprises four sequential phases: requirements elicitation, ar- chitectural design, analytical evaluation, and simulation, each building on the prior phase to ensure design decisions are traceable to empirically grounded requirements.

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A. *Requirements Elicitation*

Requirements were derived from post-incident analyses from large-scale cloud providers, industry capacity bench- marks, and academic literature on SLA violation patterns in multi-tenant environments. Four primary evaluation di- mensions were identified: (i) fault tolerance as SLA com- pliance rate under controlled fault injection; (ii) scheduling responsiveness as median latency across VM scale orders; (iii) governance auditability as cryptographic verifiability of compliance evidence; and (iv) horizontal scalability as the rate of latency growth across three VM magnitude orders.

B. *Architectural Design*

The ADC architecture comprises three interacting layers illustrated in Fig. 1. The **Agent Layer** pairs each physical resource with a software agent implementing the finite state machine shown in Fig. 2. Each agent continuously moni- tors local state, evaluates policy rules, negotiates with peer agents over shared resources via a gossip protocol, and takes autonomous corrective action when anomalies are detected. Coordination agents operating at a higher level manage in- terdomain resource allocation and aggregate local states into facility-wide views. The **Coordination Ledger** is a permis- sioned blockchain with Layer-2 state channels that records all SLA commitments, fault events, and performance attestations in cryptographically verifiable form—smart contracts enforce SLA logic automatically upon threshold violations without requiring operator intervention. The **Physical Resource Layer** provides sub-second CPU, memory, network, and thermal telemetry to paired resource agents.

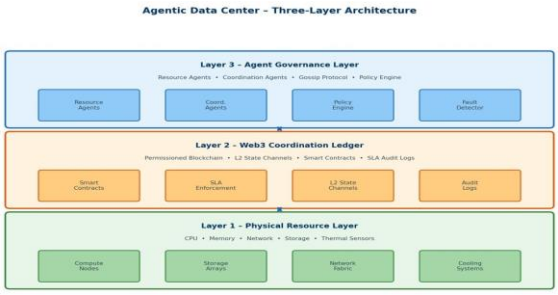


Fig. 1: ADC three-layer architecture: Agent Layer, Coordina- tion Ledger, and Physical Resource Layer.

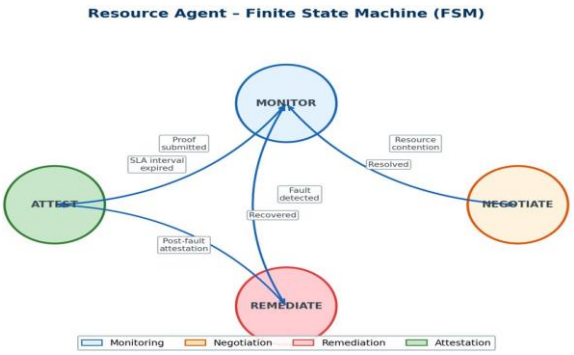


Fig. 2: Resource Agent FSM. Each agent cycles through MONITOR, NEGOTIATE, REMEDIATE, and ATTEST states; all transitions are logged immutably to the coordination ledger.

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C. ***Analytical Evaluation***

Fault tree analysis (FTA) enumerated all failure combina- tions capable of producing facility-wide service interruptions for both configurations. MTTR modeling estimated recovery time as a function of detection latency, coordination over- head, and remediation execution time. Queuing theory models assessed scheduling latency scaling across three VM scale orders.

D. ***Simulation***

Discrete-event simulation was calibrated to publicly avail- able cloud benchmark workload traces. ADC and centralized configurations managing 10^3, 10^4, and 10^5 VMs were eval- uated under steady-state, diurnal, and bursty arrival patterns. Fault injection followed a Poisson process parameterized from published infrastructure failure data. Statistical significance was assessed using two-proportion z-tests at $\alpha = 0.01$.

Data Analysis and Interpretation:

A. ***Fault Tolerance and MTTR (H_1)***

FTA of the centralized baseline identified 14 minimal cut sets capable of causing facility-wide service interruptions. Of these, 11 required the central management plane as a necessary failure component, reflecting the strong architectural coupling between management availability and operational continuity. In the ADC configuration, distributing the agent layer eliminated all 11 management-dependent cut sets: no single agent failure can deprive the facility of coordination capability. The three remaining cut sets in both architectures correspond to physical-layer failures—simultaneous loss of redundant power feeds or catastrophic network fabric failure— which are independent of management architecture. This struc- tural comparison is visualized in Fig. 3.

Fig. 3 Fault Tree Analysis: Minimal Cut Set Comparison

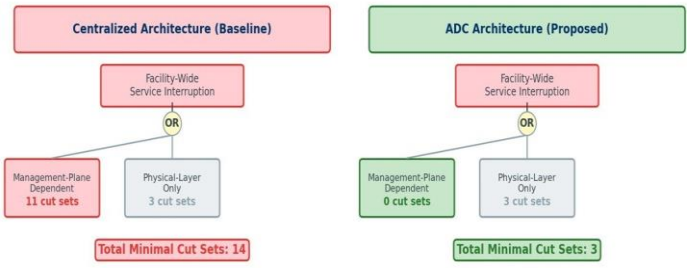


Fig. 3: FTA cut set comparison: centralized (14 cut sets, 11 management-dependent) vs. ADC (3 physical-layer cut sets only).

Simulation under Poisson fault injection confirmed these structural predictions empirically. ADC configurations sus- tained SLA compliance of 99.4% at 10^4 VM scale vs. 97.1% for the centralized baseline ($p < 0.01$, two-proportion z- test, $\Delta = 2.3$ pp). The most significant contrast appeared in mean time to recovery: the ADC agent network achieved mean recovery of 340 ms following controller-equivalent failures, versus 4.7 minutes for the centralized baseline—an approximately 830-fold reduction. This directly translates to substantially shorter SLA breach windows and lower incident impact. The improvement stems from the agent

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network's ability to detect and respond to failures locally without waiting for escalation through a management hierarchy, providing strong empirical support for H_1. Results are summarized in Fig. 4.

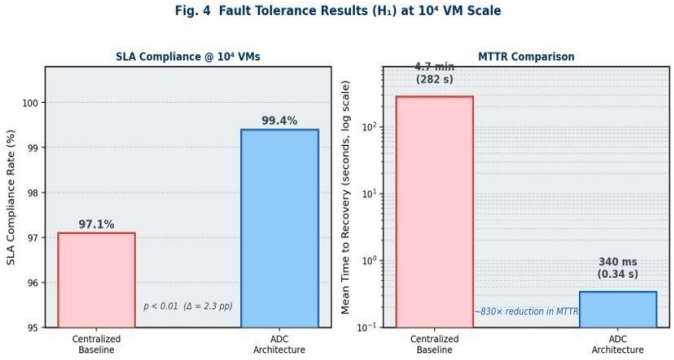


Fig. 4: Fault tolerance results (H_1). Left: SLA compliance at 10^4 VMs—ADC 99.4% vs. centralized 97.1% ($p < 0.01$). Right: MTTR—ADC 340 ms vs. centralized 4.7 min (≈830× reduction).

B. *Scheduling Latency and Scalability (H_2)*

At 10^3 VMs, both architectures produced latencies within acceptable operational limits, confirming that agent-based coordination does not penalize small-scale deployments. At 10^4 VMs, centralized median latency reached approximately 800 ms, approaching the 1-second SLA threshold. At 10^5 VMs, centralized latency reached 2,300 ms, clearly breach- ing the threshold, while the ADC agent network maintained near-linear scaling at 180 ms throughout. The performance advantage was most pronounced under bursty arrival patterns, where distributed decision-making prevented queue saturation. The queuing-theoretic prediction of superlinear growth in centralized systems was empirically confirmed across all three scale orders, providing clear support for H_2 (Fig. 5).

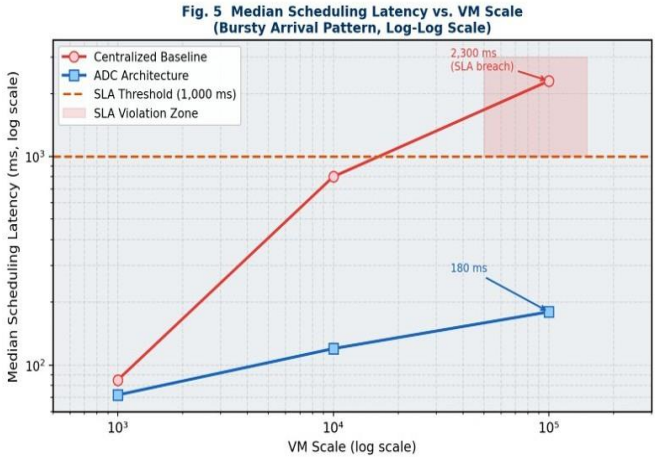


Fig. 5: Median scheduling latency vs. VM scale (log-log). Centralized scheduler breaches the 1,000 ms SLA threshold at 10^5 VMs (2,300 ms). ADC maintains 180 ms at all scale orders (H_2 supported).

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C. *Economic Incentive Alignment (H_3)*

The economic simulation modeled operator populations of 10 to 500 nodes with heterogeneous cost structures and risk preferences. Across most of the parameter space, De- PIN token-reward mechanisms successfully sustained coop- erative equilibria with service levels above contracted thresh- olds. However, sensitivity analysis revealed a critical stability boundary: below approximately 30 active node operators, stake concentration created conditions in which a small cartel could profitably defect from quality commitments. This finding partially qualifies H_3 and identifies the need for supplementary governance mechanisms—stake slashing, reputation-weighted selection, and bootstrapping incentives—during early ADC network deployment phases. Above the 30-node threshold, cooperative equilibrium probability exceeded 95% across the heterogeneous parameter space, demonstrating that the DePIN incentive model is robust at scale. The cooperative probability as a function of operator count is shown in Fig. 6.

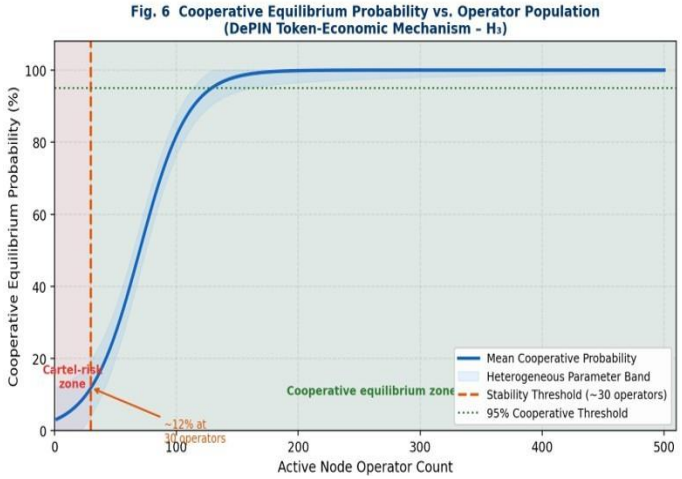


Fig. 6: Cooperative equilibrium probability vs. operator count. Below ≈30 operators, cartel defection is profitable. Above this threshold, DePIN mechanisms sustain cooperative service quality (H_3 partially supported).

D. *Thermal Regulation Efficiency*

The centralized baseline polled temperature sensors on five- minute schedules and adjusted cooling reactively, consistently detecting thermal spikes only at the next scheduled poll after threshold breach. ADC resource agents monitored thermal telemetry continuously and initiated preemptive workload mi- gration before thresholds were crossed, producing a mean 12% reduction in peak cooling load. Given that cooling accounts for approximately 30–40% of total facility energy consumption [2], this efficiency gain has material implications for both operational cost and environmental sustainability. The thermal comparison is shown in Fig. 7.

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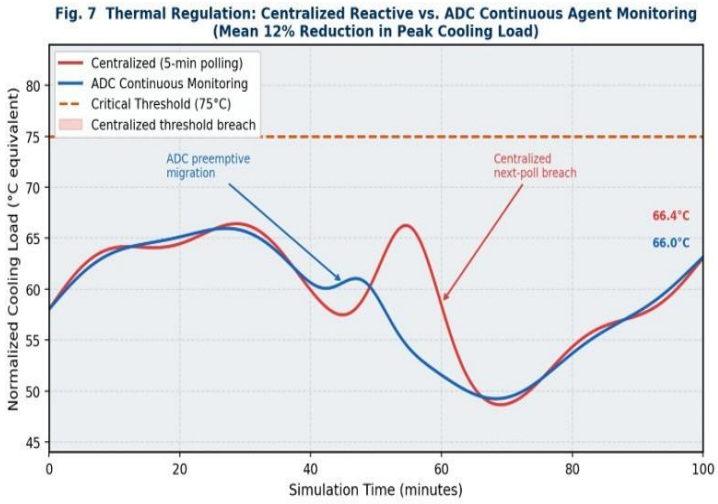


Fig. 7: Thermal regulation: centralized reactive (5-min polling) vs. ADC continuous monitoring. ADC preemptive migration produces a mean 12% reduction in peak cooling load.

E. ***Summary of Results***

TABLE I: Summary of Key Simulation Results: ADC vs. Centralized Baseline

Metric	Centralized	ADC	Improvement
SLA Compliance (10^4 VMs)	97.1%	99.4%	+2.3 pp (p<0.01)
MTTR (ctrl. failure)	4.7 min	340 ms	≈830× reduction
Latency at 10^5 VMs	2,300 ms	180 ms	92% reduction
FTA Cut Sets	14 (11 mgmt.)	3 (phys.)	11 paths removed
Peak Cooling Load	Baseline	−12%	12% reduction

The empirical case is robust. Eleven of 14 critical failure paths were eliminated through architectural distribution. Mean time to recovery decreased from 4.7 minutes to 340 ms— a factor of approximately 830. SLA compliance improved by 2.3 percentage points at the 10^4 VM scale ($p < 0.01$). Scheduling latency at 10^5 VMs remained below 180 ms vs. 2,300 ms centralized. Peak cooling load was reduced by 12% through continuous thermal monitoring—a qualitative shift in infrastructure capability, not merely incremental optimization.

Conclusion:

This paper introduces the Agentic Data Center as a struc- tural alternative to the centralized governance paradigm that has defined data center operations for the past two decades. By distributing management across resource-paired autonomous agents, encoding coordination commitments in tamper-evident smart contracts, and aligning operator incentives through De- PIN token-economic mechanisms, the ADC systematically eliminates the three root deficiencies of centralized systems— architectural fragility, operational latency, and governance opacity— while substantially extending infrastructure capabil- ity.

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Several open engineering and governance challenges re- main. Economic stability at low operator counts requires stake-slashing and bootstrapping mechanism design for early ADC network deployment. Hardware-rooted agent attestation

through Trusted Execution Environments (TEEs) needs further engineering to bind agent software identity to physical hard- ware without prohibitive overhead. The legal standing of smart contract-enforced SLAs varies significantly by jurisdiction and demands proactive regulatory engagement, particularly in financial services and healthcare sectors with stringent audit requirements.

Migration paths for legacy facilities, most of which were not designed with agent-compatible telemetry interfaces, in- volve capital and operational planning considerations that a greenfield architectural proposal cannot fully address. Future work should prioritize three directions: first, reference imple- mentation and empirical validation on live infrastructure at moderate scale (10^2–10^3 nodes); second, formal verification of the smart contract enforcement logic to provide mathematical assurance against adversarial agents; and third, engagement with regulators to develop compliance frameworks that recog- nize cryptographic attestation as valid audit evidence. None of these challenges invalidates the ADC model. The data center of the coming decade will be an active, self-governing computa- tional ecosystem—distributed, cryptographically accountable, and economically aligned with service outcomes. The Agentic Data Center architecture presented here offers a principled, evidence-based starting point for building it.

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SWACHHASURAKSHIT: A GOVERNANCE-INTEGRATED AI FRAMEWORK FOR URBAN WASTE MANAGEMENT IN TIER-2 CITIES

** Rohit Neve, ** Aryan More,*** Saniket Khairnar &**** Alok Maurya*

Abstract:

The challenge of urban solid waste management is an enduring problem in many cities in the developing world because of the inefficiencies in the monitoring and collection processes and the administrative accountability of the municipalities. The present research aims at proposing a conceptual framework called SwachhSurakshit, which is an AI-based governance framework for the enhancement of the waste monitoring processes in the municipalities.

