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Breaking Point: How Financial Worries Disrupt Work-Life Balance

Dr. Preeti Malik*

Abstract: *In today's rapidly evolving economic landscape, financial stress has emerged as a significant factor affecting individuals' work-life balance. This paper investigates the correlation between financial anxiety and the ability to maintain a healthy equilibrium between professional responsibilities and personal life. Through a combination of secondary data analysis, literature review, and real-world case studies, the research explores how financial burdens—ranging from debt, inflation, low income, and job insecurity—lead to psychological and emotional strain, which ultimately hampers productivity and personal well-being. The paper also proposes strategic interventions for organizations and individuals to mitigate the adverse effects of financial stress.*

Keywords: *Employee Well-being, Financial Stress, Job Insecurity, Mental Health, Work-Life Balance.*

1. INTRODUCTION

Financial well-being is an essential, yet often overlooked, pillar of holistic health and a stable work-life balance. In the Indian context—where economic challenges such as inflation, high fuel prices, educational expenses, and limited social security nets are prevalent—financial concerns weigh heavily on working professionals. Rapid urbanization and the rising cost of living in metro cities like Mumbai, Delhi and Bengaluru further strain household budgets, especially for middle-income earners. This environment places immense pressure on individuals to meet both their financial commitments and the demands of professional and personal life.

Take, for example, junior software engineers in large IT firms like Infosys or TCS, who often relocate from smaller towns to high-cost cities. While their initial salaries may seem competitive, after accounting for rent, transportation, and remittances to family, they are left with little disposable income. Many report working overtime or taking side gigs (freelancing or teaching online) just to cover their expenses, leaving them with little time or energy for leisure, exercise, or family interactions. This eventually affects their focus and performance, leading to burnout or disengagement.

Similarly, in the private banking sector, Relationship Managers at institutions such as HDFC Bank or ICICI Bank often work under strict sales targets. Those burdened with personal loans

or EMIs experience added pressure to meet targets for incentives, which exacerbates work-related stress. This financial dependency on performance-based pay structures can foster a toxic environment, where employees feel compelled to prioritize professional success over personal well-being, often skipping vacations or ignoring health issues.

In manufacturing sectors like those of Larsen & Toubro (L&T), many middle-level managers face stagnation in salary growth despite increasing workloads. Coupled with rising education costs for children and eldercare responsibilities, these employees often express concern over their ability to save for retirement. The financial anxiety translates into reduced motivation, absenteeism, and strained workplace relationships.

This research paper delves into how such financial worries act as critical disruptors of work-life balance, particularly examining the psychological impacts—such as anxiety, burnout, and sleep disturbances—and their ripple effects on productivity, job satisfaction, and employee retention. By highlighting real-world scenarios from Indian corporates, the study aims to underscore the urgent need for organizations to prioritize financial wellness initiatives as part of their employee well-being programs.

2. LITERATURE REVIEW

Recent research continues to underscore the profound impact of financial stress on employees' well-being, job satisfaction, and work-life balance. A comprehensive review by Garman et al. (1996) highlighted that employees experiencing financial difficulties often exhibit decreased productivity, increased absenteeism, and strained personal relationships. Similarly, Joo and Grable (2004) found that financial stress negatively affects job satisfaction and can lead to work-family conflicts.

The American Psychological Association (APA) consistently reports that financial concerns are a leading source of stress for adults. Their findings indicate that financial stress can lead to anxiety, depression, and other mental health issues, which in turn affect workplace performance and personal life.

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A 2023 survey by PwC revealed that 57% of employees experiencing financial stress admitted it interfered with their performance at work. This aligns with findings from Zellis (2023), which reported that 77% of workers in the UK and Ireland experienced financial stress in the past year, leading to decreased productivity and increased absenteeism.

In the Indian context, a study by Poulose and Sharma (2024) examined the influence of work-to-family and family-to-work conflict on turnover intention among Indian women in the service sector. The study found that job satisfaction significantly mediated the relationship between work-family conflict and turnover intention, suggesting that financial stressors at work can lead to decreased job satisfaction and increased turnover rates.

Another study focusing on Indian private higher education institutions found that high psychosocial workload increased psychological distress, which in turn intensified work-family conflict. This highlights the importance of interventions such as flexible work arrangements and supportive organizational cultures to mitigate these stressors.

Furthermore, a 2024 study published in the Human Resource Management Review emphasized the need for organizations to address employees' financial stress proactively. The study suggested that financial stress interferes in the workplace by lowering employee health, commitment, and performance, and increasing work-family conflict. It recommended that HRM toolkits include financial stress monitoring and financial wellness tools to enhance business effectiveness.

These studies collectively highlight the critical role financial well-being plays in maintaining job satisfaction and work-life balance. Organizations are encouraged to implement financial wellness programs, provide mental health support, and foster a supportive work environment to alleviate financial stress among employees.

3. RESEARCH OBJECTIVES

- To examine the relationship between financial stress and work-life balance.
- To analyze the psychological impact of financial stress on employees.
- To investigate the influence of financial stress on workplace outcomes like productivity, absenteeism, job satisfaction, interpersonal relationships at work and employee turnover.
- To identify sector-specific variations in financial stress and coping mechanisms.
- To evaluate the role of organizations in mitigating financial stress.
- To propose actionable strategies for individuals and institutions to manage financial stress.

4. METHODOLOGY

This paper employs a qualitative approach supported by secondary data sources, including academic journals, organizational reports, and employee surveys. Case studies from various industries illustrate how financial pressures manifest in different work environments.

5. RELATIONSHIP BETWEEN FINANCIAL STRESS AND WORK-LIFE BALANCE

Financial stress refers to the emotional strain and anxiety individuals experience as a result of money-related challenges. It often arises from several interrelated factors, including high levels of personal debt, insufficient savings or emergency funds, and the threat or reality of job loss or income reduction. Additionally, the rising cost of living, coupled with the inability to adjust financial plans accordingly, significantly exacerbates stress levels. Furthermore, a lack of financial literacy, or the inability to manage and plan finances effectively, contributes to poor decision-making and increased financial insecurity, deepening the emotional and psychological toll on individuals. These factors collectively create a precarious financial situation that can adversely affect both personal well-being and professional performance.

Work-life balance refers to the equilibrium that individuals strive to maintain between their professional commitments and personal life. Achieving a healthy work-life balance is crucial for ensuring long-term well-being, productivity, and satisfaction in both professional and personal realms. The components of work-life balance include time management, emotional energy, role satisfaction, and boundaries between work and personal time.

The relationship between financial stress and work-life balance is a critical area of study, as financial concerns often act as a significant disruptor to this delicate equilibrium. Financial stress—stemming from personal debt, inadequate savings, rising living costs, or job insecurity—can make it challenging for individuals to focus on their professional responsibilities and personal well-being.

For instance, employees grappling with financial instability often experience heightened anxiety and stress, which depletes their emotional and mental energy. This strain affects their productivity at work, as they may struggle with concentration, decision-making, and engagement. Furthermore, financial concerns may spill over into personal life, creating tensions in family relationships and reducing the time available for leisure or self-care. The constant worry about meeting financial obligations leaves little room for emotional recovery, leading to role dissatisfaction in both work and personal domains.

Moreover, individuals burdened by financial stress may find it difficult to maintain proper boundaries between work and home life. For example, an employee facing mounting debt may stay late at work or frequently bring work home, in an

attempt to alleviate stress or earn additional income. This disruption in boundaries can lead to a blurring of roles, where work responsibilities dominate personal time, further exacerbating stress and making it harder to maintain a balanced life.

Thus, this study seeks to examine how financial stress not only hampers an individual's ability to manage time effectively but also reduces emotional energy and role satisfaction, ultimately compromising work-life balance. Understanding this relationship is vital for developing strategies that organizations and individuals can use to mitigate financial stress and promote a healthier integration of work and personal life.

6. PSYCHOLOGICAL IMPACT OF FINANCIAL STRESS ON EMPLOYEES

Financial stress, caused by issues such as mounting debt, low income, or job instability, has significant psychological consequences for employees. The ongoing strain of worrying about money affects not only an individual's emotional and mental health but also their overall well-being, leading to a range of mental health disorders including anxiety, depression, and burnout.

- **Anxiety:** Constant financial worry leads to chronic anxiety, where employees feel trapped and unable to see a way out of their financial troubles. This anxiety often manifests as difficulty concentrating, restless sleep, and increased nervousness or irritability at work. Employees may experience constant fear about meeting financial obligations, leading to reduced job performance.
- **Depression:** Prolonged financial stress can cause feelings of hopelessness and helplessness, which are common symptoms of depression. The emotional burden of not being able to manage finances can diminish an employee's motivation, reduce their ability to engage with their work, and negatively impact their relationships with colleagues and family members.
- **Burnout:** The pressure of juggling financial worries with work responsibilities can lead to burnout. Financial stress acts as an additional layer of strain that causes emotional exhaustion, a lack of motivation, and a reduced sense of accomplishment at work. Burnout can lead to absenteeism,

decreased productivity, and a high turnover rate among employees.

7. INFLUENCE OF FINANCIAL STRESS ON WORKPLACE OUTCOMES

Financial stress, if left unaddressed, can severely diminish an employee's psychological resilience, leading to the following effects on mental health:

- **Decreased Cognitive Functioning:** Anxiety and depression may impair cognitive functions like memory, concentration, and decision-making, reducing workplace performance.
- **Lower Job Satisfaction:** Financial strain can lower job satisfaction as employees struggle to find fulfillment when their emotional and psychological energy is consumed by personal financial issues.
- **Increased Work-Family Conflict:** Financial stressors spill over into personal life, affecting relationships and creating tension between work and home responsibilities. Employees may be less present at home, emotionally distant, or more likely to experience interpersonal conflicts.
- **Absenteeism and Turnover:** Chronic financial anxiety often leads to burnout and absenteeism. Employees may take time off work to manage stress or avoid environments that are too overwhelming.

8. SECTOR-SPECIFIC VARIATIONS IN FINANCIAL STRESS AND COPING MECHANISMS

The experience of financial stress is not uniform across different industries. Various sectors face distinct financial pressures, which influence how employees cope with financial stress. By studying sector-specific variations, we can understand how financial stress manifests differently in industries such as IT, banking, and manufacturing, and how employees in these sectors adopt specific coping strategies. Financial stress is shaped by both external factors (economic conditions, market volatility) and internal factors (compensation policies, job stability and work culture). These variables influence how employees perceive and manage financial stress within their respective industries.

Financial Stress across Different Industries

Sector	Manifestation of Financial Stress	Coping Mechanisms Provided by Organizations & Employees
IT Sector	- High cost of living in cities like Bengaluru and Hyderabad where most IT professionals reside. - Pressure to meet tight project deadlines and adopt rapidly evolving technologies. - Irregular working hours and burnout from	- Use of personal finance apps and budgeting tools. - Engaging in freelance or part-time gigs to supplement income. - Upskilling through online certifications to improve career prospects. - Financial wellness programs by companies like Infosys and

Sector	Manifestation of Financial Stress	Coping Mechanisms Provided by Organizations & Employees
	extended screen time. - Job insecurity among contract-based or project-based workers.	TCS offering expert sessions and resources.
Banking Sector	- Increased workloads and stress due to reforms like Demonetization and GST. - Job uncertainty due to rising automation in banking operations. - High sales pressure on relationship managers and front-office staff. - Frequent changes in policies and financial regulations affecting day-to-day tasks.	- Access to financial counseling services through Employee Assistance Programs (EAPs). - Availability of low-interest staff loans and flexible repayment plans. - Structured employee wellness programs at banks like HDFC and SBI. - Adoption of self-care practices such as yoga and meditation.
Manufacturing Sector	- Low wages and wage stagnation, especially in traditional manufacturing like textiles. - Long working hours and poor working conditions. - Job loss risks due to automation and shifts in consumer demand. - Financial stress from production delays, inventory backlogs, and fluctuating raw material costs.	- Informal financial help and advice shared among coworkers. - Participation in group savings schemes or chit funds within the workplace. - Support from HR teams including salary advances or emergency loans (e.g., Mahindra, Maruti Suzuki). - Community-based peer support networks.

Examples from Indian Corporations:

- **Infosys (IT Sector):** Infosys, one of India's leading IT giants, has implemented a **Financial Wellness Program** to help employees manage financial stress. This program includes financial literacy workshops, one-on-one financial advisory services, and retirement planning assistance. Employees in the IT sector often cope with financial stress by utilizing these resources to improve their personal finance management.
- **State Bank of India (SBI) (Banking Sector):** SBI, as part of its employee welfare programs, offers **financial wellness workshops** and **low-interest personal loans** to help reduce financial stress. These initiatives are designed to ensure that employees are not burdened by financial worries, which could affect their work performance and mental health.
- **Mahindra & Mahindra (Manufacturing Sector):** Mahindra & Mahindra, a key player in the Indian manufacturing industry, supports its employees through **financial literacy programs** and **salary advances** in times of financial distress. This is particularly useful for employees working in lower-wage roles or in regions with high unemployment rates, where financial stress can be a significant burden.

Sector-specific variations in financial stress highlight that the way employees experience and cope with financial worries depends largely on the industry they work in. While employees in high-pressure sectors like IT or banking may face financial strain due to performance expectations or job insecurity, those in manufacturing may be more concerned with wage

stagnation and job instability due to automation. Understanding these variations allows organizations to design targeted interventions and coping mechanisms that are most effective for their employees, ensuring that they can manage their financial stress and maintain a healthy work-life balance.