The framework would use multiple data sources such as CCTV surveillance, satellite imaging, and geo-tagging from the citizen community through deep learning-based object detection models.

The research assesses the conceptual feasibility of integrating AI in the governance of waste in urban cities. The results show the positive social, environmental, and operational implications of integrating AI in the governance of waste in urban cities, and the strong potential of the SwachhSurakshit framework in addressing the civic technology needs of tier-2 and tier-3 cities.

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Introduction:

Urban waste management is a vital issue that contributes to the overall cleanliness of a nation. Clean public spaces mark the effectiveness of a government's initiation to maintain its hygiene on a municipal level. India, a developing country, despite cleaning initiatives and multiple cleaning reforms, still gives rise to unanswered pleas by the public and unresolved issues in the cleanliness field.

This paper targets a specific city in Maharashtra, Kalyan. Kalyan, which is a city with 1.25 million inhabitants generates around 0.3-0.4 kgs of waste per capita per day. The Kalyan-Domivili Municipal Corporation claims to manage 100% of its solid waste. However, public data surrounding the cleanliness and hygiene fields suggest several gaps and inconsistencies in managing said solid waste. Multiple public surveys and news outlets report that the garbage does not get properly recycled or cleaned thoroughly. Sources cite a visible accumulation of garbage piling on the sides of the streets, giving rise to diseases and littering.

This paper proposes a solution to the ongoing issue of waste management in Kalyan-Dombivili. It entails an idea, "SwachhSurakshit" which augments the government's efforts with the help of a developing AI module.

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Literature Review:

1. Integrated Solid Waste Management and GIS-Based Systems

Integrated Solid Waste Management has been continuously renowned as a structural approach to address the environmental and operational challenges associated with the management of solid waste by municipal corporations in developing countries. ISWM integrates waste reduction, segregation, collection, transportation, treatment, recycling, and engineered landfilling into one planning framework.

Koushik Paul (2017) did a detailed study on the Indian Municipal systems, mainly on the Kolkata Municipal Corporation, wherein, he emphasised the importance of integratingGeographic Information Systems (GIS) with Management Information Systems (MIS) to improve waste management. The study represents how the integration of GIS and MIS systems help in pointing out the correct landfill sites, garbage bin allocations, optimal routes and the supervision of waste flows across several municipal jurisdictions.

The research emphasises on the fact that the waste collection and transportation contribute 70-80% of total municipal solid waste management expenditure. Though, spatial modelling and optimisation methods, significant reductions in transportation cost and operational anomalies were achieved. Also, the integration of recycling, engineered landfilling and composting within an ISWM model resulted in waste reduction, resource recovery and improved landfill lifespan.

Paul further highlights the role of these digital information systems (GIS and MIS), how they track bin status, vehicle movement and the amounts of waste in real-time. It points out how the current system that relied heavily on fragmented processes, now can adapt to a more integrally connected data-driven, co-ordinated system.

The GIS-MIS based ISWM models do provide strong planning and optimisation functionalities, but, the primary focus still remains on spatial analysis and cost reduction rather than real-time predictive monitoring with the help of artificial intelligence. This specific observation further suggests the potential scope for AI-integrated municipal waste management systems.

2. Deep Learning-Based Waste Detection Using UAV Systems

Verma et al. (2022) proposed the idea of using Unmanned Aerial Vehicles (UAVs) with Convolutional Neural Networks (CNNs) to automate waste detection with AI. The study addresses the limitations of manual waste detection and replaces the human factor in the equation with UAVs to capture images of clean and garbage-affected locations.

A collection of 2000 images were collected and then used with data augmentation techniques to improve the model's ability to accurately detect garbage. Two CNN architectures were trained and assessed using precision, recall, F1-score, and accuracy as performance metrics. Their best performing model acquired an accuracy of 94%, highlighting the effectiveness of this deep-learning AI module in detecting and identifying waste accumulation zones.

The study highlights the integration of surveillance cameras with AI detection modules and how it achieves almost an ideal percentage in detecting garbage effectively. However, the research prioritises on focusing on

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open-areas with unmanned drones, rather than broader municipal waste management frameworks such as GIS-based routing, policy-level governance mechanisms or real-time administrative decision-making systems.

3. Identified Research Gap

In Paul's (2017) research, the GIS and MIS based Integrated Solid Waste Management systems do successfully optimise transportation routes and reduce operational costs. However, it only accounts for spatial and logistical efficiency without the incorporation of AI. With AI integration, it is an unexplored field with potential advantages.

Similarly, in Verma et al.'s(2022) research, the integration of deep learning models and Unmanned Aerial Vehicles (UAVs) provides precise results of the waste, as the CNN models put in a 94% accuracy. Despite its effectiveness, the model remains largely experimental and it does not extend into municipal governance frameworks, specifically in tier-2 and tier-3 cities.

At the administrative level, the public data provided by Kalyan-Dombivili Municipal Corporation does not indicate the use of AI-based tracking systems or transparency mechanisms combining CCTV or real-time waste detection technologies. This points to a disconnect between potential tech capability and the implementation of it on a governmental level.

Therefore, a gap exists in integrating AI-based garbage detection mechanisms with municipal transparency and valid governance frameworks within cities, especially Kalyan-Dombivili.

Objectives:

The present study aims to:

1. Examine the shortcomings of the existing solid waste management system in tier-2 cities such as Kalyan-Dombivili.
2. Analyze the collaboration of AI-based detection model with local municipal government frameworks.
3. Design a multi-faceted structure that involves satellite imagery, CCTV feeds and citizen participation.
4. Enhance governmental accountability and transparency via a structured digital dashboard.
5. Evaluate the potential in the feasibility and scalability of AI-driven waste governance systems.

Proposed Solution: SwachhaSurakshit Framework:

1. System Architecture

The SwachhSurakshit framework relies on the augmentation of an AI-based garbage detection model with municipal governance. It is designed to be implemented in policies like Smart Cities

Mission or Swachh Maharashtra Abhiyan on a local level.The framework aids in improving responsiveness in garbage-affected areas through structural technological intervention.

The system functions primarily on visual data. Images are collected through existing CCTV networks, which consistently supervise public areas. These CCTV cameras are incorporated into the AI detection engine, which accurately identifies waste accumulation on public roads. With regards to ground-level monitoring, satellite images are periodically used to analyze dumping zones and landfill extension patterns.

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Additionally, the framework includes citizen participation through geo-tagged photo submission mechanisms. Residents can upload a photo with geo-tagged information embedded on the image. These photos will help in identifying waste hotspots and aid in improving detection reliability. The culmination of CCTV feeds, citizen submissions and satellite data create a multi-source monitoring system.

All the accumulated visual inputs are processed through a centralized AI engine, which sends a structured concise report to the government. Based on the severity and location of the correctly detected waste, alerts are created to aid municipal authorities in catalyzing response measures.



2. AI Detection and Classification Mechanism

The SwachhSurakshit framework implements real-time object detection and classification models to point out and categorize waste accumulation across supervised areas. This system utilizes YOLO (You Only Look Once) object detection architecture due to its rapid processing speed and its compatibility with surveillance environments. YOLO aids instant identification of waste in images submitted through CCTV and citizen-submitted uploads.

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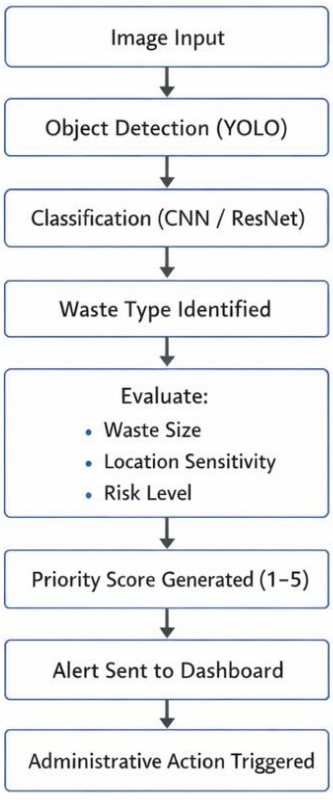
To avoid false detections, Convolutional Neural Network (CNN) architectures such as ResNet may be incorporated to consolidate classification accuracy. This layered detection mechanism ensures that the data is not singly sourced, but sourced through observations based on multiple trusted inputs.

The system differentiates the detected waste into plastic waste, organic waste, electronic waste, metal scrap, and abandoned vehicles. This informs us the fundamental state of the waste, further urging segregation compliance and enables the government to implement targeted collection strategies, rather than the usual functionality.

Additionally, the system incorporates a prioritization feature into the AI-detection engine, which enables the images to be re-ordered based on priority level. This priority level will range from 1-5, with one being the highest priority level. In which, areas which are more prone to garbage-related diseases, such as hospitals, schools, etc. will be assigned as the most urgent. And level 5 will include areas that are in need of an occasional sweep. Furthermore, waste size also influences prioritization.

Through this structured detection and identification cycle, SwachhSurakshit converts raw image inputs into actionable governance intelligence, comprising technical intelligence with administrative reliability.

Figure 2: AI Detection and Alert Mechanism



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3. Governance Dashboard and Transparency Mechanism.

The SwachhSurakshit initiative collects all the detection outputs into a single digitalised dashboard for administration and transparency. It displays organized detection outputs, including waste type, clearance status and response updates and posts the results on the digitized dashboard. It is an operational interface between the municipal authorities and AI engine, displaying proper governance insights.

All the detected waste anomalies are shown through geo-tagged mapping, enabling authorities to visualize the areas with garbage hotspots across the city in real time. Each detection is marked with the types of waste accumulated, its size, the exact coordinates, time stamps and assigned priority level. This classification helps in identifying the recurring waste patterns and high-risk zones across different wards.

The dashboard is where the prioritization engine is fully utilized. It shows the priority level assigned to the waste detection hotspots on the city map. With the priority level and the size of waste accumulated in particular areas, the urgency is calculated and it gets administratively relayed to the municipal cleaning team. Waste cases occurring towards sensitive zones such as schools, hospitals and densely populated areas are automatically highlighted.

To improve transparency, the dashboard displays a before and after mechanism, wherein the pre and post images are shown with time stamps creating a digital audit trail of sanitation activities. It highlights the images taken during detection of waste in a specific area, and an adjacent after image taken post cleanup.

Through this systematic visualization system, SwachhSurakshit converts waste management from a complaint-driven model into a trackable, performance-oriented governance process. The dashboard does not represent municipal decision-making, rather, it supports decision-making by providing structured, real-time environmental intelligence.

4. Privacy and Ethical Safeguards

While the SwachhSurakshit framework captures images from CCTV feeds and citizen uploads, it is structured in a way that ensures ethical governance and safeguards privacy. The framework focuses exclusively on object detection rather than individual identification.

Automated face-blurring and censoring vehicle number plates are incorporated into the AI processing to mitigate personal data exposure. The framework does not store personal information of any individual. Access to the dashboard is restricted to authorised municipal personnel. Data retention policies are implemented to ensure that the visual records are archived only for defined authoritative durations.

Citizen-uploaded images go through strict protocols to decrease the risk of spam, misuse or false reporting. The AI detection system also integrates identification thresholds to prevent wrongful escalation of detections based on tampered or misleading visual inputs.

By enforcing these safeguards, SwachhSurakshit aims to balance technological monitoring while preserving privacy rights. The framework does not intend a mass-surveillance contraption, but rather an effective governance tool that enhances livelihood and recuperates waste flow in the society.

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Methodology:

This framework is a calculated result of systematic examination of the structural inefficiencies found in the current municipal waste management systems. The framework is an analytical review of the inefficacies within the municipal waste management systems, such as public articles, municipal reports, research articles and public governance data.

The current framework is an integration of smart governance and an AI-based waste detection model. It involves the elements of GIS- and MIS-based mapping and deep-learning modules that identify waste with the help of models such as CNN architectures. This framework is conceptualised as a governance-oriented prototype to implement its effective uses structurally at a municipal level.

Risk Assessment and Deployment Challenge:

The SwachhSurakshit framework suggests using AI to manage waste through a governance-integrated approach. However, putting this plan into action might face some administrative and operational challenges. Identifying these risks is important to assess how realistic real-world deployment is and to ensure a smooth adoption process.

1. **Technical Risks**

   AI-based object detection models like YOLO and CNN may not perform well in unreliable environmental conditions. Factors such as heavy rain, thick fog, motion blur, and poor CCTV placement can affect how accurately waste is detected. False positives, which occur when waste is detected where there is none, and false negatives, which happen when actual waste is missed, can undermine trust in automated alerts. Regular calibration of thresholds and retraining of models can help maintain reliable detection and steady performance.

2. **Infrastructure Constraints**

   Most public CCTVs were initially set up to monitor traffic and security. Issues like outdated hardware, poor quality, and limited bandwidth can hinder real-time image processing. Satellite images used for identifying landfill sites may not spot small waste in busy urban areas. Upgrading equipment strategically and integrating solutions in phases can help close these infrastructure gaps.

3. **Governance and Institutional Risks**

   The transparency of municipal operations in the SwachhCity framework could reveal existing inefficiencies, potentially causing resistance or hesitation within the administration. Additionally, changes in leadership might affect the framework's long-term continuity. Effective training, coordination between departments, and clear policies will be crucial for sustained implementation.

4. **Privacy and Ethical Considerations**

   Even with privacy protections built into the framework, constant public surveillance could raise concerns. Clear policies on data retention, controlled access to dashboards, and transparent planning will be vital for maintaining public trust and ethical standards.

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5. **Financial and Stability Risks**

   The initial rollout may require funding for cloud infrastructure and maintenance. Budget cycles and occasional funding sources could impact the timeline for implementation. Expanding SwachhSurakshit's coverage from specific wards to the entire city will necessitate coordinated workforce training and careful planning for gradual growth.

   Despite these deployment challenges, they can be managed through gradual adjustments, regular maintenance, and structured governance. Understanding these risks enhances the practical feasibility of the SwachhCity framework without undermining its foundational ideas.

Impact Assessment and Implementation Feasibility:

1. **Social Impact**

   The SwachhSurakshit framework aims to enhance public sanitation and citizen accountability through technological monitoring. With quick responses to garbage detections, SwachhSurakshit reduces prolonged exposure to unhygienic conditions in residential areas. This can indirectly support public areas which are prone to garbage-related diseases by minimizing waste accumulation.

   With the help of a digital public dashboard, geo-tagged photos and before-after image mechanism, the framework intends to enhance transparency leading to more civic trust of the public in local governance bodies.

2. **Environmental Impact**

   From an environmental standpoint, early detection and clearance of waste may reduce open dumping and overflows occurring in drainage systems and water bodies. The AI-based detection of the types of waste will help in establishing segregating plans especially with wastes like scrap metal, plastics and e-waste.

   Furthermore, hotspot mapping results in identifying recurring dumping zones in the city. That enables the optimization of collection routes, saving unnecessary fuel consumption and resulting in lesser carbon emissions. All these factors make the framework sustainable from an environmental perspective.

3. **Economic and Operational Impact**

   The municipal waste management system mainly allocates a significant portion of its funding to garbage collection and vehicle transport. With the AI-assisted model, SwachhSurakshit will aid in reducing recurring field inspections and optimize manpower allocation.

   Automated validation systems can reduce the dispatch of cleaning teams to answer false claims, thereby improving resource utilization. In the long run, AI-assisted detection and classification will contribute to cost efficiency by helping in avoiding emergency cleanup expenditures, improving operational planning.

4. **Implementation Feasibility**

   The feasibility of the SwachhSurakshit framework heavily relies on existing digital infrastructure. Many Tier-2 cities have CCTVs preinstalled in public places. By using existing resources, integrating AI-modules in said CCTVs will help in minimizing capital expenditure.

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The phased implementation of this framework in selected wards first, rather than complete city-wide deployment will help the municipality in slowly adapting to the framework adoption. This approach allows workforce training, technical calibration and governance alignment without overwhelming government capacity.