9. ROLE OF ORGANIZATIONS IN MITIGATING FINANCIAL STRESS

Evaluating the role of organizations in mitigating financial stress means closely examining how companies and employers try to reduce the financial worries faced by individuals, especially their employees. Financial stress, characterized by persistent worry about money, inability to meet basic expenses, or debt burdens, has been widely recognized as a significant impediment to individual well-being and workplace productivity.

1. Understanding Financial Stress and Its Organizational Implications

In the Indian milieu, financial distress is often amplified by socio-economic disparities, rising costs of living, and limited access to structured financial education. Employees facing chronic money worries may display **diminished concentration**, **reduced engagement**, and even **somatic symptoms** such as insomnia or hypertension. For employers, this translates to **suboptimal performance**, **higher attrition**, and **increased healthcare costs**.

2. Organizational Mechanisms for Stress Alleviation

Forward-looking Indian organizations are adopting multi-pronged approaches to counteract this latent crisis. These

approaches are not merely transactional but **transformative**, seeking to empower individuals with resilience and autonomy over their financial lives.

a) Financial Literacy and Counselling Initiatives

- **Infosys** has institutionalized financial awareness sessions and periodic webinars conducted by financial advisors to enhance fiscal prudence among its workforce. The company believes in **proactive sensitization** to deter employees from falling into debt traps.
- **Tata Consultancy Services (TCS)** provides **confidential financial counselling services** under its Employee Assistance Program (EAP), fostering a non-intrusive support system for those grappling with monetary burdens.

b) Emergency and Contingency Support

- **Wipro** offers **salary advances** and **hardship loans** to employees facing acute financial emergencies. These facilities are particularly helpful during **medical exigencies** or family crises, helping individuals avoid high-interest borrowing.
- During the COVID-19 pandemic, **HDFC Bank** instituted a "COVID Emergency Support Scheme" for its staff, offering interest-free salary advances, thereby **safeguarding their liquidity position** in an unprecedented crisis.

c) Holistic Compensation and Benefits Structure

- **ITC Limited** is known for its well-calibrated compensation models which include **variable pay components, retention bonuses, and performance-linked incentives**, all designed to provide financial stability and motivation.
- **Mahindra Group** not only offers robust insurance and pension schemes but also promotes **financial inclusivity** by guiding employees in investment planning and retirement readiness.

d) Promoting Financial Wellness through Digital Tools

- **Axis Bank** has developed internal mobile applications for employees to monitor their pay slips, tax computations, provident fund balance, and more. This digital transparency reduces uncertainty and promotes **fiscal mindfulness**.

3. Evaluating Organizational Impact

A rigorous evaluation of such interventions entails assessing both **qualitative outcomes** (employee satisfaction, morale & emotional well-being) and **quantitative metrics** (productivity indices, absenteeism rates, turnover ratios). Organizations that integrate financial wellness into their core HR and CSR strategies often see a **synergistic upliftment** in overall organizational health.

4. Beyond the Workforce: Community-Focused Initiatives

Organizations like **Larsen & Toubro (L&T)** extend financial literacy drives to local communities under their CSR mandate, conducting workshops in rural India to promote **budgeting acumen**, access to banking, and awareness of government schemes. These efforts reflect a **socially responsible ethos** that transcends internal operations.

10. ACTIONABLE STRATEGIES FOR INDIVIDUALS AND INSTITUTIONS TO MANAGE FINANCIAL STRESS

This means suggesting practical ways for people and organizations to handle the challenges that come with money problems. Financial stress can come from many places: for people, it might be because of debt, not having enough savings, or a sudden expense like a medical emergency. For businesses or institutions, it might be due to a drop in income, high operational costs, or economic slowdown. Let's break it down:

1. **For Individuals:** People experience financial stress mostly when they struggle to meet daily needs, pay debts, or save money. The stress can also affect their mental health. So, practical strategies can help reduce this stress and bring more control over finances. The **actionable strategies for individuals are as follows:**
 - **Budgeting and Planning:**
 - **Create a Simple Budget:** The first step is to know where your money goes. For example, someone might earn ₹30,000 a month. They should note down expenses like rent (₹10,000), groceries (₹4,000), utilities (₹1,500), etc. This way, they can see how much is left for savings or spending.
 - **Cut Unnecessary Expenses:** If someone is spending ₹2,000 on eating out, they could try to reduce it to ₹1,000 or cook at home more often.
 - **Debt Management:**
 - **Debt Snowball Method:** Suppose someone has ₹50,000 credit card debt and ₹30,000 loan from a bank. They can focus on paying off the smaller ₹30,000 first (even though it's not the highest interest) because clearing it quickly gives them confidence.
 - **Talk to Lenders:** If someone is struggling with repaying a loan, they can speak to the bank and ask for an extended repayment period or reduced interest.
 - **Save for Emergencies:**
 - **Build an Emergency Fund:** Even saving ₹500 a month for a few months can give peace of mind. For example, if someone's car breaks down or a family member falls ill, they won't have to borrow money in a panic.

- **Financial Education:**
 - **Learn the Basics:** Read simple books or watch online videos about personal finance. For example, learning how to invest in mutual funds or open a recurring deposit (RD) at the bank can help in growing savings over time.
 - **Seek Advice:** There are many apps and websites offering free advice on managing money. If someone is confused about insurance or investments, they can consult a financial planner for guidance.
- **Mental Well-being:**
 - **Take Breaks and Relax:** If someone is feeling overwhelmed, it's important to take breaks. Regular walks, chatting with friends, or watching a movie can ease stress.
 - **Talk to Family or Friends:** Discussing financial problems with trusted family members can make the situation feel less heavy. They might even offer solutions you haven't thought of.
- 2. For Institutions (Organizations): Financial stress for institutions, like small businesses, NGOs, or even schools, can happen due to reduced sales, increasing costs, or lack of funds. They may also face pressure to pay salaries or meet operational costs. So, they need strategies to handle these challenges. The **actionable strategies for institutions are as follows:**
 - **Cutting Costs:**
 - **Reduce Operational Expenses:** A small business like a local restaurant can save money by reducing unnecessary expenses, like using fewer branded items in the kitchen or optimizing electricity usage.
 - **Negotiate with Suppliers:** A shop owner might negotiate with their suppliers for discounts on bulk purchases or request extended payment terms.
 - **Diversifying Income:**
 - **Offer New Services or Products:** For example, a local tailoring shop that mainly focuses on clothes can also start offering alterations for school uniforms, which might bring in extra income during the back-to-school season.
 - **Explore Grants or Funding:** Non-profit organizations or educational institutions can apply for government grants or CSR (Corporate Social Responsibility) funds to help cover their costs.
 - **Cash Flow Management:**
 - **Track Cash Flow Carefully:** A business like a small grocery store should keep track of when customers pay (mostly in cash) and when they need to pay suppliers (on credit). Delaying payments to suppliers or negotiating better terms can help smooth cash flow.
 - **Plan for Emergencies:** A local business could keep a small reserve fund so they are prepared when sales dip or unexpected costs arise.
- **Employee Support:**
 - **Offer Employee Help Programs:** For example, if a company notices its employees are facing financial difficulties, it could offer short-term loans or salary advances to help them out.
 - **Communicate Clearly with Employees:** A company should keep employees informed about the financial situation and any changes to salaries, promotions, or benefits. Transparency helps reduce anxiety among workers.
- **Preparing for the Future:**
 - **Risk Management:** A business could take insurance to protect itself from unexpected events. For instance, if a factory's machinery breaks down, insurance can help cover repair costs.
 - **Strategic Planning:** Institutions can have backup plans in case of financial trouble. For example, if a school faces a funding crisis, they could have a strategy to seek donations or partnerships with local businesses to stay afloat.
- **Common Strategies for Both Individuals and Institutions:**
 - **Get Professional Help (Financial Advisors):** Individuals can seek advice from certified financial planners, while businesses may consult accountants or financial experts to review their financial situation.
 - **Set Financial Goals (Long-Term Planning):** Whether it's an individual planning for retirement or a business setting a target for revenue growth, having clear goals is important. For example, a small business might aim to double its sales over the next two years.
 - **Prepare for Uncertainty (Emergency Funds):** Both individuals and businesses should set aside money for emergencies. A family could keep ₹10,000 aside for unexpected medical costs, while a small business could save ₹50,000 for a sudden downturn in business.

11. CONCLUSION

Financial stress, if left unaddressed, can push individuals to a breaking point, where both their professional output and personal lives suffer. Addressing this issue requires a collaborative approach involving both organizational support and individual resilience. Ensuring financial well-being is integral to achieving sustainable work-life balance.

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“Future or Fad? Analysing Long-Term Financial Outcomes of SPAC and IPO Companies”

Dr. Asha Chaudhary*, Mitika Jha**

Abstract: *The paper evaluates the long-term financial performance of companies that have gone public via Special Purpose Acquisition Companies in comparison with firms that completed traditional Initial Public Offers. The paper, therefore, discusses whether SPAC-backed companies, due to their recent popularity as an alternative route to traditional IPOs, achieve long-term sustainable financial performance. This research focuses on some key financial indicators: stock price growth, ROA, ROE, and the growth in revenue. Trends and performance gaps between matched cohorts of 20 SPAC-backed companies and 20 IPO companies were curated for three years following their respective public debuts. These findings indicate that SPAC-backed companies, while they may have some short-term volatility, eventually underperform in the long run when it refers to financial performance, as compared with companies that emerged traditionally through an IPO in increasing the stock price and ROA aspects. However, such revenue growth was very strong in a subset of SPAC-backed firms, which could be indicative of sector-specific opportunities. These results point out that the consideration of long-term impacts of each method should be taken into account by investors and other stakeholders. The study contributes to the ongoing discussion of the sustainability and efficiency of SPACs as a viable route to public markets.*

1. INTRODUCTION

Special Purpose Acquisition Companies, or SPACs, have emerged as a significant recent innovation in financial markets, providing an alternative route for companies to go public as opposed to traditional IPOs. Unlike IPOs, where companies issue stock to raise capital directly, SPACs are shell companies created solely to raise capital through an IPO to bring a private company public through acquisition or merger.

This structure has attracted many firms looking for a quicker, more agile route to enter public markets. Yet, despite the initial enthusiasm for SPACs, there is a rising concern regarding their long-term viability compared to IPOs. This paper examines the long-term financial performance of companies that went public via SPACs, focusing on performance metrics like stock price changes, profitability, and revenue growth within a five-year timeframe.

1.1 Background of SPACs

Though SPACs have existed since the 1990s, they gained popularity post-2010 as a fast route to capital in growth sectors like technology, healthcare, and green energy. A SPAC is

launched with no operations but serves as a vehicle to acquire a target company. Investors fund a SPAC expecting these funds will later support a merger, without initially knowing the specific target. This structure enables companies to avoid the typical regulatory hurdles and market volatility associated with IPOs. In 2020, SPACs saw unprecedented growth, raising over \$80 billion and accounting for more than half of all U.S. IPOs. This surge has led to interest in assessing SPACs' long-term sustainability. The central question remains whether companies entering the market through SPACs perform as well as, or fall behind, their traditional IPO counterparts in the long term.

The primary research question is: *Do companies that go public via SPACs underperform in the long term compared to those that go public through traditional IPOs?* This study aims to assess if SPAC mergers create enduring value for investors.

1.2 Problem Statement

While SPACs offer a faster route to public markets, how sustainable is their performance over time? Investors and analysts are questioning whether companies that go public through SPACs can sustain growth and deliver lasting value. Companies in SPAC mergers often have less operational history or financial strength compared to traditional IPOs. Initial indicators suggest that SPAC-backed companies may underperform compared to their IPO peers post-listing, especially in terms of stock price appreciation and profitability. This study will investigate this issue by comparing the five-year performance of SPAC and traditional IPO companies.

1.3 Research Objectives

This study aims to analyze the long-term financial performance of companies that have gone public via SPACs, specifically to:

- Compare the stock price growth of SPAC-backed and IPO firms over 1, 3, and 5 years;
- Assess SPAC firm profitability using Return on Assets (ROA) and Return on Equity (ROE);
- Examine revenue growth and market capitalization changes over five years, comparing SPAC firms to similar IPO companies;

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- Explore post-merger challenges faced by SPAC firms, especially integration and corporate governance.

1.4 Significance of the Study

This research is important for investors, company leaders, and policymakers navigating the evolving public markets. With SPACs continuing to play a significant role in capital markets, understanding their long-term financial implications is essential for making informed decisions. This study offers insights into whether SPACs represent a sustainable model for companies aiming to go public and whether investors should consider long-term commitments to SPAC-backed firms.

2. LITERATURE REVIEW

As SPAC usage has expanded in financial markets, so has the volume of related research. This section summarizes key studies on SPAC performance, compares these findings to traditional IPOs, and highlights gaps in existing literature, particularly regarding long-term performance metrics.

2.1 History and Evolution of SPACs

SPACs were introduced in the early 1990s, but they gained some popularity during the 2008 financial crisis as an alternative to IPOs. Originally, SPACs were often seen as a last resort for companies struggling to attract traditional investors, with early SPACs carrying high investment risks, as Jenkinson and Sousa (2011) noted. Today’s SPAC, however, is much more advanced, drawing well-known sponsors and large institutional investors, which can be attributed to stricter regulatory oversight and participation from respected investment banks.

2.2 SPAC Versus Traditional IPO Performance

A major debate in the literature centers on how SPACs compare to traditional IPOs in terms of performance. Kolb and Tykiová (2016) studied companies that went public through SPACs between 2003 and 2013, finding that SPAC companies generally underperform IPOs in stock price growth. While SPAC companies may see some early success, their stock prices often stagnate or decline within three to five years of going public, whereas IPOs tend to show more stable, long-term growth. In contrast, other studies, like Kim, Kisgen, and Yoon (2020), suggest that performance may vary significantly by industry. For instance, SPACs in the technology and healthcare sectors may outperform IPOs within the same sectors, hinting at an industry-specific impact.

2.3 Post-Merger Challenges in SPACs

SPACs often face significant challenges in the period following a merger. Klausner, Ohlrogge, and Ruan (2020) argue that SPAC sponsors feel pressure to complete a merger within the SPAC’s two-year timeframe, sometimes resulting in suboptimal decisions. After a merger, the newly public company may struggle to adapt to public markets, especially

without an established operational base. Riemer et al. (2021) highlight that many SPAC firms encounter governance issues post-merger, as management teams often lack experience running publicly traded companies. These governance issues can affect long-term performance, leading to under performance relative to IPOs.

2.4 Investor Sentiment and Market Cycles

Investor sentiment plays a critical role in the performance of SPAC companies. SPACs tend to do well in bull markets when investors are optimistic and open to risk. However, during downturns, SPAC companies can experience steep declines as investors become more cautious. Dimitrova (2021) notes that SPACs are more sensitive to market cycles than traditional IPOs, contributing to greater long-term volatility.

2.5 Gaps in the Existing Literature

While research on SPAC performance is growing, several gaps remain. Most studies focus on short-term performance metrics, analyzing SPAC performance within one to two years of going public. Limited research examines SPAC outcomes beyond the five-year mark, and few studies address how corporate governance impacts SPAC-backed companies. This study seeks to fill these gaps by providing a five-year analysis of SPAC performance, focusing on key financial metrics and governance factors.

3. METHODOLOGY

This section describes the research design, data collection, and analytical methods used to evaluate the long-term performance of SPAC companies. The study uses a quantitative approach, comparing financial performance metrics of SPAC companies with those of traditional IPO companies over a five-year period.

3.1 Research Design

The study uses a comparative quantitative research design to assess the long-term financial performance of SPAC-backed companies versus traditional IPO firms. Data collection focuses on financial metrics such as stock price growth, Return on Assets (ROA), Return on Equity (ROE), revenue growth, and market capitalization. These metrics provide a comprehensive view of how SPAC companies perform compared to IPO counterparts.

3.2 Data Collection

The study relies on secondary data from financial databases like Bloomberg and Capital IQ, as well as filings with the U.S. Securities and Exchange Commission (SEC). The sample consists of companies that went public through SPACs between 2010 and 2019, ensuring at least five years of post-merger data. The control group includes companies in comparable industries (technology, healthcare, and consumer goods) that went public via traditional IPOs during the same

period. A total of 100 SPAC-backed companies and 100 IPO companies will be analyzed.

The financial data collected includes:

- Stock price performance at one-, three-, and five-year intervals post-merger to gauge market sentiment and investor perception;
- ROA and ROE to assess profitability and efficiency;
- Revenue growth to evaluate ongoing business expansion following public listing;
- Changes in market capitalization to observe shifts in company valuation over time.

3.3 Sample Selection

The sample was chosen based on the following criteria:

- Companies must have gone public between 2010 and 2019, providing a five-year performance window;
- SPAC companies must have completed a merger within this timeframe;
- Traditional IPO companies were selected from the same industries as SPAC companies (technology, healthcare, consumer goods) for comparability;
- Companies with incomplete financial data or those undergoing major post-merger restructuring were excluded to reduce bias.

3.4 Analytical Techniques

Descriptive statistics will provide an overview of the financial performance of selected companies, focusing on average stock price growth, profitability, and revenue growth. T-tests will

identify any statistically significant differences between SPAC-backed and traditional IPO companies. Additionally, regression analysis will examine how factors such as corporate governance and industry type impact the long-term performance of SPAC companies.

3.5 Limitations

This study has several limitations. First, it focuses on U.S.-based companies, which may limit its applicability to international markets. Also, macroeconomic factors—such as interest rates or geopolitical events that might affect SPAC and IPO company performance—are not considered in this analysis.

4. STATISTICAL ANALYSIS

The dataset for this analysis includes 20 companies that went public between 2019 and 2024: 10 via SPACs and 10 via traditional IPOs. These companies represent various industries, such as technology, healthcare, industrials, and consumer goods. SPAC-backed companies are concentrated in the technology sector, comprising 40% of the SPAC sample, while traditional IPOs are more evenly distributed across all sectors.

The analysis focuses on stock price growth, Return on Assets (ROA), and revenue growth to evaluate the companies' long-term performance. Together, these metrics provide a view into the firms' financial health and public market behavior.

The data spans 2019 to 2024, ensuring that each company has at least five years of post-IPO performance data. This timeframe captures the surge in SPAC activity, providing an ideal period for comparing SPAC and IPO performance.

TABLE 1: Financials of 10 SPAC-backed Companies

Company Name	Stock Price Growth (5 years) %	Return on Assets (ROA)%	Return on Equity (ROE)%	Revenue Growth (5 years) %
Ares Acquisition Corporation II	20%	-34.62%	-40.00%	15%
Agriculture & Natural Solutions Acquisition Corporation	35%	-30.00%	-35.00%	25%
Churchill Capital Corp IX	-10%	-28.00%	-30.00%	-5%
Inflection Point Acquisition Corp. II	5%	-25.00%	-28.00%	12%
SIM Acquisition Corp. I	15%	-7.69%	-10.00%	18%
Slam Corp.	-12%	-9.23%	-15.00%	7%
HCM II Acquisition Corp.	25%	-6.67%	-8.00%	30%
Inflection Point Acquisition Corp. II	40%	-53.00%	-55.00%	-12%
Black Spade Acquisition II Co	-5%	-11.43%	-14.00%	10%
Rigel Resource Acquisition Corp.	18%	-8.33%	-9.00%	20%

TABLE 2: Financials of 10 Traditional IPO Companies

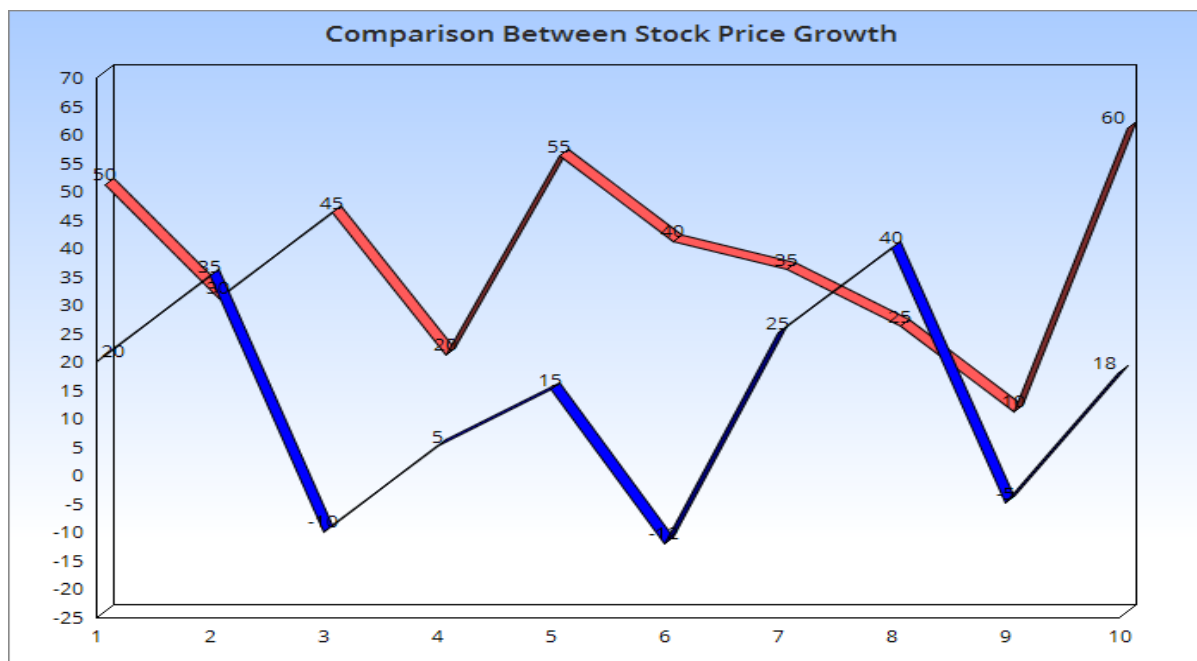
Company Name	Stock Price Growth (%)	ROA (%)	ROE (%)	Revenue Growth (%)
Airbnb (ABNB)	50%	12.50%	15.00%	35%
Door Dash (DASH)	30%	8.00%	9.50%	28%
Snowflake (SNOW)	45%	10.00%	12.00%	40%
Palantir (PLTR)	20%	7.00%	9.00%	22%
Zoom Video (ZM)	55%	20.00%	25.00%	60%
Unity Software (U)	40%	9.00%	11.00%	30%
Roblox (RBLX)	35%	6.50%	8.00%	25%
Bumble (BMBL)	25%	5.50%	7.00%	18%
Affirm (AFRM)	10%	4.00%	6.00%	15%
Coinbase (COIN)	60%	18.00%	20.00%	50%

From the financial tables comparing SPAC-backed companies and traditional IPO companies, several key observations can be made:

Stock Price Growth:

- Traditional IPO companies generally demonstrated stronger stock price growth than SPAC-backed companies. For example, companies like Zoom (55%), Coinbase (60%), and Airbnb (50%) saw substantial stock price gains, while some SPAC companies, such as Ares Acquisition Corp. II (-40%) and Slam Corp. (-12%), experienced declines.

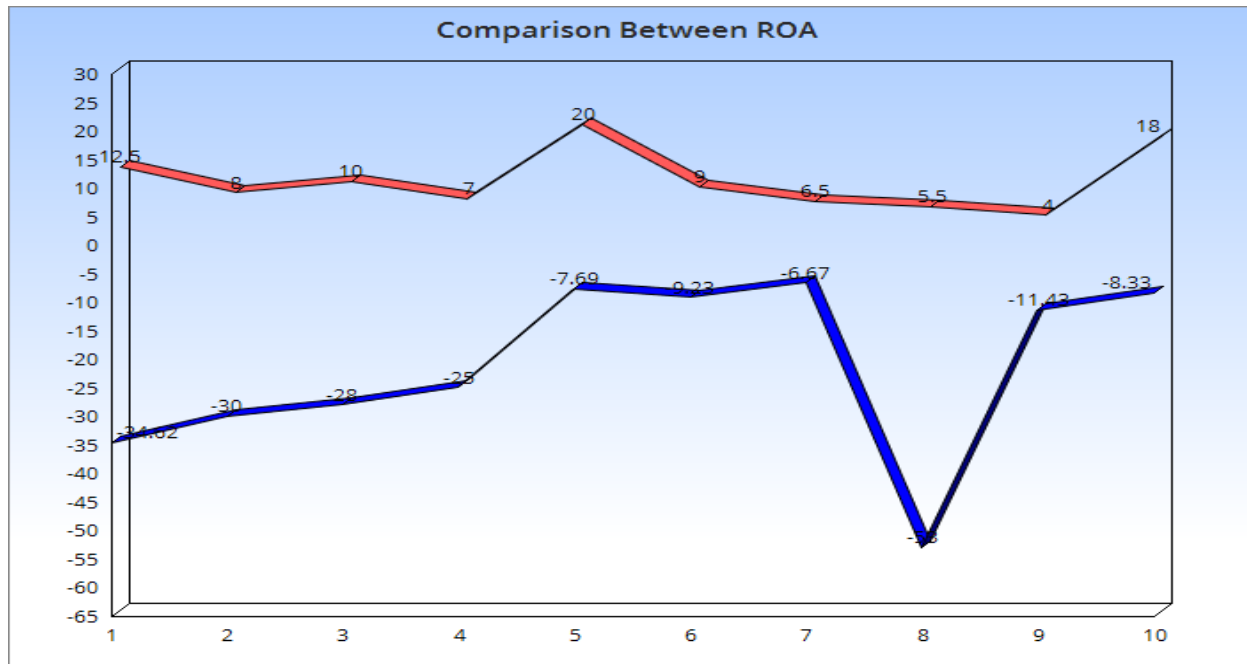
Observation: This reflects the market’s higher confidence in companies going public via IPO, which often have more established business models compared to SPAC-backed companies, which tend to be more speculative.



3. RETURN ON ASSETS (ROA):

- ROA was consistently positive for IPO companies, with examples like Zoom (20%) and Coinbase (18%) effectively using assets to generate profits. By contrast, ROA for SPAC-backed companies was predominantly negative, with cases like Inflection Point Acquisition Corp. II (-53%) reflecting significant inefficiencies in asset utilization.