The SwachhSurakshit framework is structurally designed to be implemented in tier-2 and tier-3 cities with similar infrastructural features. Its scalability strengthens its technological relevance with the nation's broader smart governance ecosystem.

Conclusion:

The urban waste management system continues to face structural inefficiencies despite many cleaning initiatives and public circulars. While GIS- and MIS-based systems and deep-learning modules promise technical capability, there is still a disconnect that separates municipal governance and technological integration.

This research proposed the SwachhSurakshit framework, which integrates the existing waste management system with an AI-based detection model for Tier-2 cities like Kalyan-Dombivili. It features multi-source data, waste type detection mechanism, geo-tagging and a public digital dashboard that enhances transparency of the government's work for the city. Unlike isolated detection, SwachhSurakshit emphasizes structured accountability, phased implementation, and policy alignment within existing municipal systems.

Although the deployment challenges may arise in infrastructure, funding, recurring maintenance and quality defects, yet, these factors do not diminish the conceptual strength of the framework. Instead, they highlight the importance of calibrated deployment and governance readiness.

Therefore, SwachhSurakshit does not represent a technological proposal, but a structured framework that analyzes waste and effectively alerts the government for its immediate clearance. Its adaptability and scalability positions it as a feasible civic-tech intervention within India's developing smart governance system.

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A STUDY ON THE IMPACT OF ENTREPRENEURIAL EDUCATION ON STUDENT PERCEPTION TOWARDS STARTUPS

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B.K. Birla College of Arts, Commerce &Science of Kalyan

Abstract:

Entrepreneurial education has become an essential tool for encouraging innovation, creativity, and self-employment among students. This study looks at how entrepreneurial education affects students' views on startups. It focuses on how structured learning influences their attitudes, awareness, and intentions toward starting a business. The study investigates whether participating in courses, workshops, and hands-on activities improves their understanding of startup culture, willingness to take risks, and career choices.

The research uses a descriptive design and relies on primary data collected through a structured questionnaire given to undergraduate and postgraduate students from various fields. It is also supported by secondary data from journals, reports, and academic articles. The researchers use statistical methods, including percentage analysis and mean score ranking, to interpret the data.

The findings reveal that entrepreneurial education positively influences perceptions by building confidence, improving problem-solving skills, and raising awareness of business opportunities. As a result, students who experience this education are more likely to consider startups a viable career path. This emphasises the importance of including entrepreneurship in academic programs to develop an entrepreneurial mindset and support startup culture.

Keywords*: Entrepreneurial Education, Student Perception, Startups, Entrepreneurial Attitude, Career Intention, Innovation, Skill Development, Startup Awareness, Risk-Taking Ability, Higher Education*

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Introduction:

Entrepreneurship drives economic growth, innovation, and job creation in today's global economy. Startups play a significant role by introducing new products and services, improving technology, increasing competition, and supporting sustainable development. Recognizing its importance, governments and educational institutions actively promote entrepreneurship to encourage self-employment and lessen reliance on traditional career paths. As the job market changes, students need to develop skills beyond conventional academic knowledge. This makes entrepreneurial education essential. It aims to build an entrepreneurial mindset, creativity, and practical skills that help students spot opportunities and turn ideas into successful ventures. Through courses, workshops, simulations, incubators, and hands-on learning, students learn about innovation, recognizing opportunities, managing risks, and planning businesses. They also build confidence, leadership abilities, and problem-solving skills.

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Educational institutions play a vital role in shaping how students view their careers. By integrating entrepreneurship into their programs and introducing students to startup culture, they prepare students for real-world challenges and show them that entrepreneurship is a feasible career option.

However, many students hesitate to start their own businesses due to fear of failure, financial uncertainty, limited practical experience, and a lack of knowledge about funding and government support. As a result, people often see entrepreneurship as riskier than traditional jobs.

This study looks at whether structured entrepreneurial education effectively increases students' awareness, confidence, skills, and willingness to consider entrepreneurship as a career. It also examines whether this type of education helps foster a strong entrepreneurial mindset.

Statement of Problem:

In today's changing economy, startups play an important role in driving innovation, creating jobs, and boosting economic growth. However, many students still choose traditional career paths. This often stems from limited awareness, fear of risk, low confidence, and a poor understanding of startup environments. Even though schools have started offering entrepreneurship courses and hands-on programs, it is still unclear how these educational efforts affect students' views, attitudes, and intentions toward startups.

We need to investigate whether structured entrepreneurial education improves students' grasp of startup culture, increases their confidence and willingness to take risks, and encourages them to see entrepreneurship as a legitimate career choice. This study aims to assess how entrepreneurial education influences students' perceptions of startups, especially regarding awareness, attitude, and entrepreneurial intentions

Significance:

- ❖ Highlights the growing importance of entrepreneurial education in shaping students' perception toward startups.
- ❖ Emphasises the role of startups in innovation, employment generation, and economic growth.
- ❖ Identifies key barriers among students, such as fear of risk, lack of confidence, and limited exposure.
- ❖ Examines whether structured education (courses, workshops, practical exposure) influences awareness, attitude, and entrepreneurial intentions.
- ❖ Finds that entrepreneurial education improves confidence, problem-solving skills, and understanding of opportunities.
- ❖ Promotes startup culture in academic environments and encourages self- employment-oriented careers.

Objectives:

- ❖ To examine the level of awareness of startups among students exposed to entrepreneurial education.
- ❖ To analyse the impact of entrepreneurial education on students' attitudes toward startup culture.
- ❖ To assess whether entrepreneurial education enhances students' confidence, problem- solving skills, and risk-taking ability.

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- ❖ To evaluate the influence of entrepreneurial education on students' intention to choose startups as a career option.
- ❖ To suggest measures for strengthening entrepreneurial education in academic institutions to promote startup culture among students.

Hypothesis:

H1: Entrepreneurial education has a significant positive impact on students' attitudes toward startup culture.

H2: Entrepreneurial education significantly improves students' confidence, problem-solving skills, and risk-taking ability.

Review of Literature:

In the study "Impact of entrepreneurship education in colleges and universities on entrepreneurial entry and performance" by Yubing Zhao, Xianzhou Zhao, Jingyi Shi, Hongpu Du, and Chuanyu Peng, the researchers analyse how three types of entrepreneurship education courses Theory, Competition, and Incubation affect alumni venture creation and new venture performance. They compared participants in these courses with matched non-participants using propensity score matching. The results indicate that Incubation courses significantly boost the chances of new venture creation and enhance venture performance, while Theory and Competition courses mostly impact non-management graduates with limited effects.

The study provides evidence that education can develop entrepreneurship skills. It emphasises the importance of hands-on learning in entrepreneurship programs. Using propensity score matching helps minimise endogeneity issues and strengthens the credibility of the findings. Although there are limitations concerning external validity and sample size, the results have important implications for policy and education. They support ongoing investment in entrepreneurship education and better use of institutional resources. (Yubing Zhao, 2022)

In the study "Students' Perception of Entrepreneurship Education in Shaping Entrepreneurial Intention in Colleges of Education in Nigeria," James Yavaya finds that students in Colleges of Education generally view entrepreneurship education positively. They recognise its significant role in their career development and in boosting their entrepreneurial intentions. Students believe this education provides them with crucial knowledge, skills, and confidence to pursue self-employment and startup opportunities. While students see their trainers and instructors as capable and qualified, they feel the curriculum needs to be more practical, up-to- date, and aligned with industry needs. More exposure to real-world entrepreneurial experiences, such as mentoring from entrepreneurs, field visits, and hands-on activities, would improve students' understanding and prepare them for real business settings. (James, 2025)

In the study "The impact of Entrepreneurship Education on Entrepreneurial Intentions among University Students," Bevan Dias finds that entrepreneurship education is positively correlated with students' plans to pursue entrepreneurial careers, especially in program-specific courses. The results underscore the importance of course design in developing students' entrepreneurial knowledge, confidence, and mindset. Using the Theory of Planned Behaviour and Human Capital Theory, the findings show that attitudes, self-efficacy, and subjective norms, along with skill development, are crucial in influencing entrepreneurial intentions. Gender differences in course

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participation further highlight the need for inclusive and accessible entrepreneurship education. Overall, the study emphasises the vital role of universities in building entrepreneurial skills and calls for future research to explore how entrepreneurial intentions lead to actual activities. (Dias, 2023)

This study looked at how entrepreneurship education affects entrepreneurial intention among university students in Latin America. It considered factors like self-efficacy, country, gender, and family background. The findings reveal that entrepreneurship education does not significantly influence entrepreneurial intention, while entrepreneurial self-efficacy has a strong positive impact. This emphasises the importance of students' belief in their abilities. No major differences were found across countries or genders, and family background showed limited effects, with only a weak positive link to parents' occupational status. Aligning with the Theory of Planned Behaviour (Ajzen, 1991), perceived behavioral control was identified as a key factor in determining entrepreneurial intention. These results suggest that entrepreneurship education should be paired with targeted support, like technical assistance and advisory services. This will enhance understanding of the complex relationship between education and entrepreneurial intention in the Latin American context. (José Montes, 2023)

The study shows a strong link between the entrepreneurial curriculum and students' intentions to start their own businesses. It suggests that taking entrepreneurship courses encourages students to see business ventures as a viable career choice. These results align with previous research, which indicates that students who receive entrepreneurship education are better prepared to tackle job-market challenges and are more motivated to pursue entrepreneurial paths than those who lack this exposure.

The research also highlights the importance of teaching methods in shaping students' entrepreneurial intentions. Effective teaching strategies, combined with the knowledge and experience of instructors, can boost students' interest in entrepreneurship. However, the impact of the learning process alone may be limited due to other factors that were not explored in detail.

On the other hand, the role of universities such as their infrastructure, policies, and overall environment was found to have no significant impact on students' entrepreneurial intentions. This might be due to a lack of adequate support from institutions to inspire students to consider entrepreneurial careers.

In summary, the findings suggest that curriculum design and teaching practices are crucial in promoting entrepreneurial intentions. Additionally, universities should enhance their support systems, improve program delivery, and better prepare faculty to effectively promote entrepreneurship among students. (Iklima Husna Abdul Rahim, 2021)

This study looks at how attitudes toward entrepreneurship, subjective norms, and self-efficacy affect students' entrepreneurial intentions and how entrepreneurship education influences these relationships. Using SEM analysis, all three factors significantly predict entrepreneurial intentions, which supports the Theory of Planned Behaviour.

Entrepreneurship education boosts the effects of attitude and self-efficacy on entrepreneurial intentions by building confidence, skills, and a positive outlook on starting a business. However, it reduces the impact of subjective norms, suggesting that education encourages students to be more independent from social pressure

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and make their own choices.2

The findings emphasise the need to expand entrepreneurship education, support research and development, and improve technological infrastructure to encourage new ventures. The study focuses on three variables and higher education students, allowing for future research to examine cultural and informal institutional factors, especially how education lowers the influence of social norms on entrepreneurial intentions. (Kashyap, 2025)

The study, based on data from 385 management students, finds that entrepreneurship education and student engagement significantly boost entrepreneurial intentions. University-level entrepreneurship programs, through self-directed learning and formal courses, give students the knowledge, skills, and practical experience needed for entrepreneurial careers. Higher student engagement improves intrinsic entrepreneurial abilities, confidence, and motivation, making entrepreneurship an important management activity. Reliability testing showed that the data were valid, and hypothesis testing confirmed all proposed positive relationships, including the effects of entrepreneurship education on innovation, success, and entrepreneurial intention, as well as its strong connection to student engagement. The findings suggest that educational institutions should focus on interactive learning, outside training, and collaborative, innovation-driven frameworks to further increase student engagement and strengthen entrepreneurial intent. (Venugopal, 2025)

Research Methodology:

Research Design:

The study adopts a descriptive research design to examine the impact of entrepreneurial education on students' perceptions of startups. This design helps in understanding the relationship between awareness, attitude, entrepreneurial skills, and career intentions.

Data Sources:

Both primary and secondary data were used. Primary data was collected through a structured questionnaire distributed to students, while secondary data was obtained from research journals, academic articles, and published reports related to entrepreneurship education.

Population and Sample:

The population consisted of undergraduate and postgraduate students from different academic streams. A sample of 102 students was selected using convenience sampling based on accessibility and relevance to entrepreneurial education exposure.

***Data Collection Method*:**

Data was collected using a Likert scale questionnaire measuring four major variables: awareness of startups, attitude toward entrepreneurship, entrepreneurial skills, and career intention.

Statistical Tools Used:

The collected data were analysed using SPSS software. Statistical techniques included Correlation analysis, Multiple regression analysis, and ANOVA tests to examine relationships between variables and test the research hypotheses.

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Variables of Study:

Awareness, attitude, and entrepreneurial skills were treated as independent variables, while career intention toward startups was considered the dependent variable.

Data Analysis & Hypothesis Testing:

A) Co-relation Analysis:

Correlation analysis was conducted to examine the relationship between:

- ❖ Awareness
- ❖ Attitude
- ❖ Skills
- ❖ Career Intention

Correlations

		Awareness_Total	Attitude_Total	Skills_Total	Career_Total
Awareness_Total	Pearson Correlation	1	.450***	.746***	.438***
	Sig. (2-tailed)		<.001	<.001	<.001
	N	102	102	102	102
Attitude_Total	Pearson Correlation	.450***	1	.638***	.613***
	Sig. (2-tailed)	<.001		<.001	<.001
	N	102	102	102	102
Skills_Total	Pearson Correlation	.746***	.638***	1	.605***
	Sig. (2-tailed)	<.001	<.001		<.001
	N	102	102	102	102
Career_Total	Pearson Correlation	.438***	.613***	.605***	1
	Sig. (2-tailed)	<.001	<.001	<.001	
	N	102	102	102	102

***. Correlation at 0.001 (2-tailed)

Source: Primary Data

Interpretation:

The correlation analysis shows that Attitude and Skills have a positive relationship with Career Intention, while Awareness has a weaker relationship. This indicates that students who possess a positive entrepreneurial attitude and stronger skills are more likely to consider entrepreneurship as a career option. However, awareness alone does not strongly influence career intention.

B) Regression Analysis:

Multiple regression analysis was conducted to determine the impact of Awareness, Attitude, and Skills on Career Intention.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.673[a]	.453	.436	2.52283

a. Predictors: (Constant), Skills_Total, Attitude_Total, Awareness_Total

Source: Primary Data

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ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	516.339	3	172.113	27.042	<.001[b]
	Residual	623.739	98	6.365		
	Total	1140.078	101			

a. Dependent Variable: Career_Total

b. Predictors: (Constant), Skills_Total, Attitude_Total, Awareness_Total

Source: Primary Data

Interpretation:

(A) Model Summary Interpretation $R^2 = 0.453$

The R^2 value of 0.453 indicates that 45.3% of the variation in Career Intention is explained by Awareness, Attitude, and Skills collectively. This suggests that entrepreneurial education plays a significant role in influencing students' entrepreneurial career decisions.

(B) ANOVA Interpretation $F = 27.042$, $p < 0.001$

Since the significance value is less than 0.05, the regression model is statistically significant. This means that the independent variables (Awareness, Attitude, and Skills) together significantly predict Career Intention.

C) Coefficient analysis:

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	3.075	1.927		1.595	.114
	Awareness_Total	-.010	.127	-.008	-.075	.940
	Attitude_Total	.415	.105	.384	3.948	<.001
	Skills_Total	.397	.141	.366	2.806	.006

a. Dependent Variable: Career_Total

Source: Primary Data

Interpretation:

Attitude is the strongest predictor of Career Intention, followed by Skills. Awareness does not have a significant direct impact on Career Intention. This implies that having knowledge about startups is not enough; a positive mindset and practical entrepreneurial skills are more important in motivating students toward entrepreneurship.

Hypothesis Testing:

Anova single factor for H1:

Entrepreneurial education has a significant positive impact on students' attitudes toward startup culture.