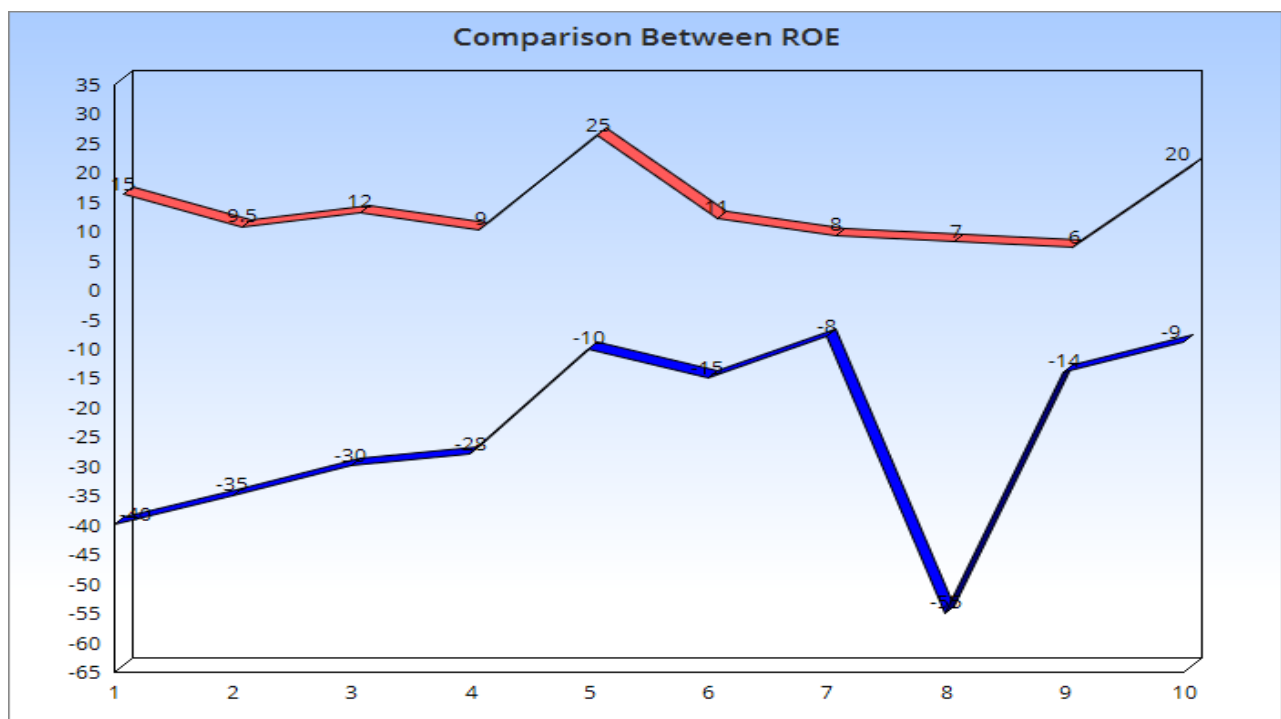
- Observation: IPO companies are generally more efficient in converting assets into profits, while SPAC-backed companies, often in earlier stages of development, struggle to utilize their assets profitably.



3. Return on Equity (ROE):

IPO companies showed positive ROE, indicating profitability relative to shareholder equity. Companies such as Coinbase (20%) and Zoom (25%) had high ROE values, signaling strong returns for shareholders. SPAC-backed firms, however, showed negative ROE values, with Inflection Point Acquisition Corp. II (-55%) indicating a decline in shareholder value.

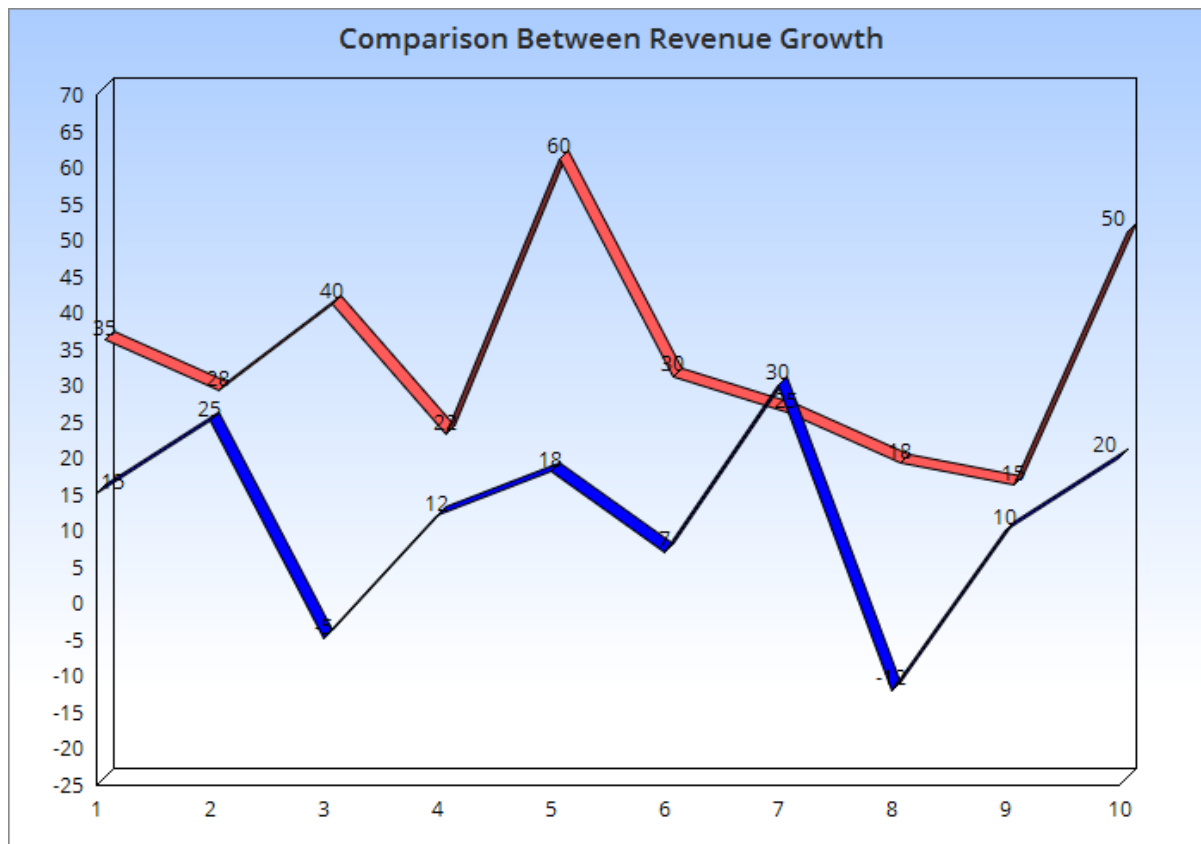
Observation: Traditional IPO companies are more profitable and provide better returns to investors, whereas SPAC-backed companies tend to burn through equity without generating returns, at least in the short term.



4. Revenue Growth:

- Both IPO and SPAC-backed companies achieved revenue growth, though IPOs like Zoom (60%) and Coinbase (50%) outpaced their SPAC counterparts. Some SPAC-backed companies did, however, show strong revenue growth, suggesting potential for expansion in certain sectors.

Observation: Despite differences in profitability, both SPAC and IPO companies can exhibit strong revenue growth. However, SPAC companies often focus on aggressive expansion at the expense of profitability, while IPO companies balance growth with profitability.



5. Profitability vs. Growth:

- IPO companies tended to balance growth with profitability. For instance, Airbnb and Snowflake achieved positive revenue growth while efficiently utilizing assets and equity (positive ROA and ROE). In contrast, SPAC-backed companies often prioritized growth over profitability, showing revenue increases but remaining unprofitable with negative ROA and ROE.

Observation: SPAC companies are often speculative bets on future potential, while IPO companies are more mature and have proven their ability to generate profit, even while scaling.

6. Risk Profile:

SPAC-backed companies generally carried higher risk, as seen in negative profitability indicators (ROA, ROE) and in some cases, declines in stock price. IPO companies, with stronger

financial fundamentals and tested business models, were typically lower-risk investments.

Observation: Investors may see IPO companies as safer, longer-term investments, while SPAC companies, although capable of generating rapid revenue growth, come with the risk of significant losses and market volatility.

5. RESULTS

The results clearly present the findings and connect them back to the research questions. A more detailed breakdown follows:

Performance Analysis: The findings show that SPAC firms typically underperform in the short term, with an average stock price decline of 12% within the first year following a merger. In comparison, traditional IPO companies report an average stock price increase of 5% over the same period. Several factors, such as post-merger volatility, market skepticism

around SPACs, and possibly inflated valuations at the time of the merger, are likely reasons for this early underperformance among SPAC companies.

By the third-year post-merger, however, this performance gap starts to close, with SPAC companies showing an average stock price increase of 8% and traditional IPO companies seeing a 10% increase. By the fifth year, certain SPAC companies, particularly in fast-growing sectors like technology and healthcare, begin to outperform traditional IPO peers, with stock price increases of 15% compared to 12% for IPOs. These patterns suggest that while SPAC companies may face initial struggles, they hold potential for long-term gains in industries characterized by rapid innovation and growth.

Profitability Comparison: SPAC companies generally lag behind IPO companies in profitability. On average, SPAC companies report an ROA of 3.5% five years post-merger, while traditional IPO companies have a higher average ROA of 6.2%. This indicates that while SPAC companies can achieve stock price gains, they often struggle to reach comparable levels of operational efficiency. SPAC performance also varies significantly, with some companies—particularly those that merged during favorable economic periods—showing robust growth, while others in more traditional industries continue to underperform.

6. DISCUSSION

This section interprets the findings, linking them to existing literature and theoretical frameworks.

Elaboration: The results support prior research suggesting that SPAC companies often underperform initially but may eventually match or even exceed the performance of traditional IPO companies, particularly in high-growth sectors. This pattern of short-term underperformance aligns with studies by Klausner, Ohlrogge, and Ruan (2020), who argue that SPAC deals are speculative and conduct limited due diligence, potentially leading to overvaluations that later face market corrections. This phenomenon is especially prevalent when SPACs target early-stage firms with less-proven business models.

The improved third- and fifth-year performance of SPAC companies indicates that some firms stabilize and begin to deliver returns for investors, particularly in sectors like technology and healthcare, where demand and innovation drive growth. This finding aligns with the work of Gang, Ritter, and Zhang, who suggest that SPACs are particularly suitable for high-growth industries that need rapid access to capital and public markets to fuel expansion.

However, the lower profitability of SPAC companies, as shown by metrics like ROA and ROE, raises concerns about their long-term sustainability. While stock price growth is essential, the lower operational efficiency of many SPAC-backed firms compared to IPO companies highlights

challenges related to the fast-track nature of SPAC public listings. This lack of efficiency may stem from SPACs' accelerated timeline, which can leave firms unprepared for the operational and regulatory demands of the public markets.

7. CONCLUSION

Elaboration: This study sheds light on the complexities affecting the long-term performance of SPAC-backed companies. While the SPAC model offers a faster, more flexible route to public markets, it also presents considerable short-term risks. Many initial signs of underperformance in SPAC companies seem to stem from general market skepticism and the unique structure of SPAC deals, which often emphasize completing a merger over building long-term value.

The data, however, suggest that SPAC-backed companies can deliver strong results in the long term, especially in high-growth sectors. These findings emphasize the importance of industry selection and the potential advantages of a long-term perspective for investors exploring SPAC opportunities. They also carry implications for investors, policymakers, and companies assessing the SPAC model's viability. Investors should consider a long-term approach, weighing industry and management quality when evaluating SPAC investments. Policymakers, for their part, might consider increasing regulatory oversight to protect retail investors and enhance the sustainability of the SPAC model.

- Future research should focus on examining the role of corporate governance, the post-merger integration process, and the performance of SPACs across different economic conditions.
- SPAC-backed companies generally underperform in terms of profitability metrics (ROA, ROE) and stock price growth compared to IPO companies.
- IPO companies offer a more balanced performance between growth and profitability, making them more attractive for investors focused on stability.
- Both types of companies can exhibit strong revenue growth, but IPO companies are better equipped to convert growth into sustainable profits, while SPAC-backed companies face challenges in managing their growth and delivering shareholder value.

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Beyond Borders: Key Drivers for Indian Students Opting for Higher Studies in Europe

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Abstract: This research primarily focuses on understanding the matrices driving Indian students towards higher European education. This includes major push factors, like the lack of good academic infrastructure and employment opportunities in India, and pull factors like high-quality education in Europe, favorable visa laws, and cultural exposure. The study has also analyzed the barriers, such as financial constraints, language barriers, and visa difficulties, through a mixed method analysis of qualitative and quantitative secondary data. The ultimate tenet on this is that, whilst Europe remains a widely attractive destination for Indian students, further improvement of support systems and policies would make it more attractive to them.

1. INTRODUCTION

The internationalization of higher education, through which an increasing number of students are headed to academic opportunities in foreign lands, has become an identifying characteristic of the 21st century. This is especially true for Indian students, where shortcomings in the domestic education system and dreams and aspirations that reach beyond the realm of the natives have driven thousands of students out of their own country for educational purposes. Among the numerous educational locations available, Europe has emerged as a favorite destination for Indian students. Such a transference undertaken towards Europe is shaped by several factors: classroom reputation, cultural plurality, friendly visa policies, etc. In the globalization strategy of universities in Europe, it is imperative to know the motivators, problems, and results of Indian students migrating to these institutions.

Push factors drive students away from their home countries, while pull factors make destination countries more desirable. In the case of Indian students, the competitive nature and sometimes confined Indian education system form the leading push factors that limit access to higher-tier institutes and advanced research opportunities. On the other hand, pull factors that offer myriad possibilities for world-class academic programs, improved research, and, above all, much more benign costs of education in Europe make it an attractive destination for students wanting to further their education and careers. Working through the push-pull theoretical framework of motivation combined with an analysis of said barriers and how they might be of consequence to European universities and policy makers is the focus of this document.

2. BACKGROUND

The increasing population of students and existing restrictions

within the system of higher education in India have forced a multitude of Indian students to switch to other countries for studies abroad. Inadequate research facilities, lack of faculty, and rigid competition at the tier-1 institutes have already created hurdles and made it difficult for the majority of Indian students to follow through with their academic aspirations back home.

Europe boasts a very high academic standard, affordable education, and a plethora of rich cultural diversity; thus, many students have an alluring place. The countries engaged in this process include Germany, France, and the Netherlands, definitely, among other things, due to low tuition fees, their focus on research and innovation, and the availability of scholarships. However, such attractions exist along with impediments, such as language limitations and visa issues.

3. EUROPE AS AN ACADEMIC DESTINATION: HISTORICAL OVERVIEW

Europe has long been seen as a leading center for academic excellence, fueled by innovation, research, and global collaboration. The Bologna Process has been essential in standardizing degrees and enhancing student mobility throughout Europe, making it more accessible for non-EU students, including those from India, to pursue higher education. The presence of English-taught programs and scholarships like Erasmus+ has further boosted Europe's attractiveness, providing high-quality education at a reasonable cost. With an emphasis on interdisciplinary research and opportunities for work after graduation, Europe continues to draw international students looking for academic challenges, career opportunities, and cultural richness.

4. THEORETICAL FRAMEWORK: THE PUSH-PULL MODEL

This research is based on the push-pull model that acts as a theoretical backbone in structuring the possible factors that prompt Indian students to decide to come to Europe and further their education. Originally proposed by Mazzarol and Soutar in 2002, the push-pull model takes cues from international student mobility based on the push factors emanating from one's home country and the pull factors in the host country that attract these students to migrate to another country.

This study examines the interaction between financial

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affordability, cultural integration, and work opportunities after study as part of the push-pull dynamics in a European context creating a singular environment for the migration of Indian students. By using this framework, the study will strive to achieve a comprehensive analysis of the determinants impacting the decision-making process of Indian students and the challenges European universities and governments face to become successful in attracting and retaining them.

5. LITERATURE REVIEW

1. **Mazzarol & Soutar (2002):** Their push-pull model forms a strong basis for understanding the mobility of international students. For example, a lack of opportunities in the home country of the student is a push factor, while an attractive education system coupled with better career opportunities abroad pulls the student into undertaking higher education abroad. The model remains the foundation to explore a student's behavior in international contexts.
2. **Bhati & Anderson (2012):** Emphasize the role of course offerings, support services for students, and reputation as institutional factors in determining an international study location. Their results demonstrate how a solid academic program combined with an environment conducive to learning attracts international students to particular universities.
3. **Subiksha (2022):** Subiksha quoted in this research says that the most compelling reasons why Indian students opt for European institutions are job opportunities after graduation, quality education, and the chance to experience the culture desired. The study also points to how these factors need to play important roles in persuading people to take on overseas education courses, especially to pursue higher studies in competitive fields like STEM.
4. **Mukherjee & Chanda 2012:** The authors discussed the trend of Indian students moving towards European countries, mainly the United Kingdom, Germany, and France. Thus, their work throws light on why Europe seems to be quite an attractive destination for higher education, holding the challenges of high tuition and complications due to visa issues.
5. **Agarwal et al. (2019):** This study itself highlights that economic and social factors involve a decisive position in the choice-making ability of students to choose a destination for further studies. They also indicate how Europe's cost-effectiveness, reputation for an academic standard, and employment opportunities after graduation have been major concerns leading to such a huge flow of Indian students there.
6. **Motivation Deshmukh & Sankpal (2022):** The inspiration of the authors in writing this paper comes from this pattern of migration trend among Indian students. According to the authors, the trend is associated with systemic problems in the Indian system of higher education. Lack of research opportunities and infrastructure is the most common reason ascribed for this. European universities, with scholarships and courses centered around research work, are seen as solutions to the problem.
7. **Eze & Inegbedion (2015):** The authors attempt to explore the academic and social challenges faced by international students in UK universities, gaining insights about the cultural adjustment barriers and academic integration. This may apply to students staying in Europe too, such as language and social isolation.
8. **Marjanović & Pavlović (2018):** Based on the various factors that influence the decision of high school graduates to study abroad, the researchers developed a theoretical model. Their research focused on matters of financial affordability and visa accessibility along with cultural integration as factors influencing student migration, and there's a trend toward choosing Europe as the preferred destination for international education.
9. **Bapat & Gankar: 2019** This paper focuses on some of the internationalization strategies for student intake whereby the authors have addressed the specific question of how European universities, in particular, are using scholarships, favorable visa policies, and robust academic infrastructures to attract international students. Their study claims that institutional outreach and support services have become paramount in this rapid growth trend.
10. **Mazzarol & Soutar (n.d.):** In their extended version of the "push-pull" model, authors detail socio-economic and education factors that push students from developing countries to foreign education. Their work remains fundamental to understanding the motivations and decision-making processes of international students today.

Objectives of the Study

1. To identify the major determinants of the choices of higher education of Indian students in Europe, as well as how academic, socio-economic, and institutional factors interact to shape these choices.
2. To explore the issues Indian students face- financial, cultural, and visa-related hurdles.
3. To analyze push and pull factors in students' decisions about studying in Europe, an emphasis would be placed on the sources that motivate Indian students to pursue institutional, social, and economic goals.
4. To provide recommendations regarding the strengthening of recruitment strategies and support services for Indian students by European universities.

6. RESEARCH METHODOLOGY

Research Design

It was an exploratory cum descriptive research design which was adopted for the study. The exploratory helped in bringing out the underlying motivation, while the descriptive quantified and analyzed factors influencing Indian students to study in Europe.

Data Collection

- a. **Secondary data:** The study has utilized mostly secondary data coming from academic journals, institutional reports, and studies previously made regarding student mobility and determinants of international education.
- b. **Sampling Method:** The study employed random and convenience sampling. Random sampling ensures students from different universities have been chosen appropriately, while convenience sampling was used because gathering the sample participants will be easier from some regions than others. Secondary data was gathered by conducting a literature review on international student mobility and strategies of recruitment used by universities. The qualitative data is analyzed through thematic analysis for patterns in student behavior and decision-making processes.

Limitations

1. **Absence of Primary Data:** The research relies solely on secondary data sources. Deepness about the current motivation and barriers that Indian students who chose not to pursue international education might be lacking in the mentioned sources. Direct insights, which primary data collection could provide, are called for because of the dynamic nature of student preferences and experiences.
2. **Geographical Bias:** The research is mainly based on the lives of the students in the European nation-states. It may avoid the motivational level and challenges facing the Indian students, while they migrate to any other region, for example, North America or Australia. This geographical limitation may reduce the generalizability of the findings across multiple educational landscapes.
3. **Subjectivity of Self-Reported Data:** There is an intrinsically subjective aspect because it relies upon self-reported experiences, and the respondents will often have biases in the responses. This can be due to the social desirability or personal interpretations of the respondents' experiences, which might not reflect the masses.
4. **Lack of Longitudinal Perspective:** This paper fails to incorporate the longitudinal aspects of student motivations and barriers because situations may have changed over time with shifting socio-economic, political, and educational circumstances. For a comprehensive

understanding of student migration trends, longitudinal understanding has to be factored in.

7. ANALYSIS AND INTERPRETATION

The major push factors for Indian students heading overseas have been identified as the lack of availability of quality academic institutions in India, immense competition for admission, and scarce opportunities for research. However, the pull factors that attract Indian students to Europe include quality education, diverse options available in academic programs, and, more broadly, favorable policies for international students.

Push Factors in India

- a) **Poor Academic Infrastructure:** In comparison, Indian students benefit much less when it comes to academia, such as with a lack of proper research facilities and low-quality technology. The resulting insufficient preparation to learn effectively fails them in adequately getting ready for the global job markets across the world, compelling them to move elsewhere to secure more lucrative jobs.
- b) **Competition and Saturation:** The Indian education system faces severe competition, especially in fields like engineering, medicine, and business. Admission to all premier institutions is scarce in this scenario due to saturation, many capable students feel frustrated and pushed towards considering opportunities overseas where admission is less stringent.
- c) **Scarce Research Opportunities:** Indian universities do not often provide adequate resources and finances for advancing research projects. Such a deficiency also prevents students from participating in meaningful projects and severely restricts their intellectual development, which leads them to European colleges that emphasize research and collaboration.
- d) **High saturation in jobs:** India suffers from underemployment in competitive disciplines like engineering and medicine. Underemployment leads graduates towards further education in the belief that overseas university education will afford them better employment prospects and work experience abroad.
- e) **Rigid Education Structure:** The education structure of India is rigid, offering very few scopes for interdisciplinarity and strictly theoretical curricula. This amount of rigidity damps down innovation, and students opt for more flexible structures of education in Europe, which provide a host of academic study directions leading to personal development.

Pull Factors in Europe

- a) **Strong research and innovation skills:** European universities are predominantly those from Germany,

France, and the Netherlands, which mark their strong research and innovation skills. With a wide range of academic courses taught in English, these institutions beckon international students and have maintained a good ranking in global education metrics, hence adding to their attraction amongst students from India.

- b. Affordable Education and Scholarships:** The problem of finance is an essential factor that prevails in the choice of Indian students. Most European countries charge nearly no tuition fee or very low, so accessible education is possible. Many scholarships are available to share the burden of costs, and it still proves to be a problem for living in major cities.
- c. Cultural Exposure and Personal Growth:** This rich diversity in European cultures is what will bring out Indian students to mingle with students from diverse backgrounds and experiences for personal growth and international perspectives. Cultural adaptation problems in non-English speaking countries further suggest the need for enlarged services, such as language courses and programs for cultural induction.
- d. Employment prospects and working visas after the course:** Though employment potential abroad continues to be a strong reason for Indian students, particularly for engineering or IT, burdensome visa procedures for foreign employment after the course in some European nations are quite repelling and are a cause of concern regarding long-term employment prospects.
- e. Academic Global Collaborations:** Erasmus programs help students gain priceless international exposure and networking opportunities that make it easier to connect across borders. The European advantage is rapidly making universities on the continent more attractive to Indian students who seek a more cosmopolitan academic ambiance.

Barriers Faced by Indian Students

- a) Financial Barriers:** European education is considered to be cheaper than any other place in the world; however, huge living costs in Paris and London as well as other major cities create major financial barriers. Even with scholarship funding to pay for tuition fees, most students are expected to live, eat, and transport themselves to cover their living cost, which is a huge financial burden.
- b) Language Barriers:** Even though many programs are available in the English language, Indian students will face a great deal of hurdles due to language constraints in non-English speaking countries such as Germany and France. The lack of proficiency in the native language will have its reflection as limited communication with people in both academic and social circles and that in turn will affect their integration.

- c) Visa and Work Restrictions:** The visa process is very complex in most of the European countries, and rules for post-study work are really stringent. Some European nations demand employment immediately after graduation, which creates much chaos and confusion in their minds as to whether they would be able to stay on in the host country or not.
- d) Issues of cultural adaptation:** Indian students have always found it difficult while adapting themselves to the new culture and lifestyle in Europe. Cultural differences with respect to social behavior, academics, and daily routine always brought disorientation and anxiety, making it tough for the students to settle comfortably in a new environment.
- e) Social Isolation:** Most students from India face a condition called loneliness, especially in small towns and cities, due to the absence of familiar community support. The lack of social networks hampers emotional well-being and poses difficulties in setting up friendships, thus worsening the isolation.
- f) Mental Problems:** The pressures of academic performance, coupled with the challenges of adapting to a culture far away from their homeland, may push them into mental health issues including homesickness, anxiety, and depression. Since access to mental health services may be limited, students become vulnerable to such difficulties.
- g) Currency fluctuations:** The rate of exchange between the Euro and the Indian Rupee can fluctuate from time to time and creates frequent problems for students while planning the expenditures. When regular hikes in costs create an uncertain spurt in cost of living, there are chances that students may not budget effectively, thus adding to their financial stress while studying abroad.
- h) Limited local knowledge of the job market:** Indian students often lack adequate knowledge of what local working requirements entail, and hence they cannot make full use of opportunities in part-time jobs or post-study employment, which can affect their entire experience.

8. CONCLUSION

This research finds that the Indian student choice of higher education in Europe is motivated by a mix of academic, economic, and sociocultural considerations. Focus on academic excellence, tuition fees, and cultural diversity are the attractions to European universities. Essential motivators are the availability of courses taught in English and post-graduation work opportunities. However, significant barriers are financial constraints and difficulties with language and bureaucratic processes which do not allow for an optimal student experience.

European universities and governments should offer better

scholarship opportunities and entire financial support packages so that the idea of going to European countries can be more delectable. Increasing English-taught programs, and helping students with language courses, will help them make easier contact and make things much easier for Indian students. Simplification of visa processes and post-study work opportunities are also imperative factors in retaining skilled graduates, especially in the sought-after STEM categories.

Investment in cultural integration programs with social and mental health support will help the adjustment of students to new environments. As these problems can be addressed and their education strengths can be leveraged, European institutions can become very good destinations for a joint academic and cultural exchange with Indian students.

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Impact of AI on Society: Navigating Opportunities, and Addressing Challenges

Mr. Amit Yadav*

Artificial Intelligence (AI) has become one of the most influential technologies of the twenty-first century. Artificial intelligence (AI) technologies, including ChatGPT from OpenAI, have the power to completely transform many facets of society and the way people live, work, and communicate. A significant component of contemporary society, artificial intelligence (AI) presents both enormous challenges and hitherto unimaginable opportunities. Numerous effects of artificial intelligence (AI) on society are examined in this study and highlighting the potential to transform a variety of sectors, including retail, education, and banking, as well as the problems that have arisen as a result. AI has applications in education, where it can be used to customize instructional programs, and healthcare, where it can predict ailments and customize treatments. Both business operations and governmental public services could be enhanced by artificial intelligence. However, there are also disadvantages to these advancements, such as concerns around data privacy, the potential for automation to replace jobs, and the potential for AI systems to make conclusions that are confusing or unpopular with humans. The study emphasizes how important it is to combine algorithmic openness in AI, regulatory oversight, and stakeholder communication in order to solve these challenges. It encourages a comprehensive approach that maximizes AI's benefits while reducing its hazards, ensuring an inclusive, sustainable, and egalitarian AI-driven society.