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Summary

Groups	Count	Sum	Average	Variance
DO YOU FEEL THAT STARTUPS ARE AN ATTRACTIVE CAREER OPTION FOR YOUNG PEOPLE?	102	429	4.205882	0.580955
DO YOU BELIEVE STARTUP CULTURE ENCOURAGES CREATIVITY AND INNOVATION?	102	436	4.27451	0.577364
DO YOU FEEL POSITIVE ABOUT WORKING IN A STARTUP ENVIRONMENT?	102	390	3.823529	0.760629
DO YOU THINK STARTUPS CONTRIBUTE SIGNIFICANTLY TO ECONOMIC GROWTH AND EMPLOYMENT?	102	409	4.009804	0.663269
DO YOU FEEL ENTREPRENEURIAL EDUCATION HAS CHANGED YOUR ATTITUDE TOWARDS STARTUPS POSITIVELY?	102	405	3.970588	0.642691

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	13.63529	4	3.408824	5.285149	0.000355	2.38959
Within Groups	325.7157	505	0.644982			
Total	339.351	509				

Source: Primary Data

Interpretation:

Since the F value exceeds the critical value and the p-value is below 0.05, the result is statistically significant. This means entrepreneurial education positively influences students' attitudes, making them view startups as attractive, innovative, and beneficial for economic growth.

***Anova: Single Factor H2*:**

Entrepreneurial education significantly improves students' confidence, problem-solving skills, and risk-taking ability.

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Summary

Groups	Count	Sum	Average	Variance
DO YOU FEEL CONFIDENT IN PRESENTING YOUR IDEAS AFTER LEARNING ENTREPRENEURSHIP?	102	399	3.911765	0.6159
DO YOU BELIEVE ENTREPRENEURIAL EDUCATION HAS IMPROVED YOUR PROBLEM - SOLVING SKILLS?	102	400	3.921569	0.766065
DO YOU FEEL MORE CAPABLE OF HANDLING UNCERTAIN OR CHALLENGING SITUATIONS?	102	404	3.960784	0.592506
DO YOU FEEL ENCOURAGED TO TAKE CALCULATED RISKS BECAUSE OF ENTREPRENEURIAL LEARNING?	102	399	3.911765	0.596098
DO YOU THINK ENTREPRENEURIAL EDUCATION HAS HELPED YOU DEVELOP LEADERSHIP QUALITIES?	102	409	4.009804	0.801883

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.733333	4	0.183333	0.27181	0.896137	2.38959
Within Groups	340.6176	505	0.67449			
Total	341.351	509				

Interpretation:

Here, the F value is lower than the critical value and the p-value is greater than 0.05, showing no statistically significant difference. This suggests that entrepreneurial education alone does not significantly improve students' confidence, problem-solving skills, or risk-taking ability at a measurable level.

Challenges:

- Students prefer traditional career paths due to fear of failure and financial uncertainty, which discourages them from choosing startups.
- Awareness about startups is present, but it does not strongly influence students' intention to pursue entrepreneurship.
- Entrepreneurial education alone does not significantly improve confidence, problem- solving ability, or risk-taking skills at a measurable level.

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❖ Limited practical exposure prevents students from understanding real-world startup environments.

Remedies:

❖ Provide mentorship programs, interaction with entrepreneurs, and guidance on funding opportunities to reduce fear and build confidence.

❖ Emphasise experiential learning methods such as startup simulations, case studies, and business plan development instead of only theoretical teaching.

❖ Conduct practical training, workshops, and skill-based activities to enhance entrepreneurial competencies.

Offer incubation support, startup internships, and hands-on experiences to create a strong entrepreneurial ecosystem within institutions.

Conclusion:

This shows that just knowing about startups isn't enough. A positive mindset and solid entrepreneurial skills matter more when shaping career intentions.

This study aimed to look at how entrepreneurial education affects students' views and career intentions regarding startups.

The results show that the questionnaire used was very reliable (Cronbach's Alpha = 0.916), which means the measurement scale was consistent.

Correlation and regression analyses showed that entrepreneurial education strongly influences students' career intentions. However, this effect varies across different areas.

The regression model explained 45.3% of the variation in career intention, indicating that entrepreneurial education plays a significant role in shaping students' choices about entrepreneurship.

The most important findings of the study are:

❖ Attitude toward entrepreneurship was the strongest predictor.

❖ Entrepreneurial skills also significantly influence career intention.

❖ Startup awareness alone does not directly affect career intention.

This suggests that while students may know about startups, awareness by itself doesn't encourage them to pursue entrepreneurial careers. A positive attitude toward entrepreneurship and strong skill development are more decisive.

These findings support the goal mentioned in the abstract, which is that entrepreneurial education shapes students' views and career intentions mostly through mindset and skill improvement rather than just awareness.

Therefore, the study concludes that entrepreneurial education programs should focus more on:

❖ Practical skill development

❖ Experiential learning

❖ Startup simulations

❖ Mentorship and incubation exposure

❖ rather than just theoretical awareness.

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BEYOND THE HUMAN SCREEN: CASE STUDY OF BOVINE RELATIONALITY AND ECOCRITICAL FUTURES

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Abstract:

This paper presents a case study of bovine–human relationality in the desert ecologies of western India, focusing on Kachchh, located at the edge of the Thar desert. Based on The Kachchh Cattle Study 2024, a field investigation conducted across nine talukas and forty villages, the research examines the ecological, economic, and cultural dimensions of cattle rearing in arid regions. The study documents how cattle continue to play a central role in household livelihoods, ecological adaptation, and cultural practices despite persistent challenges such as fodder scarcity, inflation, and modernization. The paper is framed within Third World Environmentalism, emphasizing the interconnection between poverty, ecological degradation, and resource distribution, and engaging with the concept of the environmentalism of the poor. Drawing on perspectives from Ecocriticism, Eco-Marxism, Eco-Feminism, Deep Ecology, and critiques of Anthropocentrism, the study situates pastoral practices and panjrapole within broader debates on multispecies ethics, sustainability, and social justice. The research further identifies a gap in existing digital cattle-management technologies, which remain largely text-based, linguistically exclusive, and inaccessible to illiterate pastoral and tribal communities. The paper outlines the need for accessible, multilingual, voice-based digital tools as a potential intervention to support cattle care, ecological sustainability, and rural livelihoods, while maintaining the ethical and cultural dimensions of human–animal relationships in arid landscapes.

Keywords: *Third World Environmentalism; Environmentalism of the Poor; Ecocriticism; Bovine Relationality; Desert Ecology; Kachchh; Panjrapole; Eco-Marxism; Eco-Feminism; Anthropocentrism; Technology and Ecology*

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Introduction:

This study is situated at the intersection of pastoral literature, ecocritical theory, and Third World environmental realities, using Kachchh as a living archive of human–animal relationality under ecological stress. Moving beyond romanticized Western pastoral traditions, the paper frames Kachchh as a "counter-pastoral" landscape, where survival is shaped by scarcity, labor, and ethical responsibility rather than leisure or abundance (Williams). Drawing upon eco-Marxist, ecofeminist, deep ecological, and postcolonial environmental frameworks, the paper examines how cattle function not merely as economic assets but as ecological agents,

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cultural kin, and ethical subjects within a fragile desert ecology. Anchored in *The Kachchh Cattle Study 2024*, the research positions Kachchh as an ecocritical site where literature, lived ecology, and political economy converge.

Statement of the Problem:

Despite the centrality of cattle to pastoral survival in arid regions, contemporary development models increasingly treat livestock through anthropocentric and capitalist logics, reducing them to units of productivity while externalizing ecological and emotional costs onto marginalized communities. In Kachchh, rising fodder prices, shrinking commons, disease outbreaks, and institutional neglect threaten both cattle survival and pastoral lifeworlds.

Existing technological and policy interventions remain linguistically, culturally, and structurally inaccessible, reinforcing ecological injustice. The problem this study addresses is the growing rupture between traditional ecological knowledge and modern regimes of capital, governance, and technology, and the absence of relational, multispecies perspectives in environmental planning.

Significance of the Study:

The study is significant on multiple levels. Literarily, it extends pastoral and postcolonial ecocriticism by grounding theory in empirical field data from the Global South. Theoretically, it synthesizes eco-Marxism, ecofeminism, deep ecology, and Third World environmentalism to analyze cattle not as metaphors but as co-survivors. Socially, it foregrounds the invisible labor of care, particularly women's ecological work, often erased from economic metrics (Shiva). Environmentally, it contributes to debates on justice-oriented sustainability, emphasizing survival rather than preservationist ideals. Finally, the study opens a futuristic intervention, proposing accessible, voice-based AI systems rooted in local languages and ethics.

Limitations of the Study:

While the research offers a multidisciplinary perspective, it is limited geographically to selected talukas of Kachchh and temporally to the 2024 fieldwork period. Quantitative data, represented through pie charts, capture proportional patterns but cannot fully articulate emotional, cultural, or ethical dimensions of loss. The study also does not include long-term longitudinal climate data or comparative regional analysis, which could further strengthen its predictive scope.

Objectives of the Study:

The objectives of this research are:

1. To examine cattle rearing in Kachchh as a multispecies ecological practice rather than a purely economic activity.
2. To analyze pastoral life through eco-Marxist, ecofeminist, and deep ecological frameworks.
3. To situate Kachchh within Third World environmentalism, where ecology and survival are inseparable.
4. To interpret quantitative data critically, revealing structural inequality and ecological precarity.
5. To explore the ethical role of panjrapols as counter-capitalist institutions of care.

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6. To propose inclusive, relational technological futures grounded in ecological justice.

Hypothesis of the Study:

H1 (Research / Alternative Hypothesis)

Cattle in Kachchh function as ecological partners rather than expendable economic resources, and their survival and well-being are significantly sustained through relational ethics, gendered care labor, and socio-cultural values, while capitalist restructuring and technological exclusion exacerbate ecological vulnerability; conversely, accessible, care- centered, and culturally inclusive technological interventions have the potential to enhance multispecies resilience and sustainability.

H0 (Null Hypothesis)

Cattle in Kachchh function primarily as economic resources, and their survival is determined predominantly by market efficiency and institutional management, with relational ethics, gendered care labor, and socio-cultural values having no significant impact on ecological sustainability; further, capitalist restructuring and technological accessibility do not significantly influence ecological vulnerability or multispecies resilience.

Literature Review:

1. The present study is situated at the intersection of pastoral literary studies, ecocriticism, and political ecology, drawing upon critical traditions that interrogate the relationship between nature, labor, power, and cultural memory. Central to this framework is Raymond Williams's seminal critique of pastoral idealization in *The Country and the City*, where he dismantles the romantic myth of the rural as timeless harmony and instead foregrounds the countryside as a "working landscape" shaped by labor, inequality, and historical struggle (Williams). This insight is crucial for reading Kachchh not as an idyllic pastoral but as a lived ecology marked by endurance, scarcity, and multispecies interdependence.
2. Eco-Marxist scholarship further deepens this analysis. John Bellamy Foster's *Marx's Ecology* exposes how capitalist systems alienate both human and non-human life by commodifying nature and externalizing ecological costs onto marginalized communities. Foster's work provides a critical lens to understand how fodder inflation, enclosure of commons, and uneven access to veterinary care in Kachchh are not isolated agrarian failures but structural outcomes of capitalist ecological relations (Foster). This critique is reinforced by Joan Martínez-Alier's formulation of the *Environmentalism of the Poor*, which reframes environmental struggle in the Global South as a fight for survival, livelihood, and justice rather than aesthetic conservation (Martínez-Alier). His work is foundational in positioning Kachchh within Third World Environmentalism, where cattle function as life-sustaining ecological partners rather than surplus capital.
3. Indian environmental historiography, particularly Madhav Gadgil and Ramachandra Guha's *This Fissured Land*, situates pastoral and agrarian communities as "ecosystem people" whose livelihoods remain embedded within local ecological cycles. Their work emphasizes that sustainability in India has historically emerged from culturally embedded practices rather than technocratic interventions (Gadgil and Guha). This perspective resonates strongly with the panjrapol system and household cattle rearing in Kachchh, where ecological care is sustained through ethical, religious, and communal frameworks.

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4. Ecofeminist theory, particularly Vandana Shiva's *Staying Alive*, exposes the gendered dimensions of ecological labor, revealing how women's care work, feeding, cleaning, nursing, and sustaining life, remains invisibilized within dominant development narratives (Shiva). This framework is vital for interpreting the unrecorded yet essential role of women in maintaining cattle survival in Kachchh, especially in contexts of disease, drought, and institutional neglect.
5. Literary interventions further enrich this study's analytical depth. Mahasweta Devi's fiction and essays foreground environmental injustice as inseparable from caste, class, and tribal marginalization, portraying human–animal relationships as ethical sites of resistance against extractive modernity (Devi). Similarly, Amitav Ghosh's *The Great Derangement* critiques modernity's failure to acknowledge non-human agency and climate catastrophe, arguing that the ecological crisis is also a crisis of imagination (Ghosh). These literary texts provide narrative and ethical vocabularies through which the lived realities of Kachchh's pastoral communities can be read as forms of ecological testimony rather than data alone.
6. Additionally, Arne Naess's Deep Ecology challenges anthropocentric hierarchies by asserting the intrinsic value of all life forms, offering an ecocentric framework to interpret cattle not as expendable resources but as participants in a shared ecological web (Naess). Rob Nixon's concept of "slow violence" further illuminates how ecological harm in regions like Kachchh unfolds gradually through neglect, disease, and infrastructural absence, disproportionately affecting vulnerable communities (Nixon).

   Collectively, these theoretical, historical, and literary works form the critical scaffolding for the present study. They enable a reading of Kachchh as both a material ecology and a literary-ecocritical text, where cattle embody ecological agency, cultural memory, and ethical responsibility. The existing literature, however, largely neglects the role of accessible, inclusive technology in sustaining such multispecies relationships—particularly in low- literacy, linguistically marginalized pastoral communities. By foregrounding this gap, the present study extends environmental literary discourse into the domain of ecocritical futurity, where care-centered, language-inclusive technological interventions are imagined as tools for ecological justice rather than instruments of extraction.

Research Methodology:

This study employs a mixed qualitative–quantitative research methodology to examine bovine relationality within the fragile pastoral ecologies of Kachchh.

- **Primary data** were collected during fieldwork conducted in February 2024 across nine talukas of Kachchh, using semi-structured interviews, participant observation, and site visits to households, panjrapols, dairies, and farms. Quantitative data concerning cattle population, mortality rates, household ownership, and institutional concentration were analyzed through proportional visualizations (pie charts) to identify structural patterns, ecological vulnerability, and asymmetries of care.
- **Secondary data** comprise literary texts, environmental history, ecological theory, and environmental sociology, situating the field findings within a broader humanities- based ecological discourse. The analytical framework integrates ecocriticism, eco- Marxism, ecofeminism, deep ecology, Third World

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environmentalism, and postcolonial studies, enabling a critical reading of cattle not merely as economic units but as ecological agents embedded in cultural memory, gendered labor, and subaltern lifeworlds. This interdisciplinary methodology allows the study to read Kachchh simultaneously as a lived pastoral ecology and an ecocritical text, bridging empirical data with literary and theoretical interpretation.

Data Analysis and Interpretation:

Quantitative findings reveal significant institutional concentration of cattle within a few panjrapols and a mortality rate that, while statistically moderate, carries disproportionate ecological and emotional weight in desert economies. Interpreted through Third World environmentalism, these figures expose structural inequality, uneven care distribution, and ecological vulnerability. Ecofeminist analysis highlights the unrecorded labor sustaining high survival rates, while deep ecology reframes cattle loss as a rupture in ecological relations rather than economic deficit. The data thus function not as neutral statistics but as ethical indicators, demanding relational and justice-oriented responses.