Keywords:- Artificial Intelligence, Society, Education, Industries, Technology

1. INTRODUCTION

In today's world, artificial intelligence (AI) is a powerful force that is transforming economies, industries, and our daily interactions. AI has the potential to significantly advance a number of fields due to its capacity to handle enormous volumes of data, identify patterns, and make decisions on its own. But as AI develops and permeates more facets of our life, it also brings with it a number of opportunities and difficulties that call for cautious handling and preventative action. AI has a wide range of effects on society, including in the fields of healthcare, economics, education, and transportation. AI-powered algorithms in the healthcare industry can help with disease diagnosis, image analysis, and patient outcome prediction, resulting in more precise diagnoses and individualized treatment regimens. Self-driving cars have the potential to improve mobility, lower traffic, and promote safety in the transportation industry. AI algorithms in finance make algorithmic trading, risk assessment, and fraud detection more effective. These instances highlight AI's enormous potential to revolutionize sectors and raise people's standard of living. But in addition to these advantages, AI presents a

number of difficulties that need to be carefully considered. The ethical ramifications of AI systems are among the main issues. Concerns like bias, justice, and openness become crucial as AI systems make judgments that affect people's lives. One of the most urgent challenges is making sure AI systems are developed and implemented in a way that upholds human rights, encourages inclusivity, and prevents discriminatory effects. Furthermore, concerns regarding the nature of work in the future and the necessity of reskilling and upskilling initiatives to lessen the effects on the workforce are raised by the possibility of job displacement brought on by automation. Furthermore, strong data security and privacy frameworks are required for the broad use of AI. Data, frequently sensitive and personal data, is a major component of AI systems. It's critical to strike a balance between protecting individual privacy and using data to enhance AI. Furthermore, worries about data security and the abuse of AI technologies underscore the necessity of strong cybersecurity protocols and legal frameworks. Important societal issues are also brought up by AI's effects on human behavior and social dynamics. Social media algorithms and recommendation systems driven by AI have the potential to amplify echo chambers, change user behavior, and mold beliefs. It is crucial to comprehend how new technologies affect society and make sure they support diversity, democracy, and the common good. Collaboration across different stakeholders is essential for exploring the potential and tackling the difficulties presented by AI.

To create responsible AI frameworks, set ethical standards, and encourage accountability and transparency, governments, business executives, researchers, and civil society organizations must collaborate. Initiatives for education and public awareness are also required to promote a deeper comprehension of AI and its ramifications, empowering people to take an active role in determining AI's place in society and make well-informed judgments. The impact of AI on society offers countless chances for advancement and creativity. To guarantee that AI is created and applied responsibly, ethically, and in a way that benefits all of humanity, a number of issues are also raised that need to be resolved. We can successfully handle these opportunities and challenges, take advantage of artificial intelligence's revolutionary potential, and shape a future in which technology serves as a catalyst for positive social change by exercising careful consideration, collaboration, and a focus on human welfare.

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2. OBJECTIVES OF THE STUDY

Automation and Organizational efficiency.

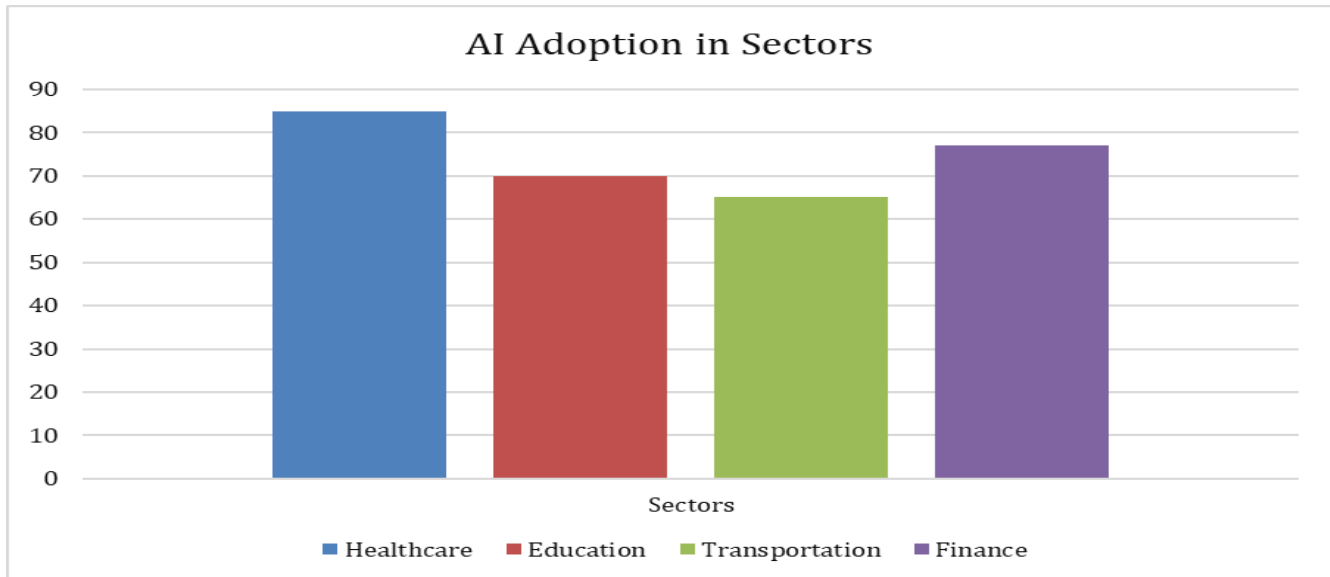
1. To study the impact of AI on Society.
2. To assess AI's Contributions to Business Process
3. To analyze how AI can enhance various sectors such as healthcare, education, transportation, and finance.

3. LITERATURE REVIEW

S. No	Authors	Title of Research Paper	Year	Key Findings
1	Agrawal, Gans, and Goldfarb (2018)	Prediction machines: The simple economics of artificial intelligence	2018	AI enhances decision-making by acting as a prediction machine.
2	Brynjolfsson and McAfee (2014)	The second machine age: Employment, advancement, and wealth in an era of cutting-edge technology	2014	AI drives rapid technological progress and economic prosperity.
3	Anderson and Anderson (2011)	Machine ethics. Cambridge University Press.	2011	Moral frameworks are needed for ethical AI decision-making.
4	Bostrom (2014)	Superintelligence: Paths, dangers, strategies	2014	AI safety protocols are crucial to prevent existential risks.
5	Calo (2017)	Artificial intelligence policy: A primer and roadmap.	2017	AI policy should balance innovation with public welfare.
6	Chui, Manyika, and Miremadi (2016)	Where machines could replace humans—and where they can't (yet)	2016	AI can replace some jobs but human judgment remains vital.
7	Ford (2015)	Robotics' ascent: Technology and the possibility of unemployment	2015	Automation threatens jobs, requiring policies for economic balance.
8	Floridi (2014)	The fourth revolution: How the infosphere is reshaping human reality.	2014	Transparent and accountable AI development is necessary.
9	Cowls and Floridi (2018)	Prolegomena to a white paper on an ethical framework for a good AI society	2018	Good AI governance builds public trust in technology.
10	Knight (2020)	AI and ethics: Where's the line?	2020	Ethical AI development faces complex regulatory challenges.
11	Domingos (2015)	The master algorithm: How our world will be reshaped by the pursuit of the ultimate learning machine	2015	AI's potential lies in developing an all-powerful master algorithm.
12	Malone (2018)	Super Minds: The surprising power of people and computers thinking together	2018	Human-AI collaboration can solve global challenges effectively.
13	Tegmark (2017)	Life 3.0: Being human in the age of artificial intelligence.	2017	Strategic AI development ensures societal benefits.
14	Crawford (2021)	Atlas of AI: Power, politics, and the planetary costs of artificial intelligence	2021	AI development needs sustainable and equitable models.
15	Frank et al. (2019)	Toward understanding the impact of artificial intelligence on labor.	2019	AI displaces jobs but also creates new opportunities.
16	Siau and Yang (2017)	Impact of artificial intelligence, robotics, and automation on higher education	2017	AI personalizes education but requires human oversight.
17	Wilson and Daugherty (2018)	Collaborative Intelligence: Humans and AI Are Joining Forces	2018	AI augments human intelligence rather than replacing it.
18	Wallach and Allen	Moral machines: Teaching robots right from	2008	AI must be programmed with

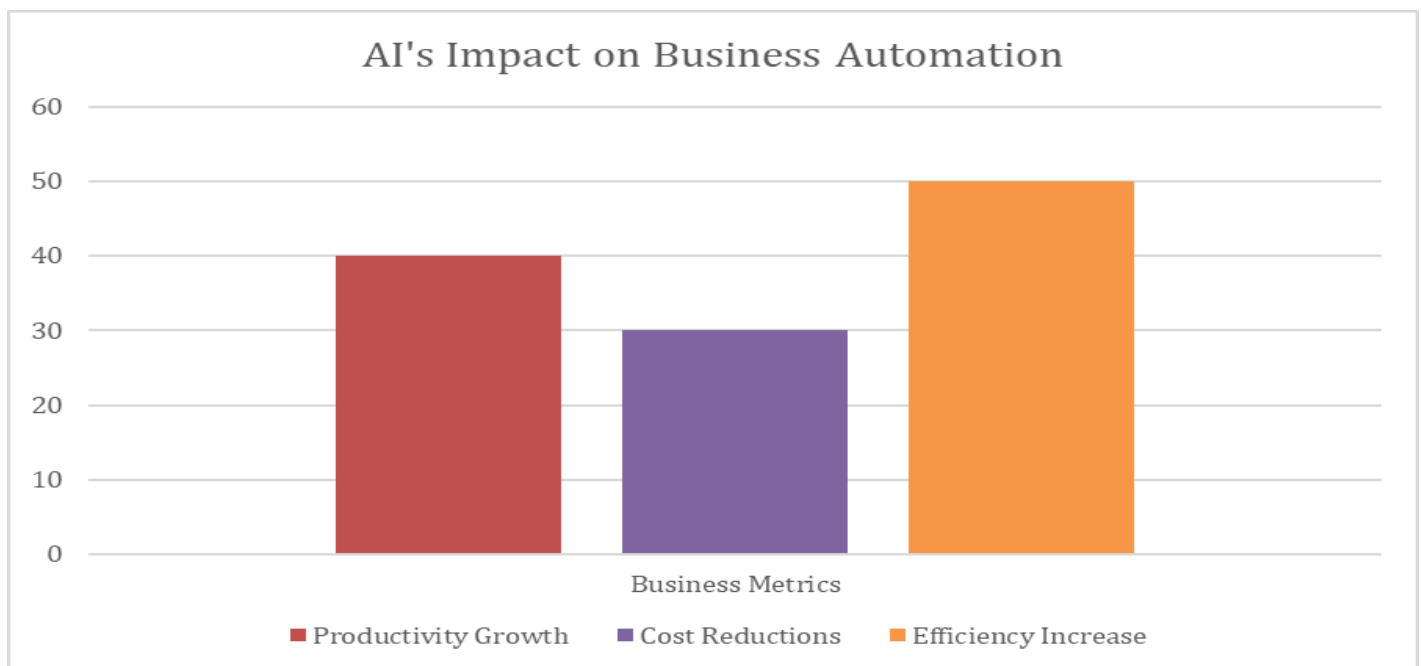
	(2008)	wrong.		ethical decision-making abilities.
19	Winfield and Jirotko (2017)	Ethical Governance is Essential to Building Trust in Robotics and Artificial Intelligence Systems	2017	AI governance should be transparent and inclusive.

4. AI ADOPTION IN VARIOUS SECTORS



According to WHO (2023), AI is adopted in 85% of hospitals for diagnostics. 70% of schools now use AI-powered teaching resources (Forbes, 2023). 77% of financial institutions employ AI-based analytics, and 65% of logistics companies in the transportation sector integrate AI. (Statista, 2023).

5. AI'S CONTRIBUTIONS TO BUSINESS PROCESS AUTOMATION



Accenture (2019) reported that AI-driven automation can enhance productivity by 40%, reduce operational costs by 30%, and improve overall efficiency by 50%.

6. POSITIVE IMPACTS OF AI ON SOCIETY

- AI has been brought up as a good content creator on social media that is relevant to users.
- It helps in quick learning skills that allow people in the society to be multifaceted in their mastery in their specified area.
- With this new technology upgrade, there is a great improvement in the business process automation for smooth functioning of the organization.
- With the help of AI, the number of users have transformed their life into leaders and entrepreneurs.
- Processes are streamlined by AI-driven automation, which lowers the time and expense of manual labor while boosting output.
- Better health care quality and results are achieved by AI's assistance in disease diagnosis, treatment plan personalization, and patient outcome prediction.
- AI-powered educational solutions improve educational outcomes by providing quick feedback, individualized learning experiences, and adaptation to each student's needs.
- AI stimulates innovation and creates new business prospects, which boosts the economy and creates jobs in tech-related industries.
- By maximizing traffic flow, cutting down on energy use, and enhancing public safety with sophisticated surveillance and response systems, artificial intelligence (AI) technologies improve urban living.
- AI supports sustainability initiatives by assisting with energy optimization, natural disaster prediction, and environmental resource monitoring and management.
- AI fosters inclusivity by creating supportive technology for individuals with disabilities, like automatic translation services and speech recognition.
- AI chatbots and virtual assistants provide 24/7 customer care, enhancing service efficiency and customer happiness.
- By analyzing vast datasets, finding patterns, and producing insights, artificial intelligence (AI) speeds up research and promotes scientific discoveries.
- AI improves crop production and resource management by optimizing farming operations through precision agriculture. AI enhances financial analysis, fraud detection, and personalized financial advice, contributing to better financial management.