Introduction : A Fragile Pastoral at the Edge of Survival:

Kachchh, located on the western edge of Gujarat at the threshold of the Thar Desert, is a landscape where survival is neither accidental nor romantic. It is a region shaped by scarcity of water, of cultivable land, of institutional care, yet sustained through long-standing relationships between humans, cattle, and a fragile ecology. In Kachchh, environmentalism is not a matter of abstract preservation; it is a daily negotiation between life and loss. This condition situates the region squarely within what scholars identify as **Third World Environmentalism**, where ecological concerns are inseparable from poverty, livelihood, and social justice rather than wilderness protection alone (Guha and Martínez-Alier). Historically a crossroads of civilizations, from the Harappan settlement of Dholavira to later influences from Sindh, Persia, Marwar, and Gujarat, Kachchh bears a layered cultural memory

embedded in pastoral practices, artisanal traditions, and oral narratives. These cultural forms function as ecological texts, encoding strategies of adaptation in a harsh environment. Unlike the idealized pastoral landscapes of Western literary tradition, the pastoralism of Kachchh reflects what Raymond Williams terms a "working country" a lived ecology shaped by labor, precarity, and unequal power relations rather than pastoral leisure (Williams). This distinction is crucial, as it resists anthropocentric fantasies of nature as scenic background and instead foregrounds multispecies interdependence. Ecologically, Kachchh exemplifies vulnerability. With an average annual rainfall of less than 400 mm and frequent drought cycles, agricultural stability remains uncertain. In this context, cattle emerge as ecological mediators, converting sparse vegetation into sustenance, recycling resources, and stabilizing household economies.

As N. S. Jodha observes, livestock in dryland regions function as systems of "risk

distribution, resource recycling, and cultural identity" (1170). This relationship challenges anthropocentric development models that treat animals as expendable resources, aligning instead with **ecocentric** and **Deep Ecological** perspectives that recognize non-human life as integral to ecological balance rather than subordinate to human utility (Naess).

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This paper is grounded in **The Kachchh Cattle Study 2024**, a multidisciplinary field investigation conducted across nine talukas: Bhachau, Rapar, Mandvi, Anjar, Mundra, Bhuj, Lakhpat, Abdasa, and Gandhidham, by Somaiya Vidyavihar University and K. J. Somaiya College of Arts & Commerce, Mumbai. Through interviews, site visits, and observational analyses at panjrapole, farms, and households, the study documents the socio-cultural, economic, psychological, medical, and environmental dimensions of cattle rearing. The findings demonstrate that despite rising fodder costs, shrinking grazing commons, inflation, and market dependency, cattle remain central to survival and cultural continuity.

However, this pastoral ecology is increasingly destabilized by **capitalist agrarian restructuring**, a condition illuminated by **Eco-Marxist** analysis. Market-driven dairy economies commodify cattle as units of productivity, erasing their ecological and ethical value while transferring environmental risk onto marginalized rural communities. Grazing lands shrink as commons are enclosed or repurposed, and veterinary care becomes unevenly accessible, reflecting what Marxist ecologists identify as the unequal distribution of environmental costs under capitalism (Foster). Simultaneously, **Eco-Feminist** insights reveal how the labor of care, feeding, cleaning, nursing, and emotionally sustaining cattle, is disproportionately borne by women, remaining undervalued and invisible within both economic metrics and policy frameworks (Shiva). This feminized labor sustains ecological balance yet receives little recognition, reinforcing gendered hierarchies within environmental management.

Institutions such as panjrapole occupy a critical moral position within this landscape. Rooted in spiritual and religious ethics of non-violence, panjrapole resist the total commodification of animal life by sheltering abandoned, injured, and economically "unproductive" cattle.

Their existence embodies a counter-anthropocentric ethic, one that values life beyond market logic. Yet these institutions themselves struggle under financial constraints, reflecting the contradiction between ethical environmental care and capitalist neglect. Literarily, these realities resonate with postcolonial environmental writing that foregrounds ecological injustice rather than ecological nostalgia. The rural landscapes of Mahasweta Devi expose how environmental degradation disproportionately burdens marginalized communities, while Amitav Ghosh critiques modernity's refusal to acknowledge non-human agency and climate vulnerability. Kachchh, like these literary terrains, emerges as a site where environmental crisis is lived as economic anxiety, cultural erosion, and emotional dislocation rather than abstract catastrophe.

The urgency of this study lies in the accelerating rupture between traditional ecological knowledge and contemporary regimes of development, governance, and technology. As climate instability deepens and pastoral livelihoods are pushed to the margins, the future of human–animal relationality in regions like Kachchh stands at a critical threshold. This paper positions the region as a living ecocritical text, one that demands an environmentalism grounded not in exclusionary preservation but in justice, care, and multispecies survival.

1. Quantitative Analysis:

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Pie charts have been employed to represent proportional relationships within the dataset, particularly institutional concentration and mortality ratios, allowing for immediate visual comprehension of structural imbalance and ecological vulnerability. The pie charts derived from *The Kachchh Cattle Study 2024* do not merely represent numerical distributions; they visualize structural inequalities, ethical tensions, and ecological precarity embedded within desert pastoral economies.

Figure 1 reveals a significant institutional asymmetry: over one-fifth (21.4%) of the surveyed cattle population is concentrated within a single panjrapol, Radhe Krishna Gauseva Charitable Trust, Padhar, while the remaining 78.6% are dispersed across thirty-six smaller institutions. From an Eco-Marxist perspective, this concentration mirrors broader patterns of resource centralization characteristic of capitalist modernity, even within ostensibly charitable systems. While panjrapols function as ethical counter-spaces to market logic, their uneven capacity reflects the material realities of funding flows, donor visibility, and infrastructural access. This distribution also exposes the limits of privatized care in environmental governance. The burden of sustaining cattle life in arid Kachchh is disproportionately borne by a few well-resourced institutions, while smaller panjrapols and households struggle under rising fodder costs and ecological instability. Such imbalance reinforces Guha and Martínez-Alier's argument that environmental crises in the Global South
cannot be disentangled from questions of economic inequality and uneven development, marking this system as a clear instance of Third World Environmentalism, where survival itself becomes an ecological act.

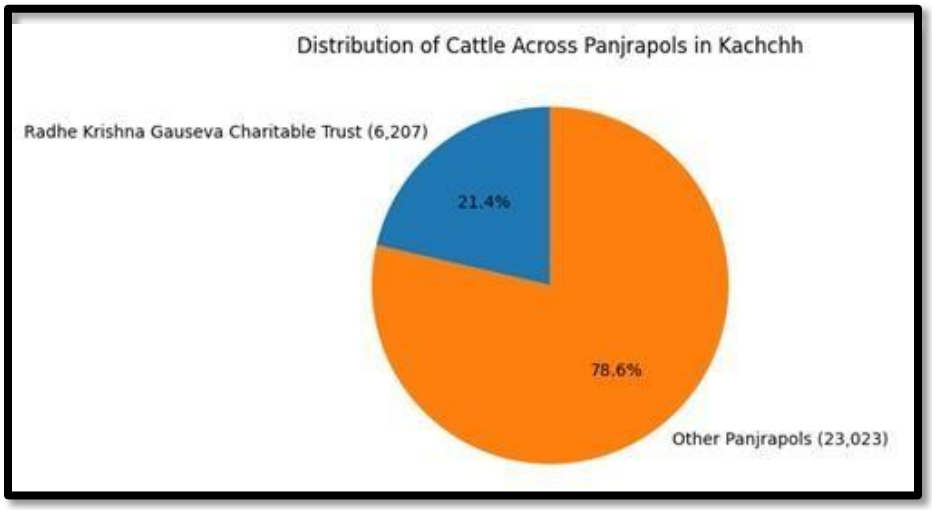


Fig. 1. Proportional distribution of cattle across 37 panjrapols surveyed during *The Kachchh Cattle Study 2024*. The Radhe Krishna Gauseva Charitable Trust, Padhar, alone shelters 6,207 cattle, accounting for approximately 21.4% of the total population surveyed (29,230), highlighting the centralization of care within select institutional spaces.

While the survival rate appears high, the mortality percentage remains significant in arid ecologies where each loss carries economic, emotional, and ecological consequences for already vulnerable households.

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Figure 2 illustrates a cattle mortality rate of 7.8% over the past two years, primarily due to lumpy skin disease. Though numerically marginal, this percentage assumes grave
significance within desert ecologies, where livestock represent not surplus capital but fragile lifelines. In the context of Environmentalism of the Poor, each animal lost signifies not only economic depletion but the erosion of emotional bonds, cultural continuity, and ecological reciprocity. The chart's visual simplicity risks masking the qualitative weight of loss. Mortality here must be read against limited veterinary access, delayed medical intervention, and infrastructural neglect, conditions that disproportionately affect marginalized rural and pastoral communities. The data thus reveal how environmental vulnerability is intensified by structural abandonment, reinforcing the argument that conservation without social justice reproduces ecological violence.

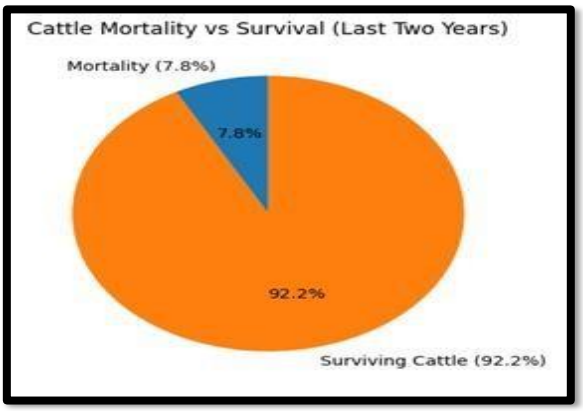


Fig. 2. Comparative proportion of cattle mortality (7.8%) versus survival (92.2%) over the past two years, with mortality largely attributed to lumpy skin disease and limited access to timely veterinary care.

1. ***Care, Gendered Labor, and Ecofeminist Insights***

   Although not explicitly gendered in the charts, the data invoke Ecofeminist concerns by pointing to the invisible labor sustaining cattle survival. Women in rural Kachchh often manage daily feeding, cleaning, and nursing of cattle, forms of care that remain statistically unrecorded yet are critical to maintaining the 92.2% survival rate shown in Fig. 2. The reliance on institutional shelters further marginalizes this domestic, feminized labor, transferring care from intimate, relational spaces to bureaucratic structures. Ecofeminism critiques this displacement as part of a broader epistemic erasure, where nurturing practices are undervalued while technological or institutional solutions are privileged. The charts, therefore, indirectly expose a gendered ecology of care that sustains multispecies life under conditions of scarcity.

2. ***Deep Ecology, Ecocentrism, and Ethical Tensions***

   From the lens of Deep Ecology, the charts challenge anthropocentric interpretations of utility and loss. Cattle mortality is not merely a reduction in economic assets but a rupture in the web of life that binds soil fertility, pastoral rhythm, and human survival. Panjrapole, despite their structural limitations, gesture toward an ecocentric ethic, where animal life is preserved beyond productivity, resisting the instrumental logic of

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capitalism. Yet the necessity of such institutions also reveals a contradiction: care becomes reactive rather than integrative, addressing the symptoms of ecological degradation rather than its systemic causes. This tension underscores the ethical limits of anthropocentric environmental management and calls for a relational framework that recognizes cattle as ecological participants rather than managed dependents.

3. ***Futurity and the Limits of Quantification***

on survival rates obscures the daily precarity faced by cattle owners navigating disease, drought, and market volatility. This limitation reinforces the need for futuristic, inclusive technological interventions, such as multilingual, voice-based AI systems, that can democratize access to veterinary knowledge and reduce dependency on centralized institutions. In this sense, the pie charts serve not as conclusive evidence but as ethical prompts, inviting a reimagining of human–animal–technology relations grounded in equity, care, and ecological justice.

- **Visit to Panjrapols / Dairy / Farm:** 22nd to 25th February 2024.

Sr. No.	Name of Panjrapol / Farm / Dairy	No of cattles
1	Matushree Ratanben Bharmal Mapshi Panjarpol, Bhachau	4336
2	Shree Jivdaya Panjrapol	1300
3	Shree Chapredi Gauseva Samiti	120
4	Shree Vivekananad Charitable Trust	400
5	Radhe Krishna Gauseva Charitable Trust, Padhar	6207
6	Madhapar Gau Rakshan Trust	500
7	Shree Momay Gauseva Charitable Trust, Jambudi	500
8	Sajanadh Trust	250
9	Harudi Charitable Trust, Harudi	236
10	Shree Ramkrishna Trust, Kukma	300
11	Ramvav Dairy (Samdi Bhai)	06
12	Bhimsar Gaushala	2200
13	Shree Gaurakshak Seva Samiti Gandhidham	580
14	Adipur gaushala (Mahesh joshi)	1750
15	Sethiya Farm	30
16	Pabuji Maharaj, Bandhara Nana, Ner	1000
17	Kamdhenu Gau Seva Trust, Anjar	1750
18	Shree Gaushala Trust (Mota Varnora)	160
19	Shree Vageshwari Gaushala, Habay	200
20	Ramesh Naudejhamil, Kunaria	300
21	Shree Ramnandi Gaushala Trust, Jamkunariya	200

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22	Shree Yadunandan Gauseva Kendra, Sumarasar	200
23	Shree Kandagra Panjrapol Jeevdaya Seva Trust, Kandagra	415
24	Shree Ratadia (Ganesh) Gaushala Panjarapol, Ratadia	715
25	Shree Mangaldeep Foundation Charitable Trust, Patri	269
26	Nakhatrana Gaushala Trust, Piyoni road	750
27	Shree Patidar Seva Sangh and Gauraksha Kendra, Matthal	600
28	Shree Nirona Fulpeerdada Gaushala Trust, Nirona	100
29	Shree Ashapura Mataji Mandir and Gaushala, Nana Ratadiya	156
30	Shree Gadhshishajiv Suraksha Jain Charitable and Research Trust, Gadsisa	1350
31	Shree Rampar Gurukul Trust, Rampar	250
32	Shree Dharmbhakti Prem Subodhsuri Aradhna Bhawan Jain Trust, Koday	304
33	Raydhanpur Panjrapol, Raydhanpur	175
34	Govind Gaushala Trust, Chapredi	175
35	Atalnagar Gaushala	250
36	Murlidhar Gaushala Trust, Zikdi	200
37	Kaali Talavadi Gauseva Samiti, Kaali Talavdi	650

- **Households visited:**

Sr. No.	**Name of householder**	**No of cattles**	**Sr. No.**	**Name of householder**	**No of cattles**
1	Manjula	02	32	Ramabhai	05
2	Deepali Runchodgagal.	04	33	Pachan bhai	500
3	Karmatrava	01	34	Karsan bhai	05
4	Jesha bhai	04	35	Hari bhai	01
5	Bhoja bhai	04	36	Devshi bhai guruji	200
6	Karsan bhai Mukhi	10	37	Prabhaben sodha	02
7	Ranchodbhai rabari	03	38	Jasuba jadega	02
8	Bhimabhai Rabari	01	39	Jigna ben sodha	01
9	Devabhai rabari	04	40	Ramuben Pala	03
10	Savabhai rabari	04	41	Ramila ben akhadiya	03
11	meghabhai rabari	05	42	Paluben Gandhi	02
12	Thavabhai rabari	03	43	Palji kadsan	02
13	Desarbhai rabari	03	44	JItubhai sisodiya	03
14	Vebhabhai rabari	03	45	Surendrabhai Chaudhary	02
15	Mahesh Thakkar	30	46	Virendra singh sodha	02
16	Bhikha bhai luha	02	47	Dharamba sodha	01

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17	Naran ramji desai	02	48	Meenaba sodha	01
18	Ambavi Raghu	01	49	Vajubhai Jalubhai Sodha	01
19	Moti ba	01	50	Manubhai Jalubhai sodha	02
20	Ratan ba	02	51	Pala bhana	02
21	Mahedra sodha	03	52	Jaga pala	03
22	Dhari pancha	03	53	Dilip ghanchordas sodha	02
23	Meenaben rabari	02	54	Premji akhai akhadiya	02
24	Laxmiben rabari	02	55	Ambavi Devraj chaudhary	03
25	Januben Rabari	03	56	Ramesh kadsan	04
26	Manbhai rabari	02	57	Ramesh dharamshree Gandhi	02
27	Jethabhai rabari	02	58	Pareen valji Gandhi	03
28	Laxmiben	02	59	Khamma bha sodha	04
29	Suja bhai	02	60	JIlu bha sodha	60
30	Ridhhi rabari	07	61	Narayan bhai	02
31	Viji rabari	02	62	Shanti ben narsi	03

Critical Discussion: Cattle, Crisis, and the Fractured Pastoral:

1. ***The Crisis of Survival: Ecology under Capitalist Pressure***

The data from Kachchh exposes a stark contradiction at the heart of contemporary pastoral life: cattle remain emotionally sacred yet economically burdensome. Fodder scarcity, inflation, disease outbreaks, and rising medical costs have transformed everyday care into a site of chronic distress. The strong correlation between fodder price escalation and household vulnerability confirms what eco-Marxist theorists identify as the commodification of nature under late capitalism, where survival systems are subjected to market volatility rather than ecological rhythms (Foster 42). What emerges here is not merely an agrarian problem but a structural ecological injustice. The transportation of fodder across districts, its price inflated by fuel costs and intermediaries, exemplifies how rural ecologies subsidize urban and industrial economies. This aligns with Joan Martínez-Alier's concept of the "ecological debt" borne disproportionately by the Global South, where environmental degradation and climate stress are endured without commensurate economic benefit (Martínez-Alier 58). Kachchh thus becomes a living archive of Third World environmentalism, where survival is negotiated daily against climatic precarity and capitalist neglect.

2. ***Pastoral Ethics versus Utilitarian Modernity***

The socio-cultural findings; where 78% of respondents perceive cattle as family, echo the ethical universe of pastoral literature, from classical georgic traditions to postcolonial rewritings. Unlike the romanticized pastoral of abundance, Kachchh represents what Raymond Williams calls the "counter-pastoral," where rural life is marked by endurance, labour, and sacrifice rather than leisure (Williams 35). This ethical pastoral finds resonance in Indian literary traditions as well. Mahasweta Devi's writings repeatedly foreground non-

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exploitative human–animal relations as acts of resistance against extractive modernity. Her depiction of marginalized communities shows how care for animals becomes a moral stance against systems that value productivity over life (Devi 112). Similarly, Amitav Ghosh's ecological imagination warns against the erasure of non-human agency in capitalist narratives of progress, arguing that climate crisis is inseparable from cultural amnesia (Ghosh 84).

In Kachchh, the older generation's refusal to abandon unproductive cattle embodies an ecocentric worldview, where value is not measured by output alone. The younger generation's shift toward utilitarian attitudes reflects an anthropocentric rupture, mirroring global trends where animals are reduced to economic instruments rather than relational beings.

a. ***Panjrapole: Institutional Care and Emotional Absence***

Panjrapols function as paradoxical spaces, simultaneously ethical and bureaucratic. While they shelter thousands of abandoned or injured cattle and demonstrate environmental responsibility through manure recycling and tree transplantation, the absence of emotional bonding highlights a shift from relational ethics to institutional management. This tension aligns with eco-feminist critiques, which argue that care systems detached from empathy risk reproducing patriarchal and capitalist logics of control (Shiva 67). Yet panjrapols also embody hope. Their manure economies, organic farming linkages, and religious philanthropy reflect what Gadgil and Guha describe as the practices of "ecosystem people," whose livelihoods remain embedded within ecological cycles rather than abstract markets (Gadgil and Guha 133). These institutions reveal that sustainability is not merely technological but ethical and cultural.

b. ***Body, Disease, and Ecological Violence***

The prevalence of lumpy skin disease and foot-and-mouth disease reveals another layer of structural violence. Disease here is not accidental but symptomatic of ecological imbalance, climate stress, and infrastructural neglect. The villagers' reliance on traditional healing methods, particularly among the Rabari community, signals both cultural resilience and systemic exclusion from accessible veterinary care. This condition parallels what Rob Nixon terms "slow violence," where environmental harm unfolds gradually, invisibly, and disproportionately affects marginalized communities (Nixon 2). The ingestion of plastic and metal by roaming cattle further exposes the ecological costs of consumer culture, where waste becomes a lethal interface between humans and animals.

c. ***Technology, Exclusion, and the Digital Divide***

While modern dairy cooperatives and technical support systems exist, they remain linguistically and structurally inaccessible to many pastoral communities. Most technological interventions assume literacy, digital fluency, and stable connectivity, conditions absent in many villages. This reflects a broader problem of language exclusivity in technological design, where innovation speaks the language of the elite while silencing subaltern users. A voice-based AI interface in regional languages, designed for low-literacy users, could radically transform this landscape. Such technology could disseminate real-time information on fodder management, disease prevention, sustainable practices, and alternative income

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generation using dung, urine, and by-products. By centering accessibility, such an intervention would align with eco-feminist and subaltern ethics, technology not as domination, but as care.

d. Toward a Futuristic Pastoral: Reimagining Human–Animal Futures

The findings compel an urgent rethinking of sustainability, not as abandonment of tradition, but as its ethical evolution. The cattle–human bond in Kachchh represents what deep ecology terms an ontological kinship, where humans are not masters of nature but participants within it (Naess 95). Preserving this bond is not nostalgic; it is futuristic. Pastoral and subaltern literature teach us that survival lies in relationships, not extraction. As Ghosh reminds us, the climate crisis is also a crisis of imagination, our inability to envision non-exploitative futures (Ghosh 129). Kachchh offers such an imagination: where cattle are ecological partners, dung becomes fertilizer, care becomes resistance, and technology serves life rather than capital.

Conclusion: Beyond the Human Screen, Toward an Ethics of Relational Futures

This study has argued, across data, theory, and literary imagination, that the crisis of cattle in Kachchh is not an isolated agrarian problem but a civilizational question, one that asks how futures are to be imagined when human survival is inseparable from non-human life. What unfolds in Kachchh is a fragile pastoral at the edge of collapse, where cattle are at once kin, capital, ecological agents, and ethical subjects. The findings compel us to recognize that the erosion of this bond signals not progress, but a deepening rupture produced by capitalist modernity, ecological neglect, and technological exclusion. From an eco-Marxist perspective, the data reveal how pastoral life absorbs the hidden costs of development, fodder inflation, disease, enclosure of commons, while urban and industrial economies reap its benefits (Foster). Through the lens of Third World Environmentalism, Kachchh stands as a living archive of survival, where environmentalism is practiced not as luxury conservation but as daily resistance against scarcity and dispossession (Guha and Martínez-Alier). Ecofeminist insights expose how the invisible labor of care, performed largely by women, sustains both cattle life and ecological balance, even as it remains unrecognized within policy and technological design (Shiva). Deep Ecology and ecocentrism remind us that each animal lost is not a statistical reduction but a rupture in the web of life itself (Naess).

Literarily, the region speaks the language of a counter-pastoral. Unlike the idyllic landscapes of classical pastoral, Kachchh resonates with what Raymond Williams calls a “working country,” marked by endurance rather than leisure, by care rather than consumption (Williams). In this sense, the lived realities of Kachchh echo the ethical terrains of Mahasweta Devi’s marginalized ecologies and Amitav Ghosh’s insistence on recognizing non-human agency within the climate crisis. Here, cattle are not metaphors; they are co- survivors. Yet the study also reveals a decisive fault line: technology exists, but it does not speak to those who need it most. Contemporary systems assume literacy, connectivity, and linguistic dominance, rendering pastoral communities technologically invisible. This is where the future must intervene, urgently and ethically.

The conclusion of this paper, therefore, is not merely diagnostic; it is futural and propositional. What Kachchh demands is a relational, AI-driven intervention that does not replace pastoral knowledge but amplifies it. A

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multilingual, voice-based AI application: designed in regional languages, accessible to low-literacy users, and rooted in local ecological practices, can become a transformative bridge between tradition and futurity. Such an app could:

- provide real-time veterinary guidance and early disease alerts,
- offer fodder planning and climate-adaptive strategies,
- disseminate sustainable practices using dung, urine, and by-products,
- enable innovative, ethical capital generation without ecological harm, and
- preserve oral knowledge by translating lived wisdom into shared digital memory.

Crucially, this technology must be guided by care, not control, aligned with ecofeminist ethics, subaltern accessibility, and ecocentric values. In doing so, AI ceases to be an extractive tool of surveillance capitalism and becomes an instrument of ecological justice.

The urgency of this intervention cannot be overstated. As climate instability accelerates and pastoral life worlds are pushed further to the margins, the loss at stake is not only economic but ethical and imaginative. If the human–cattle bond collapses, what disappears with it is an entire way of inhabiting the world, one that understands survival as interdependence rather than domination. In reimagining Kachchh as a living ecocritical text, this paper asserts that the future of sustainability lies beyond the human screen: in technologies that listen, in development that cares, and in environmentalism that remembers its most vulnerable custodians. To sustain cattle in Kachchh is, ultimately, to sustain a vision of life where

progress is measured not by accumulation, but by the capacity to live together, human and non-human, in dignity, reciprocity, and hope.

- ***Photos with Geo-Tags:***



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Visit to farm to learn sustainable agriculture usi ng cattles



Visit to Ner village

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Visit to dairy supported by AMUL



School visit in Ramvav to learn the perspectives of the new generation about cows

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Students interacting with cattle owners in Galpadar village



Cattle treatment area in the animal hospital

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Students interacting with veterinary doctor in Panjrapol Meghpar



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EMERGING TRENDS IN DIGITAL JOURNALISM : A CONTENT ANALYSIS OF ONLINE NEWS START-UPS IN INDIA

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Abstract:

Digital journalism in India is rapidly transforming due to technological innovation, artificial intelligence (AI), platform dependency, and changing audience behaviour. This study examines emerging trends among national digital news start-ups using qualitative and quantitative content analysis. It analyses their content strategies, revenue models, distribution patterns, AI integration, audience engagement, and editorial positioning.

Findings show increasing use of AI tools for content production, summaries, translations, and data analysis to improve efficiency and reduce costs. However, this has led to content homogenisation and reduced differentiation among platforms. With declining advertisement revenue and lower search traffic, many start-ups are shifting toward subscription and membership-based models.

The study also highlights fragmented distribution across social media, newsletters, and messaging apps, along with growing information inequality as premium journalism moves behind paywalls. While AI offers innovation opportunities, sustainable growth depends on credibility, niche focus, and audience trust.

Keywords: *Digital Journalism, Online News Start-ups, Artificial Intelligence in Media, Media Convergence, Audience Engagement*

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Introduction:

The media ecosystem in India is changing dramatically as a result of the quick development of internet-based communication technologies, smartphone usage, and digital innovation. Unlike earlier times when print newspapers and broadcast television dominated, modern journalism is increasingly affected by digital-first platforms, algorithmic distribution systems, and audience- centered content techniques. The way Indian journalists create, disseminate, and consume their work is being altered by online news start-ups, which have emerged as important actors in this evolving ecosystem. Because of this, digital news startups are not just copying old media models, instead, they are launching new formats including data-driven articles, podcasts, newsletters, explainer videos, short-form journalism, and interactive elements built for online interaction.

1. *Statement of the Problem*

The rapid expansion of internet technologies and digital innovation has significantly transformed India's media ecosystem. Digital news start-ups have emerged as influential actors, introducing new content formats, algorithm-driven distribution systems, multilingual outreach, and AI-assisted journalism. However, despite their

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growing presence, there is limited systematic academic research examining how these platforms structure their content, integrate technology, differentiate editorial strategies, and sustain revenue models.

Furthermore, the increasing reliance on data analytics, platform algorithms, automation, and subscription-based models raises important questions about content homogenisation, accessibility, editorial independence, and the future of journalistic standards in India. Therefore, this study seeks to critically examine the emerging trends shaping digital news start- ups in India.

2. *Significance of the study*

Despite the rapid proliferation of online news start-ups in India, there remains limited systematic academic analysis of how these platforms structure their content, utilize technology, and differentiate themselves within the broader media ecosystem. While existing research discusses digital journalism and media convergence, fewer studies focus specifically on content patterns within Indian online news start-ups.

This study seeks to address this gap by conducting a qualitative content analysis of selected online news start-ups in India. By examining editorial strategies, content formats, technological integration, and audience engagement practices, the research aims to identify key emerging trends shaping digital journalism in the Indian context.

3. *Limitations of the Study*

The study is subject to the following limitations:

1. The research is restricted to six selected digital news platforms which are
   - The Quint
   - The Print
   - The Wire
   - Dailyhunt
   - Inshorts
   - Khabar Lahariya
2. The analysis is based on content evaluation and does not include interviews with journalists, editors, or audiences.

   Despite these limitations, the study provides a focused and structured understanding of emerging patterns in Indian digital journalism.

4. *Objectives of the Study*

The study aims to:

1. Examine emerging trends in digital journalism among selected online news start-ups in India.
2. Analyse content formats, editorial positioning, and storytelling techniques adopted by these platforms.
3. Evaluate the role of technology, AI tools, and automation in content production and distribution.
4. Assess revenue models including subscription-based and membership-driven approaches.

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5. Study multilingual outreach, personalization, and audience engagement strategies.
6. Understand how digital-native platforms are redefining journalistic norms in India.

Literature Review:

The digital transformation of journalism has been widely recognized as one of the most consequential shifts in the history of news media, bringing with it new organizational forms, business models, and editorial norms (Rai, Jha & Uttam, 2026). Scholars and practitioners alike argue that the increasing integration of digital technologies has fundamentally restructured the processes through which news is produced, circulated, and consumed. This shift is characterized by the rise of digital-native news organizations commonly known as digital news start-ups which utilize mobile platforms, social media, automation tools, and algorithm-driven distribution strategies to engage audiences outside traditional mass media channels.

A seminal contribution to this field is the *Digital Journalism Start-Ups in India* report by Sen and Nielsen (2016), which systematically analysed Indian digital news start-ups to understand how they develop editorial priorities, distribution strategies, and funding models appropriate to the Indian digital media context. Sen and Nielsen found that while start-ups leverage mobile- first and social-first strategies, sustainable business models remains challenging to attain against the backdrop of declining traditional advertising and high dependence on platforms like Facebook and Google.

Correspondingly, academic research has examined how digital news start-ups reflect a broader trend toward entrepreneurial journalism**,** where journalistic innovation is intertwined with market logic and resource constraints. Prasad (2019) examined digital disruption in Indian journalism and shows that start-ups are experimenting with new revenue strategies, audience analytics, and technological tools, highlighting both opportunities and limitations of their digital first models.

Dahiya's *Digital First: Entrepreneurial Journalism in India* (2023) further contextualizes this transformation by exploring the structural features, strategic intent, and editorial policies of key digital start-ups across India. Dahiya's work elaborates how these organizations combine journalistic ambition with entrepreneurial practices to compete with large legacy media houses, yet also underscores persistent challenges related to revenue generation, audience monetization and organizational capacity in a crowded digital field.

Scholars have also noted the platformization of digital news. Algorithm-driven distribution and social media engagement have reshaped editorial workflows, with digital news start-ups relying on data analytics and audience metrics to inform content decisions. This reflects broader trends discussed in literature on digital journalism, where the shift from professional gatekeeping to networked, metrics-oriented news ecosystems affects what kinds of stories are produced and how they reach audiences (Briggs, 2015).

In addition to business model and technological considerations, a growing body of research highlights the structural obstacles to sustainable independent journalism. Studies on venture philanthropy and media innovation show that initiatives like the Google News Initiative and Meta Journalism Project attempt to infuse capital and capacity into local and start-up journalism, yet raising substantive funding remains a challenge for many organizations pursuing public-interest or non-profit journalism (Creech, 2024; Journalism Funders Forum, 2023). Such challenges are

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compounded in the Indian context where philanthropic networks and grant funding are relatively nascent compared to Western media markets.

Further literature also highlights the political and economic pressures that influence digital news start-ups. Non-profit organizations such as The Wire and Khabar Lahariya strive to maintain editorial independence while navigating political pressures, legal risks, and resource scarcity, illustrating the delicate balance between journalistic autonomy and operational viability (Business Standard, 2015).

Collectively, the existing literature underscores that while digital journalism start-ups in India are innovative in form and strategy, they are confronted with enduring challenges related to monetization, audience loyalty, technological dependency, and competitive pressures from both global technology companies and established media institutions. Notwithstanding these constraints, digital start-ups represent a dynamic and evolving segment of India's media ecosystem, contributing to pluralism, niche reporting, and the redefinition of journalistic norms.