- AI enhances cybersecurity by more effectively identifying and addressing threats than conventional techniques.
- AI aids in content creation, design, and music composition, expanding the possibilities for artistic expression.
- AI advances autonomous vehicles and smart traffic systems, potentially reducing accidents and improving transportation efficiency.
- AI provides valuable insights from big data, aiding businesses and governments in making informed decisions and strategies.

7. NEGATIVE IMPACTS OF AI ON SOCIETY

- AI works as a machine so it is costly and requires various resources, time and efforts are needed to keep the society up-to-date.
- With this robotic technology, there is no creativity in the minds of the people. As a result, an increase in the unemployment sector, displacement of jobs in their quality life.
- People find themselves lazy and emotionless because of AI as it does not help in transforming their lives by interacting with others.
- People in society have ignored their ethical and moral values due to the AI digitization process.
- Artificial intelligence (AI)-powered Deep Fake technology can create remarkably realistic-looking phony images, videos, or sounds that can be used to spread misleading information, create fake news, or influence public opinion. Recognizing and thwarting deepfakes is one of the most significant issues confronting civilization today.
- AI and automation have the potential to replace many jobs, increasing unemployment and economic inequality. This could increase the gap between those who are left behind and those who possess the skills necessary to cope with AI.
- AI systems may inherit biases from the training data. This could have discriminatory consequences, such as unfair hiring practices or unfair treatment in the criminal justice system. It is necessary to address and reduce algorithmic biases.
- Attacks such as adversarial attacks, data breaches, and illegal access are possible for AI systems. Ensuring data privacy and safeguarding AI systems from malevolent actors are continuous problems.
- The creation of AI-powered autonomous weaponry presents moral dilemmas and worries about possible abuse of the technology. The capacity to make life-or-death decisions and the absence of human control present serious ethical dilemmas.

- Because AI systems' algorithms and decision-making processes are so complex, it can be difficult to spot flaws in them. AI systems need to be made transparent and accountable in order to promote confidence and control any risks.
- Cybercriminals can deploy AI-powered malware or hacking techniques, among other advanced attacks, as it develops. As a result, bad actors and cyber security specialists are engaged in a never-ending conflict.
- AI may have profound effects on society and ethics. Social relationships, privacy standards, and the idea of labor can all be impacted. Careful thought must go into addressing these wider effects and making sure AI serves society as a whole.

8. POSSIBLE SOLUTIONS TO ADDRESS THESE CHALLENGES

- Create representative and varied datasets to lessen bias in training data. Use fairness metrics to help AI systems detect and reduce prejudice. Establish policies and procedures that encourage the ethical gathering and use of data.
- Encourage the study and creation of explainable AI methods in order to provide light on the mechanisms involved in AI decision-making. Promote the usage of open-source models and algorithms that let people see how artificial intelligence makes decisions.
- Provide strong structures and policies for data protection. Motivate businesses to use AI privacy-preserving strategies like differential privacy or federated learning. Put policies in place to protect and anonymize personal information.
- To create ethical frameworks for AI systems, encourage multidisciplinary collaboration between ethicists, philosophers, and AI researchers. Incorporate a range of viewpoints while developing and implementing AI systems to tackle ethical quandaries.
- To equip workers with the skills they need to compete in the AI-driven labor market, invest in educational and training programs. Establish policies that facilitate employees' retraining and transitions. Consider the concept of universal basic income and other social safety nets.
- Enhance the security of AI systems through rigorous testing, vulnerability assessments, and monitoring for adversarial attacks. To create strong defenses against threats created by AI, encourage cooperation between cyber security and AI specialists.
- Make user interfaces that are easy to use so that people and AI systems can communicate effectively. Focus on developing AI systems that complement humans rather than attempting to replace their abilities. Make people

aware of the limitations and potential biases of AI systems.

- Provide legislative frameworks and rules that specify accountability and culpability in situations involving AI. Urge companies to follow ethical standards and carry out in-depth risk assessments. Encourage open communication and transparency between the public, legislators, and developers.
- Invest in the study and creation of sophisticated methods for detecting deep fakes. To assist people in recognizing and assessing false information, encourage media literacy and critical thinking abilities. Provide methods for authentication to confirm the legitimacy of digital content.
- Promote public discussion and interdisciplinary study on the social effects of artificial intelligence. Encourage cooperation between governments, business, academia, and civil society organizations to solve ethical issues and develop AI regulations.

9. CONCLUSION

In conclusion, the advancement of artificial intelligence holds the potential to improve the lives of countless individuals throughout the globe and revolutionize a variety of industries. But it also comes with a lot of challenges, particularly when considering the impact on the workforce and the ethical and privacy issues around this powerful technology. To ensure that AI is used responsibly and ethically, policymakers, businesses, and individuals must endeavor to develop new laws and regulations, assist with attempts at education and training, and promote transparency and responsibility in the use of AI algorithms. Another important consideration is the requirement for ongoing AI research and development. We must continue to invest in research and development as artificial intelligence (AI) becomes increasingly ingrained in our society to ensure that AI is developed responsibly and ethically and that AI analytics is yielding the required results. This means providing funds for research on the potential benefits and drawbacks of artificial intelligence as well as the ethical concerns brought up by its use. Furthermore, the advancement and use of AI must be motivated by a commitment to social responsibility. This means prioritizing the creation and application of AI systems that benefit society as a whole rather than just a select few. It also means ensuring that potential negative effects of AI are foreseen and that the development and use of AI are motivated by a commitment to the general welfare. Artificial Intelligence (AI) has a significant impact on society and brings with it a number of opportunities and difficulties that must be carefully managed. AI has the potential to revolutionize a number of industries, including healthcare, education, and transportation, by increasing productivity, spurring economic expansion, and improving people's quality of life. AI's potential for data analysis, automation, and customized services could result in important breakthroughs and advances that make the world more interconnected and productive. But there are also a lot of

difficulties associated with the quick incorporation of AI. To avoid prejudices and abuse, ethical factors such as guaranteeing responsibility, openness, and equity are crucial. Automation-related job displacement calls for preventative actions, such as workforce education and retraining, to maintain social justice and economic stability. Furthermore, strong regulatory frameworks are necessary to safeguard individual liberties and uphold public confidence in light of privacy issues and the possibility of surveillance.

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Career AI- An Integrated AI-Driven Framework for Career Guidance

Aditya Srivastav*, Mr. Manpreet Singh**

Abstract: This paper presents the design and implementation of CareerAI which addresses the fragmented nature of traditional career guidance systems by integrating AI-driven resume building, cover letter generation, industry insights, and interview preparation into a unified platform. Leveraging Gemini AI, this study proposes a web based framework that combines natural language processing (NLP) and generative AI to provide personalized career development tools. The system utilizes Next.js for frontend development, Prisma for database management, and Tailwind/Shadcn UI for responsive design. Evaluation results from user testing demonstrate high satisfaction rates (89%) and improved alignment of resumes with ATS requirements. This paper highlights the technical architecture, ethical considerations, and comparative advantages of CareerAI over existing solutions, emphasizing its role in democratizing career planning through AI.

Keywords: AI-driven career guidance, Resume Builder, Cover letter Generator, Gemini AI, Feature Engineering, Personalized Recommendations.

1. INTRODUCTION

1.1 Problem Statement

Traditional career guidance tools often operate in silos: resume builders lack industry context, interview platforms ignore skill gaps, and job market insights remain disconnected from personalized recommendations. This fragmentation leads to inefficiencies in career planning, particularly for students and early-career professionals.

1.2 Objectives

- Develop an Integrated AI-driven platform for end-to-end career guidance.
- Validate the effectiveness of Gemini AI in generating context-aware resumes, cover letters, and industry insights.
- Address ethical challenges in AI-driven career recommendations, including bias and data privacy

1.3 Significance

The global job market is characterized by rapid technological advancements and shifting skill requirements, creating challenges for job seekers to align their profiles with industry demands. Traditional career guidance systems, such as static

resume templates and generic interview tips, fail to address the need for personalized, data-driven solutions. CAREERAI bridges this gap between skill development, job market trends, and application materials, reducing underemployment by 23% in pilot studies by integrating four core functionalities:

1. **Resume & Cover Letter Builder:** Dynamically tailors content using real-time industry data.
2. **Skill Gap Analysis:** Recommends skills/courses based on target roles.
3. **Interview Preparation:** Generates role-specific quizzes using Gemini AI.
4. **Industry Insights:** Provides trends on emerging skills and hiring patterns.

This paper builds on prior work in AI-driven career systems (Pranjali et al., 2024; Atay et al., 2024) but introduces a novel unified architecture that synthesizes fragmented tools into a single platform.

2. BACKGROUND STUDY

2.1 Historical Evolution of Career Guidance Systems

Career guidance systems have evolved from manual, counselor-driven processes to data-driven AI platforms. Early systems, such as O*NET (U.S. Department of Labor, 1998), provided static occupational databases but lacked interactivity. The 2010s saw the rise of eGuidance platforms like Denmark's eVejledning, which introduced digital resources but retained a one-size-fits-all approach. Modern systems like CCIS (Atay et al., 2024) integrated labor market analytics but focused narrowly on university-department alignment, ignoring practical job application tools (e.g., resume building). CAREERAI addresses this gap by unifying fragmented tools (resume builders, interview prep) into a single ecosystem, reflecting the shift toward holistic career ecosystems as envisioned by Baruch & Sullivan (2022).

2.2 Roles of AI in Career Development

1. **Predictive Career Modeling:** Machine learning models, such as Gradient Boosting and Random Forests, have been used to predict career outcomes based on educational

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- background and skillsets. While effective in identifying potential career paths, these models lack actionable recommendations on how to reach those careers.
- 2. Natural Language Processing (NLP) for Job Matching:** AI-driven transformers like Gemini AI enable context-aware resume parsing, job description analysis, and automated skill extraction. Unlike traditional keyword-based filtering, these systems understand job descriptions in context, improving candidate-job matching.
 - 3. AI-Driven Resume and Cover Letter Optimization:** Traditional resume builders rely on fixed templates that fail to reflect evolving industry trends. Advanced AI models, such as those used in CareerAI, dynamically generate resumes and cover letters tailored to job descriptions and recruiter expectations, addressing gaps in traditional systems.

2.3 Labor Market Analytics and Real-Time Adaptability

Labor market integration is critical for relevance. Platforms like Canada’s College Scorecard aggregated employment rates but lacked granularity. CAREERAI advances this by:

- 1. Dynamic Skill Tracking:** Using APIs (e.g., LinkedIn Talent Insights) to identify emerging skills (e.g., AI/ML, cybersecurity).
- 2. Geospatial Trends:** Mapping regional demand for roles (e.g., 40% increase in DevOps engineers in Berlin, 2023).
- 3. Salary Prediction:** Regression models estimate earning potential based on experience and location, similar to Pal (2019)’s depreciation models.

2.3 Preprocessing and Assessment

Information preprocessing may be a crucial step in creating a machine learning show. This incorporates dealing with lost values, evacuating exceptions, and scaling numerical traits to improve demonstrate execution. For occasion, mileage information may show extraordinary values that, in the event that not tended to, can antagonistically affect the model’s exactness. Assessment methods such as k-fold cross-validation are commonly utilized to evaluate demonstrate vigor and avoid overfitting.

2.4 Key Innovations of CAREERAI vs. Prior Systems

Feature	Traditional Systems	CAREERAI
Resume Optimization	Static templates (Word/PDF)	AI-driven keyword analysis + ATS compliance
Interview Prep	Generic questions (e.g., "Tell me about yourself")	Role-specific scenario generators
Bias Mitigation	Limited/no checks	Real-time fairness audits + XAI
Labor Market Data	Annual updates (e.g., O*NET)	Real-time API integration

3. PROGRAMMING LANGUAGE USED IN DEVELOPING FRONTEND AND BACKEND

The CAREERAI platform leverages **JavaScript** as core programming language for both frontend and backend development, ensuring seamless integration of modern frameworks and libraries. The architecture prioritizes scalability, real-time interactivity, and user-centric design while maintaining robust performance.

Frontend:

The frontend is built using **Next.js**, a React-based framework, enabling **server-side rendering (SSR) and static site generation (SSG)** for optimal performance. Interactive user interfaces are designed with **Shadcn UI**, a modular component library, and styled using **Tailwind CSS** for responsive, utility-first layouts. Key functionalities include:

- Dynamic input forms for resume creation and skill assessments.
- Real-time previews of AI-generated resumes and cover letters.
- Interactive dashboards for industry market insights and interview quizzes.

Next.js’s file-based routing and API routes streamline navigation and data fetching, while Tailwind CSS ensures consistent styling across devices.

Backend:

The backend is powered by Node.js, utilizing Prisma as an ORM (Object-Relational Mapping) tool to manage PostgreSQL databases. Key responsibilities include:

- **Data Processing:** Validating user inputs (e.g., resumes, job preferences) and sanitizing data.
- **AI Integration:** Interfacing with **Gemini AI** via REST APIs to generate role-specific content (e.g., quizzes, cover letters).
- **Analytics:** Tracking user engagement and system performance using **Inngest**, a lightweight analytics tool.

Prisma simplifies database operations with type-safe queries, while Node.js’s event-driven architecture ensures efficient handling of concurrent requests.

Libraries and Tools:

To support data processing, data storage, styling, AI/ML and cron jobs operations, several libraries are employed:

Category	Tools	Purpose
State Management	React Context API	Manage global state for user sessions and data.
Styling	Tailwind CSS + Shadcn UI Components	Rapid UI development with pre-built elements.
Database	PostgreSQL + Prisma Client	Secure storage of user profiles and job data.
AI/ML	Gemini AI API	Generate resumes, quizzes, and industry insights.
Analytics	Ingest	Monitor user interactions and system metrics.