Despite this growing body of research, there remains a gap in systematic content-based comparative analysis across different types of digital start-ups in India. Much of the literature focuses on business models, organizational structures, or technological frameworks, with less emphasis on how editorial content itself is shaped and differentiated across models. The present research addresses this gap by conducting a content analysis of selected digital news start-ups to identify emerging trends and editorial strategies that define digital journalism in India today.

Research Methodology:

The study focuses on six selected digital news platforms in India representing diverse organizational and technological models:

1. **The Quint** – Profit-based digital news platform
2. **The Print** – Profit-based digital news platform
3. **The Wire** – Non-profit digital news platform
4. **Dailyhunt** – Technology-driven news aggregation platform
5. **Inshorts** – Technology-based short-format news application
6. **Khabar Lahariya** – Non-profit, rural and grassroots digital news platform

These platforms were selected to ensure representation of profit-based, non-profit, and technology-driven digital journalism models in India.

a. Research Design

The research follows a descriptive research design using quantitative content analysis. This design is appropriate as the study aims to identify patterns, frequency distribution, and thematic representation in the content published by selected digital news start-ups. The approach enables objective comparison across different digital platforms.

b. Unit of Analysis

An individual news article published on the selected digital news platform serves as the unit of analysis for this study. Each article is treated as a distinct textual unit that reflects the editorial choices.

c. Data Collection Procedure

News articles were collected directly from the official websites of the selected digital news start-ups. Each article

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was examined through a structured coding framework designed to identify recurring themes, narrative patterns, editorial framing, and content presentation styles.

Results and Discussion:

This chapter presents the results of the qualitative content analysis conducted on six selected digital news start-ups in India. A total of 120 news articles (20 from each selected digital news platform) were systematically selected and analysed. Each article was carefully examined to understand its dominant themes, headline patterns, narrative structure, framing of issues, and editorial positioning.

1. ***Content and editorial narrative analysis of selected digital news start- ups:***

Table 01

Platform	Nature of Headlines	Content and Narrative Analysis	Editorial Perspective
The Quint	Semi-emotional, engaging, and opinion-driven	Descriptive articles, social justice narratives, and political analysis	Issue-driven and evidence-based
The Print	Formal in tone with a strong emphasis on governance issues	In-depth analysis of public policy, governance, and political developments.	Data-driven and expert-centred in discourse
The Wire	Direct and accountability-focused in expression	Investigative reporting, political critique, and civil rights based journalism	Autonomous journalism with a strong watchdog role
Dailyhunt	Informative and neutral in tone	Concise and structured summary format	Technology-driven Neutral content distribution
Inshorts	Direct and attention-oriented	Brief summaries of political, economic, and current affairs news	Neutral and speed-driven digital journalism
Khabar Lahariya	Community-oriented with a field-based perspective	Grounded and people-centric storytelling incorporating voices of affected communities	Participatory journalism promoting local empowerment

The table indicate that while some platforms emphasise analytical and accountability journalism, others prioritise speed, aggregation, and accessibility in digital news dissemination.

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2. A content analysis of union budget session 2026 across selected digital news platforms

i. The Qunit:

Figure 1 (Source: Internet)



The Quint's fact-checking initiative WebQoof plays a significant role in combating fake news by systematically identifying, verifying, and debunking misinformation circulating on digital platforms, particularly social media. In the case of the viral claim alleging that Finance Minister Nirmala Sitharaman stated there is no poverty in the country, WebQoof conducted a structured investigation by first identifying the trending claim, then analyzing the viral graphic for inconsistencies such as watermarks, and tracing the original source through reverse image search and source verification. The team cross-checked the statement with official government speeches, parliamentary records, budget presentations, credible news reports, and government channels, finding no evidence to support the claim. Based on this verification process, WebQoof concluded that the graphic had been digitally manipulated to misrepresent the facts. Through evidence-based reporting, transparent methodology, and the use of digital verification tools, WebQoof strengthens journalistic accountability, promotes media literacy, and helps prevent the spread of misinformation.

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ii. The Print:

Figure 2 (Source: Internet)



At 11:55 on February 1st, The Print posted on social media, asking viewers to submit any queries they may have about the Union Budget 2026–2027. The post said that on their weekly show #ShekharSeSawaal, journalist Shekhar Gupta and Apoorva Mandhani would answer a few chosen queries. By giving viewers a forum to ask questions and acquire information about the Union Budget, the message sought to promote audience participation and public engagement. Additionally, a brief link to submit queries was included in the piece.

iii. The Wire:

Figure 3 (Source: Internet)



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The Wire published a video titled "Will Budget 2026 Solve Your Problems?" on February 1, 2026, in which it analyzed the Union Budget and its economic impact. The discussion highlighted market reactions, including the decline in stock indices such as the Nifty and Sensex, and examined key budget priorities like capital expenditure and the focus on youth empowerment (Yuvashakti). The video critically explored themes such as revenue distribution between individual taxpayers and corporates, concerns about employment generation, infrastructure outcomes, and the broader implications of India's growth model. Through analytical commentary and data-driven discussion, the program evaluated whether the budget effectively addressed public needs or primarily supported corporate and macroeconomic interests.

iv. The Dailyhunt:

Figure 4 (Source: Internet)



The coverage of the Union Budget 2026 by Dailyhunt demonstrates a visually driven and audience-centric approach to digital news dissemination. The platform presented the budget highlights through an infographic titled "What Gets

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Cheaper, What Turns Costlier After Budget 2026," simplifying complex fiscal announcements into easily digestible categories such as healthcare, education, electronics, financial transactions, and compliance penalties. By clearly dividing the information into "Cheaper" and "Costlier" segments, Dailyhunt framed the budget primarily from a consumer impact perspective rather than a macroeconomic or policy-analysis lens. The emphasis on smartphones, EV batteries, medicines, and taxation changes reflects a middle-class and market-oriented framing strategy aimed at maximizing reader engagement. The use of bold visuals, color contrast (green for relief, red for cost increase), and minimal textual explanation indicates a shift toward infographic-based, quick-consumption journalism typical of mobile-first news platforms. This coverage suggests that Dailyhunt prioritized accessibility, shareability, and simplified economic interpretation over detailed fiscal analysis, aligning with contemporary digital news consumption patterns.

v. Inshorts:

Figure 5 (Source: Internet)



The analysis of Inshorts coverage of the Union Budget 2026–27 indicates a concise, highlight- driven, and platform-optimised presentation style. Rather than offering in-depth policy analysis or critical commentary, Inshorts focused on delivering key announcements and sector-wise highlights in a swipe-based visual format. The headline framing "Swipe through the key highlights" reflects a mobile-first, engagement-oriented approach designed for quick consumption. The coverage emphasised major announcements made by the Finance Minister and sectoral impacts, without extensive contextual interpretation or ideological positioning. This suggests that Inshorts prioritises brevity, accessibility, and rapid information dissemination over analytical depth, aligning with its speed-driven and summary-based digital journalism model.

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vi. Khabar Lahariya:

Figure 6 (Source: Internet)



The Khabar Lahariya's coverage of the Union Budget 2026–27 reflects a grassroots and ground-reality-driven journalistic approach. Unlike summary-based or policy-centric reporting, Khabar Lahariya contextualised the budget announcement particularly the allocation for Saksham Anganwadi and POSHAN 2.0 within the lived realities of villagers in Prayagraj. The headline framing, "Budget Rises Again, Yet Ground Reality Reveals Decades of Delays," indicates a critical and accountability-focused perspective. The narrative structure prioritises field reporting, highlighting infrastructural gaps, community concerns, and the discrepancy between policy announcements and implementation. By incorporating local voices and specific village-level details, the platform adopts a participatory and empowerment-oriented editorial stance. This suggests that Khabar Lahariya frames the Union Budget not merely as a financial document but as a social justice issue linked to governance effectiveness and rural development.

The content analysis of the Union Budget Session 2026 across selected digital news platforms reveals significant variations in editorial strategies, narrative depth, and audience engagement models. While The Quint emphasized

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fact-checking and misinformation verification through its WebQoof initiative, reinforcing journalistic accountability, The Print adopted an audience- engagement approach by inviting public queries and facilitating expert-led discussion. The Wire provided analytical and critical commentary, examining the broader economic and structural implications of the budget. In contrast, Dailyhunt and Inshorts prioritised simplified, visually driven, and summary-based formats that focused on accessibility and quick information consumption rather than detailed policy analysis. Meanwhile, Khabar Lahariya distinguished itself through grassroots reporting, contextualising budget allocations within local realities and highlighting gaps between policy announcements and implementation.

Overall, the findings demonstrate that digital news platforms interpret and present the Union Budget through diverse editorial lenses ranging from watchdog and analytical journalism to platform-based aggregation and community-centred storytelling reflecting the evolving and multi-layered nature of digital news ecosystems in India.

Conclusion and Recommendations:

1. Conclusion

This study examined emerging trends in Indian digital journalism through content analysis of selected digital news platforms representing investigative, policy-driven, aggregator-based, and community-oriented models. The findings reveal that digital journalism in India operates within a diverse and evolving ecosystem shaped by technology, editorial ideology, and financial structures.

The integration of artificial intelligence and digital automation has significantly influenced news production and dissemination. AI tools enhance efficiency in summarisation, translation, and content distribution, however, excessive reliance on algorithms may lead to content standardisation and reduced editorial independence. Additionally, declining advertisement revenues and shifting digital visibility have encouraged many platforms to adopt subscription and membership-based models. Although these approaches support financial sustainability, they also raise concerns about unequal access to high-quality investigative journalism.

2. Recommendations

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

1. **Strengthening Editorial Differentiation**
   Digital news platforms should develop clear niche specialisations to avoid content homogenisation caused by AI-driven automation and platform dependency.
2. **Balanced Integration of Artificial Intelligence**
   AI tools should be used to enhance efficiency and data analysis while maintaining human editorial oversight to preserve journalistic integrity and originality.
3. **Enhancing Media Literacy**
   Fact-checking initiatives and transparent verification processes should be strengthened to combat misinformation and build public trust.
4. **Support for Grassroots and Regional Journalism**
   Policymakers and funding bodies should encourage rural and community-based journalism to promote pluralism and represent diverse voices within India's media landscape.

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CRYPTOCURRENCY MARKET BEHAVIOR: AN ANALYTICAL STUDY WITH IMPLICATIONS FOR RETAIL TRADERS AND INVESTORS

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Abstract:

This study examines cryptocurrency market behaviour during crash conditions and evaluates the extent to which structured risk management techniques and behavioural biases affected financial losses. The study employs a quantitative design that is bolstered by qualitative observations. A structured questionnaire was used to gather primary data from (111) retail cryptocurrency traders. In order to obtain a deeper understanding of behaviour, (12) active cryptocurrency market traders were interviewed for qualitative analysis. The relationships between behavioural biases, social media influence, risk management techniques, and financial losses were examined using one-way ANOVA and Pearson correlation analysis. The results show that emotional biases like panic selling, overconfidence, FOMO, and frequent short-term trading greatly increase financial losses. A majority of respondent groups' trading decisions were found to be influenced by social media sentiment. Most significantly, correlation analysis confirms that disciplined strategies significantly lower the magnitude of losses during times of high volatility by showing a strong negative relationship between structured risk management practices and financial losses.

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Introduction:

The Cryptocurrency market is one of the highly volatile markets of the financial markets and Global Financial System. Because prices change quickly and there is a lot of speculation in this market. The crash of 2025-26 showed how dangerous it is for normal retail traders and investors, especially when the market is very volatile. In the last few years, more people have started trading in Cryptocurrencies at high volume. However, many of these traders do not know how to manage their risks properly. Trading decisions are often affected by Behavioral biases such as Fear of Missing out (FOMO), Panic selling, Overtrading, and Over Confidence. These biases can cause big losses when the market goes down. The study seeks to analyze:

The behavior of the Cryptocurrency market during the crash conditions and evaluate its effects on the financial losses incurred by retail traders. It also looks at whether structured risk management practices really do cut losses or not. The study is done to promote sustainable and disciplined trading and investing in highly volatile markets.

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(Conceptual Framework of the Study):

- **Cryptocurrency: -**

  Cryptocurrency is a type of digital asset that is decentralized and runs on blockchain technology. It is not controlled by banks or governments. Satoshi Nakamoto, who used a fake name, created Bitcoin in 2008. It was the first Cryptocurrency, and it is still well unowned digital asset on the market. Over time, Cryptocurrencies like bitcoin and Ethereum have become very popular around the world because they have the potential to make a lot of money and more institutions are getting involved.

  But unlike other Traditional financial assets, the prices of Cryptocurrencies are getting affected by market sentiment, speculative trading, macroeconomic changes, regulatory uncertainty, and lack of centralized regulation and the fact that trading is always going on make prices even more unstable.

- **Risk Awareness:**

  Many retail traders in the cryptocurrency market don't know how to properly manage their risk and often make decisions based on how they feel instead of sticking to plan. They buy stocks because they are afraid of missing out when prices go up quickly, and they sell stocks in panic when the market crashes, which is the worst time to do so. They lose even more money by overtrading, using too much leverage, and not managing their risk well, like not using stop-loss, sizing their position wrong, and not diversifying. Many traders don't have a structured trading plan or a long-term vision because they are influenced by social media hype and the hope of making quick money. Because of this, inexperienced and uninformed investors often lose money trading cryptocurrencies because they don't know enough about them, don’t have enough discipline or don't know how to control their risks.

Background of Current Cryptocurrency Market:

The Cryptocurrency market in 2025-226 was very unstable market and had one of the biggest corrections in recent years. After a long rally Bitcoin dropped almost 20000 points in a short amount of time, which caused a lot of panic in the market. The crash caused record number of leveraged liquidations, which showed how risky speculative trading positions are. Global macroeconomic uncertainty, trade tensions, geopolitical conflicts, and changing risk sentiment in international financial markets made this correction worse. Episodes of instability caused by war and sudden political changes made the market even more scared, which lead to quick capital flows from risk sensitive assets like Cryptocurrencies.

The big sell off and the big price drops showed that retail trading has more structured problems, especially when people use too much leverage and don’t have structured risk management plans. These conditions are important for looking at retail financial losses and how important is disciplined risk management during times of high volatility and crashes.

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- **VARIABLES:**

INDEPENDENT VARIABLES: -	**DEPENDENT VARIABLES: -**
Market volatility Price trends Global economic news Social media sentiment	Investment Decisions Risk taking behavior Trading frequency

ODERATING VARIABLES: -
Financial literacy Experience level Risk tolerance News Awareness

Review of Literature:

Author Name	**Research Findings**	**Research Gap**
C Chinazzo, V Jeleskovic 2024	According to the study, Bitcoin has extremely high volatility on a daily and annual basis across all methodologies. It also emphasizes how estimates of implied volatility may be impacted on the lack of liquidity in the Bitcoin options market, especially for options with longer maturities or extreme moneyness.	This study primarily focuses on quantitative volatility comparisons in the cryptocurrency market. However, risk management advice specifically for retail investors is missing. The paper does not discuss how new retail traders can practically apply these techniques in real trading and investment decisions.
J Qi, Y Zhang, C Ouyang, 2025.	According to the study, investors who rely significantly on financial advisors are less likely to make current and future cryptocurrency investments. On the other hand, dependence on social media and the media boosts present and future cryptocurrency investment. It	While this study is useful in understanding investor psychology in the cryptocurrency markets, it does not address proper risk management techniques.

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	demonstrates that greater investor confidence raises investing in cryptocurrency.	Does not provide insights into future growth prospects of the cryptocurrency market.
S Li, J Ma, 2024	This study found that the sentiment on Twitter has a mixed impact on the short-term price movements of five different cryptocurrencies. It also demonstrates that the prices of all five cryptocurrencies are adversely impacted by increased interaction with original Twitter posts.	The study mainly focuses on investment intention rather than risk management practices adopted by retail traders, especially during periods of high volatility. It does not propose or evaluate structured risk management or discipline strategies that retail investors can use to control behavioral biases. The limited sample size restricts its applicability to evolving cryptocurrency market conditions.
So, Han, 2025	According to the paper, investor sentiment has a big impact on cryptocurrencies' returns. A study found that speculative assets are overpriced. Cryptocurrencies that are highly sensitive to positive sentiment produce lower returns than those with moderate sentiment sensitivity, which yield higher risk-adjusted returns. These outcomes hold true for various model and liquidity metrics.	Although the study examines the impact of investor sentiment on cryptocurrency prices, it does not consider recent market crash conditions of 2025-26. Does not provide a framework for understanding future cryptocurrency price growth.
M Sahu, F Uddin, MB Hossain, 2025	The findings show that psychological factors strongly affect the investment decision of Indian crypto investors. Personality traits like extraversion, agreeableness and openness increase biases such as the disposition effect an availability bias. In the highly volatile crypto market, biases often lead to illogical investment decisions.	The paper does not analyze structured risk management techniques used by retail investors or traders. The study focuses on psychological factors; it does not examine how these biases cause financial losses, particularly during times of high volatility or crashes. It also lacks a forward-looking viewpoint on market growth and risk management in the cryptocurrency market.

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BW Miba'am, H Güngör 2025	The study finds that geopolitical risk and pandemic risk negatively affect Bitcoin returns, while economic policy uncertainty has a positive effect. The outcome demonstrates that bitcoin returns act as a hedge against EPU in the lower and middle return levels and against pandemic risk at lower levels. The study concludes that uncertainty in the US affects Bitcoin returns, with economic policy uncertainty having the strongest impact, supporting cryptocurrency hedging and safe-haven role.	It fails to show any real connection between political figures or tweets to investor's behavior. Analysis of social media manipulation by influencers or political commentary is ignored. No implication or future growth potential for the market and retail risk management is provided.
M Cary, 2024	The study shows that cryptocurrency market crash affects investors' sentiment differently. Crypto-focused investors are becoming more neutral and less negative compared to traditional investors. Also, they felt less happiness and surprise after the crash, and cryptocurrency enthusiasts increased their social media activity. Analysis of tweeted content indicates that the cryptocurrency investors heavily exhibit herding behavior.	The study does not offer a systematic comparison between the crash and typical market phases The direct correlation between the degree of loss and the severity of behavioral biases like panic or herding is not analyzed. No analysis is done on post-crash recovery participation patterns, which include investors re-entry or exit from the market.
H Mauludin, VMN Marayana, 2026	The results of this study state that factors such as herding, loss aversion, reflection effect significantly influence crash-prone behavior, with risk perception being the strongest predictor. The study finds that higher risk perception increases investor's fear of losses, but it has no effect or herding behavior. It contradicts the traditional prospects theory by lessening the reflection effect.	The paper does not compare crash market vs normal market behavior. The relationship between actual loss amount and bias strength is not analyzed. The study yet fails to find out whether people re-enter the market after crashing or staying away.

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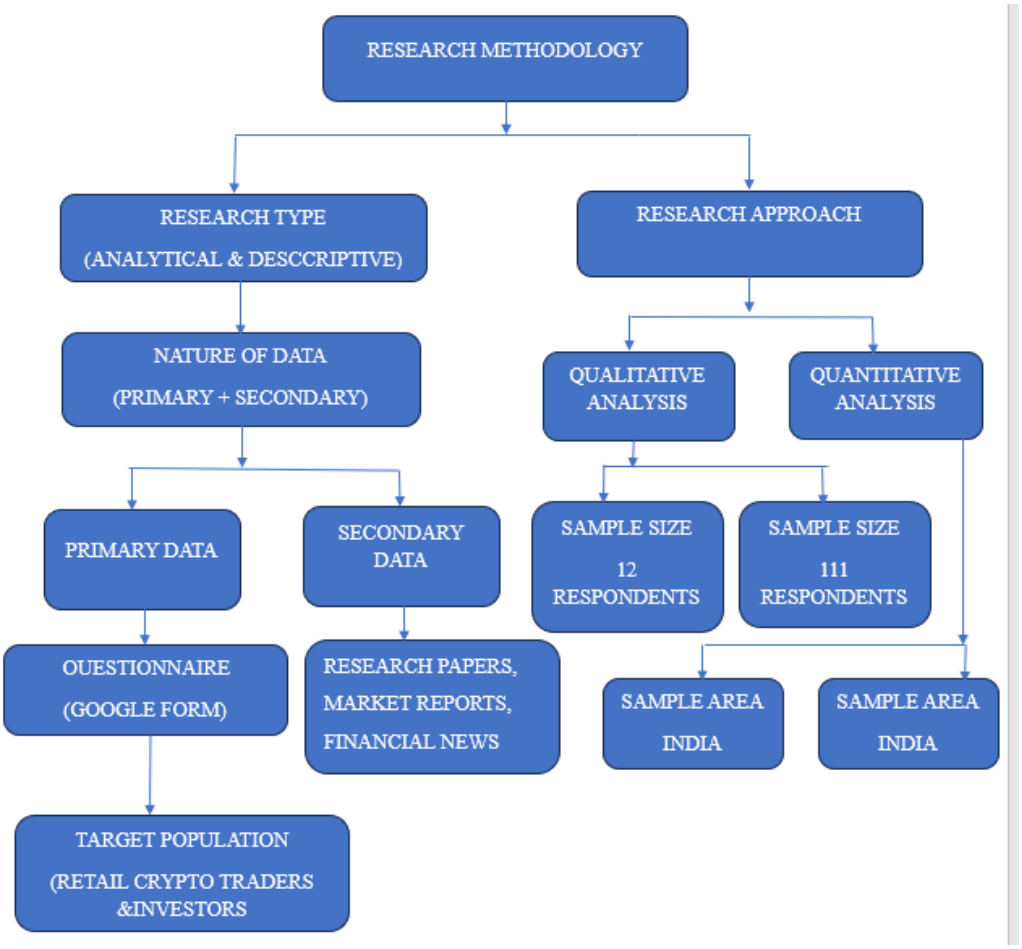
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Research Methodology:



Objectives of the Study:

- To analyze Cryptocurrency market behavior during high-volatility period and crash conditions (2025-26).
- To evaluate the extent and causes of financial losses experienced by retail traders, during the crash.
- To examine whether structured risk management practices significantly reduce financial losses among existing retail traders and Investors.
- To propose practical risk management guidelines for new retail participants based on the study findings.

Hypothesis of the Study:

- H0: Cryptocurrency market volatility during crash conditions has no significant impact on financial losses experienced by retail traders.
- H1: Cryptocurrency market volatility during crash conditions significantly increases financial losses experienced by retail traders.
- H0: Market conditions and behavioral factors do not significantly influence the extent of financial losses experienced by retail traders during the crash.

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- H2: Market conditions and behavioral factors significantly influence the extent of financial losses experienced by retail traders during the crash.
- H0: Structured risk management practices do not significantly affect the magnitude of financial losses among retail traders.
- H3: Retail traders who adopt structured risk management practices experience significantly lower financial losses compared to those who do not.

Significance of the Study:

The study looks at retail traders' increasing involvement in the extremely volatile Cryptocurrency market, especially during the crash 2025-26. It concludes that investors who lacked structured risk management and were influenced by behavioural biases like panic selling and FOMO suffered large financial losses. The study offers empirical proof that disciplined risk management techniques lessen the size of losses by examining the connection between market volatility, behavioural biases and losses. The study provides useful insights that highlight the significance of discipline and strategic consistency for long- term retail participation by combining psychological aspects, market behaviour and structured risk management into a single framework.

Limitations of the Study:

- The sample size of the study is limited to retail traders, which generalizes the diverse characteristics of Cryptocurrency investors across different countries and markets.
- The Cryptocurrency market is very dynamic and continuously developing, therefore findings based on 2025-26 period may not remain applicable under future economic and regulatory changes.
- It is difficult to accurately measure behavioural biases and emotional biases and emotional decision- making by the investors because of their subjective and psychological nature.

Data Analysis and Interpretation:

To examine the research objectives, both one-way ANOVA and correlation analysis were applied to the collected primary data.

1. **FOMO-Based Investment Behavior (ANNOVA result):**

   One-way ANNOVA test was conducted to examine whether there was a statistically significant difference in FOMO-based investment behavior between respondent groups (PG and PA).

Anova: Single Factor

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
PG	111	139	1.252252	0.190336		
PA	111	187	1.684685	0.926945		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	10.37838	1	10.37838	18.57792	2.46E-05	3.884075
Within Groups	122.9009	220	0.55864			
Total	133.2793	221				

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The result indicated:

2. F = 18.57
3. P-value 0.0000246 < 0.05

   Since the P value was less than 0.05 significance level and calculated F-value exceeded the critical value, the null hypothesis was rejected.

   Interpretation:

   There is a statistically significant difference in FOMO-driven investment behavior between the groups. This suggests that emotional decision-making plays a substantial role in Cryptocurrency trading behavior.

2 Influence of Social media sentiment:

One- way ANOVA was conducted to determine whether educational qualification influenced the impact of social media on trading and investment actions.

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
PE	111	173	1.558559	0.757903
PG	111	139	1.252252	0.190336

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	5.207207	1	5.207207	10.9829	0.001075	3.884075
Within Groups	104.3063	220	0.47412			
Total	109.5135	221				

Result showed:

- F = 10.98
- P-value 0.001075 < 0.05

  The One-Way ANOVA reveal a statistically significant difference between PE and PG respondents regarding the influence of social media sentiment on trading actions ($F(1,220) = 10.98$, $p < 0.05$). Therefore, the null hypothesis is rejected, indicating that educational qualification significantly affects the impact of social media sentiment on trading behaviour.

  Interpretation: Social media sentiment significantly influences trading decisions and its impact varies across respondent groups. This confirms that external information triggers and contributes to behavioral volatility in Cryptocurrency markets.

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3. Risk Management Practices:

ANOVA was conducted to compare 5 structured risk management practices:

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Do you regularly use stop-loss orders	111	331	2.981982	2.6724		
Do you follow fixed position sizing rules	111	308	2.774775	1.903358		
Do you diversify your investments across assets	111	324	2.918919	1.602457		
Do you control leverage usage carefully	111	337	3.036036	2.562326		
Do you frequently enter and exit trades within short periods.	111	319	2.873874	2.547584		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4.493694	4	1.123423	0.497613	0.737512	2.388139
Within Groups	1241.694	550	2.257625			
Total	1246.187	554				

One-Way ANOVA was conducted to compare five trading practices. The results showed no statistically significant difference among the groups ($F(4,550) = 0.498$, $p > 0.05$). Therefore, the null hypothesis is not rejected, indicating that respondents exhibit similar behaviour across the selected trading practices.

- Stoploss
- Position Sizing
- Diversification
- Leverage Control
- Structured Trading Plan

The result showed:

- $F = 0.498$
- $P=0.737512 > 0.05$

Interpretation: There was no Statistically significant difference among the adoption levels of various risk management practices, indicating that respondents exhibit relatively similar behavior across these practices.

4. Behavioral Bias Factors:

One-way Anova was conducted to compare five behavioral factors that influence Cryptocurrency trading behavior.

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Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Do you invest due to Fear of Missing Out FOMO	111	396	3.567568	2.629484
Do you panic sell during market crashes	111	382	3.441441	1.339722
Do you follow social media trading signals during volatile periods	111	361	3.252252	1.881245
Do you feel overconfident after making profits	111	384	3.459459	2.541523
Do you frequently enter and exit trades within short periods.	111	394	3.54955	2.213432

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6.983784	4	1.745946	0.82314	0.510724	2.388139
Within Groups	1166.595	550	2.121081			
Total	1173.578	554				

One-Way ANOVA was conducted to compare five behavioural bias factors affecting trading decisions. The results revealed no statistically significant difference among the variables ($F(4,550) = 0.823$, $p > 0.05$). Therefore, the null hypothesis is not rejected.

- FOMO (Fear of missing out)
- Panic selling during market crashes
- Following social media trading signals
- Overconfidence after making profits
- Following social media signals
- Over trading

The result showed:

- $F(4, 550) = 0.823$
- $P= 0.510724> 0.05$

  Since the calculated F value (0.823) was lower than the critical value the P – value exceeded the 0.05 significance level, the null hypothesis was not rejected.

Interpretation: These findings suggest that the behavioural bias factors do not significantly differ in their average influence on trading decisions. In other words, respondents exhibit relatively similar levels of behavioural tendencies across the selected bias dimensions.

However, while comparing bias factors it was found to be not statistically different, corelation analysis revealed that behavioural bias intensity is positively associated with financial losses. Therefore, although the bias does not differ significantly from one another, their collective influence remains economically important in explaining loss magnitude during high- volatility market conditions.

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5. **Correlation Between Financial Losses and Structured Risk Management:**

Correlation analysis was conducted to examine the relationship between financial losses structured risk management practices.

Correlation: Pearson Product-Moment Correlation

Variables	Count	Correlation (r)
Loss vs Risk Management Score	111	-0.647

Correlation result:

r = 0.647

n = 111

Interpretation: The correlation coefficient (r = -0.647) indicated a strong negative relationship between structured risk management practices and financial losses.

Since r > 0.60 null hypothesis is rejected.

This means that retail traders who adopt disciplined strategies such as stop-loss usage, position sizing, diversification, leverage control, and structured trading plans experience significantly lower financial losses during high-volatility and crash periods.

6. **Corelation between Financial losses and behavioural bias:**

Pearson correlation was conducted to analyse the relationship between financial losses and Behavioural bias.

Variables	Count	Correlation (r)
Loss vs Behavioural Bias Score	111	0.611

Correlation result:

- r = 0.611
- n = 111

Interpretation: The correlation coefficient (r = 0.611) indicated a strong positive relationship between behavioural bias intensity and financial losses.

Since r> 0.60, the null hypothesis is rejected.

This suggests that traders exhibiting higher levels of FOMO, Panic Selling, Overconfidence, and frequent short-term trading experience greater portfolio losses during the 2025-26 crash period.

Emotionally driven trading often increases financial vulnerability in volatile cryptocurrency markets.

Overall Statistical conclusion:

- The findings confirm that behavioural biases significantly increase financial losses.
- Social media sentiment primarily influences trading behaviour.
- Structured risk management practices majorly reduce financial losses.

  Thus, the study strongly validates that disciplined trading frameworks are essential for retail traders and new market participants operating in highly volatile markets.

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Qualitative Findings:

The qualitative findings show that most participants engaged in short-term and futures trading. During the 2025-26 crash, traders experienced fear, uncertainty and FOMO, which increased emotional pressure and led to impulsive decisions. Although many reported using risk management strategies , some deviated from their plans under stress. Social media also moderately influenced trading behaviour, highlighting the importance of emotional discipline and structured risk management.

Solution for Minimizing Financial Losses:

1. **Structured Risk Management Framework:**

   Based on correlation findings (r = -0.647), the study suggests:

   - Mandatory stoploss-loss placement.
   - Fixed Position Sizing (1-2% capital rule).
   - Leverage control (avoid excessive margin trading).
   - Portfolio Diversification.

2. **Behavioral Bias Control Mechanism:**

   Since r = 0.611 (Bias ↑ → Loss ↑), suggest:

   - No-Trade rule during emotional spikes.
   - 24-hour rule before high-risk trades.
   - Avoid trading based on social media hype.
   - Maintain a trading journal.

3. **Crash-Phrase Trading Protocol:**

   During high volatility:

   - Reduce position side by 50%
   - Avoid Averaging down blindly.
   - Avoid revenge trading.
   - Increase cash Allocation.
   - Risk-to-Reward minimum 12

   The proposed remedies were drives from empherical findings of the study and are designed to reduce loss magnitude and improve survival possibility among retail participants in volatile Cryptocurrency market.

Conclusion:

The study comes to the conclusion that retail traders' financial losses during the 2025-2026 cryptocurrency crash were greatly impacted by behavioral biases and market volatility. Higher loss magnitude was significantly correlated with emotional factors like FOMO, panic selling, and overconfidence. Trading decisions were also significantly influenced by sentiment on social media. Most importantly, the results demonstrate that disciplined strategies like stop-loss usage, position sizing, diversification, and leverage control significantly reduce risk exposure. They also confirm a strong negative relationship between structured risk management practices and financial losses. The study confirms that in order to guarantee long-term capital preservation and sustainable

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participation, retail traders operating in extremely volatile markets must implement structured and methodical risk management frameworks.

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