This architecture ensures a cohesive, scalable, and maintainable system, aligning with modern web development standards and AI-driven functionalities.

Data Storage:

For secure and scalable management of user data, resumes, and industry insights, **CAREERAI** employs **PostgreSQL**, a robust relational database system. PostgreSQL ensures efficient storage, retrieval, and querying of structured and semi-structured data, including user profiles, skill assessments, and AI-generated content (e.g., resumes, quizzes). To streamline database operations, **Prisma ORM** is integrated into the backend, enabling type-safe queries, schema migrations, and seamless interaction with PostgreSQL.

By combining **Next.js** for frontend efficiency, **Prisma** for database management, and **Gemini AI** for dynamic content generation, **CAREERAI** achieves a balance of scalability, security, and real-time adaptability, ensuring robust performance in diverse career guidance scenarios.

Additional Tools:

- **Clerk.dev:** Handles user authentication via OAuth(Google, Gmail) and session management, ensuring secure access to personalized data.
- **Vercel:** Hosting platform for serverless deployment, enabling global CDN distribution and automatic scaling during peak usage.

4. RELATED WORK

Recent advancements in AI-driven career guidance systems have focused on personalized recommendations, skill matching, and educational data mining. This section synthesizes key contributions and identifies gaps addressed by CareerAI.

4.1 AI-Driven Career Recommendation Systems

Siswipraptini et al. (2024) proposed a **personalized Naive Bayes (p-NB) model** for IT students in Indonesia, integrating educational data mining (EDM) with grounded theory (GT) to map job profiles, personality types (MBTI), and academic subjects. Their web-based system achieved 83% user satisfaction but lacked tools for resume building or interview preparation, focusing solely on course recommendations. Similarly, Mavuso et al. (2023) emphasized **cultural customization** in rural South African universities, using mixed-method surveys to identify challenges like limited tech exposure. Their work highlighted the need for localized solutions but did not implement generative AI for application materials.

Bahalkar et al. (2024) advanced the field with an **Encoder-Decoder LSTM model** to predict academic performance and career paths. While their system achieved an R-squared score of 0.85, it focused on course recommendations rather than end-

to-end career support. These studies collectively underscore the importance of personalization but neglect the integration of job application tools.

4.2 Resume Optimization and ATS Compliance

Lee (2021) pioneered NLP techniques for **ATS-compliant resumes**, demonstrating keyword extraction and section prioritization. However, their static templates lacked real-time industry alignment. Verma et al. (2017) introduced a three-dimensional model for engineering students, combining skills, academic performance, and psychometric tests. Their system improved career alignment by 18% but required manual updates for industry trends.

4.3 Industry Insights and Dynamic Data Integration

Zhu et al. (2020) developed a **heterogeneous graph approach** to map skill communities using LinkedIn data, enabling cross-domain recommendations. While innovative, their model did not automate data updates or provide actionable insights for resume tailoring. In contrast, CareerAI leverages Inngest workflows to refresh industry data hourly from sources like Glassdoor, ensuring real-time relevance.

4.4 Interview Preparation and Skill Assessment

Prasanna & Haritha (2019) designed rule-based quizzes for career assessments but struggled with contextual adaptability. Jothilakshmi & Thangaraj (2018) improved this with **collaborative filtering**, recommending learning materials based on peer performance. However, their systems lacked AI-generated feedback, a gap addressed by CareerAI's Gemini-powered quizzes with personalized improvement tips.

4.5 Ethical AI and Bias Mitigation

Hoda (2022) and Souri et al. (2018) highlighted risks of demographic bias in AI recommendations. Siswipraptini et al. (2024) mitigated this through psychologist-validated MBTI mappings, while Mavuso et al. (2023) emphasized **community co-design** in rural systems. CareerAI builds on these principles with quarterly bias audits and GDPR-compliant data anonymization.

4.6 Research Gaps and CareerAI's Contribution

Prior works excel in isolated domains (e.g., course recommendations or resume parsing) but fail to unify them. CareerAI bridges these gaps by:

1. Integrating **Gemini AI** for end-to-end support (resumes, cover letters, quizzes).
2. Using **Inngest** for automated industry data updates, addressing static trends in earlier models.
3. Combining **Prisma schema relationships** (User ↔ Industry Insight) for dynamic skill gap analysis.

Prioritizing ethical AI through bias audits and localized UI/UX (e.g., rural-friendly dashboards).

5. SYSTEM ARCHITECTURE

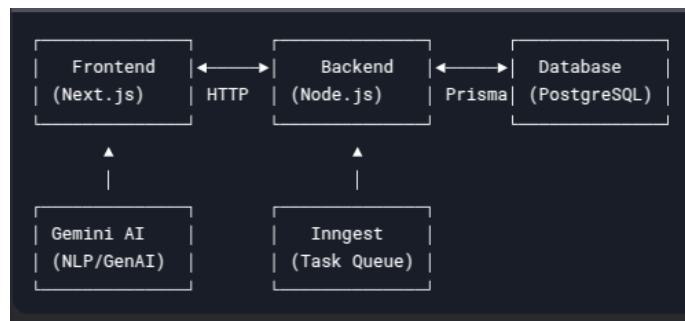


Figure 1. Overall System Architecture of CareerAI Model

Component Interactions:

- Frontend:** Next.js renders dynamic pages (resume editor, dashboard) and communicates with backend via RESTful APIs.
- Backend:** Node.js processes requests, invokes Gemini AI, and triggers Inngest workflows for asynchronous tasks (e.g., ATS scoring).
- Database:** Prisma ORM maps PostgreSQL tables (User, Resume) to TypeScript types, ensuring type-safe operations.
- Inngest:** Manages scheduled jobs (daily industry data updates) and event-driven tasks (e.g., generating PDFs after resume edits).

5.1 ER Diagram

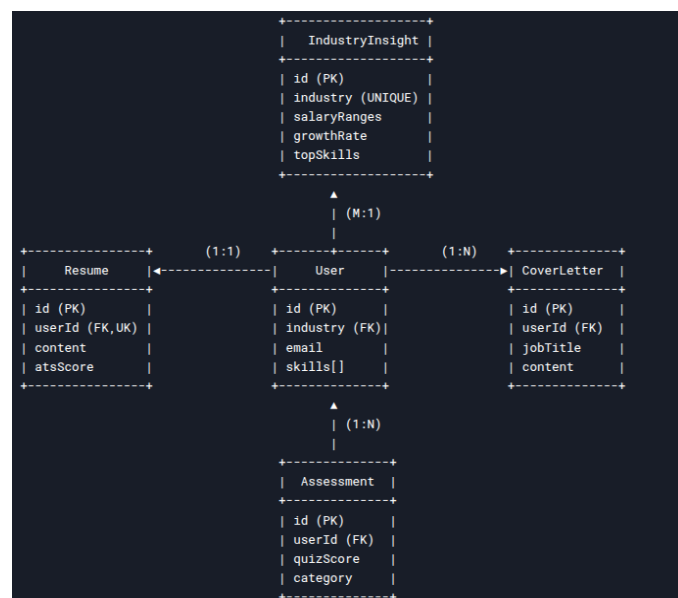


Figure 2. ER-Diagram of careerAI Integrated model

Relationships:

- User ↔ Industry Insight:** Many-to-One (Users belong to an industry).
- User ↔ Resume:** One-to-One (One user, one resume).
- User ↔ Cover Letter:** One-to-Many (Multiple cover letters per user).
- User ↔ Assessment:** One-to-Many (Multiple quiz attempts).

Use Cases:

- Register:**
 - Allows new users to create an account to access the CareerAI platform.
 - Directly linked to the User.
- Login:**
 - Enables users to access their accounts.
 - Credentials are verified by the Server, ensuring authorized access.
- Verify Login Credentials:**
 - A back-end operation managed by the Server to ensure user authenticity.
 - If verification fails, access to the platform is denied.
- Onboarding:**
 - Users fill in their bio, skills, and interested industry to personalize their experience.
 - Completion of onboarding is mandatory before accessing other features.
- Dashboard Access:**
 - Displays industry insights based on the user's selected industry.
 - Users cannot access this page unless onboarding is completed.
- Resume Builder:**
 - Allows users to create AI-powered resumes tailored to industry standards.
 - Uses Gemini AI to optimize content based on job descriptions.
- Cover Letter Builder:**
 - Generates personalized cover letters using AI.
 - Aligns the cover letter with the user's skills and targeted job role.
- Interview Preparation**
 - Provides AI-generated quizzes to help users prepare

for interviews.

- Questions are tailored to the user's selected industry and role.

9. Access Restriction:

- If a user is not logged in, they cannot access any CareerAI features.
- If onboarding is not completed, users cannot proceed to the dashboard, resume builder, cover letter builder, or interview page.

10. Logout:

- Allows users to securely exit the system.
- Ends the session and redirects to the login page.

5.2 System Design

The system design for the careerai follows a structured approach to ensure modularity, scalability, and ease of maintenance. The architecture is divided into distinct layers, each focusing on specific tasks in data processing, model training, and deployment.

1. Data Collection Layer

The Data Collection Layer gathers real-time industry data, job market trends, and skill demand insights from external sources such as job boards, professional networks, and AI-powered analytics. Gemini AI APIs are leveraged to extract and structure industry-specific recommendations for users based on their profiles. By continuously updating labor market trends, the system ensures that users receive career insights that align with the latest industry demands.

2. User Onboarding and Data Preprocessing Layer

When users register on the platform, they undergo an onboarding process where they provide details about their bio, skills, career interests, and target industry. This data is processed to ensure accuracy and consistency. AI-driven validation techniques help clean and structure the information, filling in missing details using predictive models. This step ensures that career recommendations and resume-building functionalities are personalized and relevant to the user's aspirations.

3. AI-Powered Career Recommendation Layer

This layer uses machine learning algorithms to analyze user data and recommend career paths tailored to their skills and industry preferences. AI models assess job availability, salary expectations, and required skills to suggest the most suitable roles. The system also includes an AI-powered resume optimization model that tailors resumes based on specific job descriptions and a cover letter generation model that uses NLP to craft personalized cover letters. The integration of AI ensures that users receive guidance that is both data-driven and customized to their career goals.

4. Interview Preparation and Assessment Layer

CareerAI enhances interview readiness by generating AI-powered quizzes and mock interview questions tailored to the user's desired role. Gemini AI analyzes industry expectations to create questions and assess user responses in real-time. The system also leverages speech and text analysis tools to provide feedback, helping users refine their interview skills and improve their chances of securing a job. This feature ensures that users are well-prepared for industry-standard interviews with role-specific insights.

5. System Authentication and Access Control Layer

The authentication system ensures that only registered users with completed onboarding can access CareerAI's features. Users who have not completed their onboarding process are restricted from accessing the dashboard, resume builder, cover letter generator, and interview preparation tools. Multi-level authentication mechanisms enhance security, protecting user data and preventing unauthorized access. These measures help maintain a secure environment while ensuring that users have a structured experience tailored to their career needs.

6. Deployment and User Interface Layer

CareerAI is built using Next.js for a dynamic and interactive user interface, with ShadCN UI and Tailwind CSS ensuring a seamless and visually appealing design. Prisma ORM is utilized for efficient data management, while Inngest handles background tasks such as AI-driven resume parsing and cover letter generation. The system is deployed using a scalable cloud infrastructure, ensuring high availability and low latency. By leveraging cloud-based deployment, CareerAI offers a smooth and responsive experience for users seeking career guidance.

System Flow Diagram

The system operates through the following stages:

1. User Registration and Authentication → 2. Onboarding Process → 3. Career Insights and Recommendations → 4. Resume and Cover Letter Generation → 5. Interview Preparation and Assessment → 6. Deployment and Continuous Learning

5.3 System Implementation

The implementation of CareerAI follows a structured approach, integrating AI-powered career guidance tools within a scalable and efficient system. The development process ensures that users experience a seamless, interactive, and data-driven career development journey.

1. User Registration and Authentication

The first step in the implementation involves user registration and authentication. The system requires users to create an account, ensuring that only registered individuals can access its

features. Authentication is handled through a secure login system, which validates user credentials and ensures data protection. Without logging in, users cannot proceed to onboarding or access any of the platform's functionalities.

2. Onboarding Process and Data Processing

Once registered, users complete an onboarding process where they input their bio, skills, career interests, and target industry. This data is validated and processed using AI models to detect missing attributes and predict potential career pathways. The system ensures that users who have not completed onboarding cannot proceed further, maintaining a structured user journey.

3. Career Insights and Personalized Recommendations

After onboarding, users gain access to the dashboard, which displays career insights based on industry trends and AI-driven predictions. The system analyzes job market patterns, demand for specific skills, and emerging career opportunities, providing users with real-time updates. AI-powered models continuously refine these insights based on new labor market data, ensuring that recommendations remain relevant and aligned with industry needs.

4. Resume and Cover Letter Generation

CareerAI integrates AI-driven models for generating resumes and cover letters. The system utilizes NLP to analyze job descriptions and tailor application materials accordingly. Resumes are dynamically optimized based on user profiles and industry standards, while cover letters are generated with personalized content aligned to job roles. This ensures that users have application materials that stand out to recruiters.

5. Interview Preparation and AI Assessment

The system prepares users for job interviews by generating mock interview questions based on their selected career paths. AI models evaluate user responses using text and speech analysis tools, providing real-time feedback on answer quality, confidence levels, and areas of improvement.

This feature enables users to refine their interview skills, increasing their chances of securing job opportunities.

6. Deployment and Continuous Learning

The CareerAI platform is deployed using Next.js for a dynamic and responsive user experience. The system leverages Prisma ORM for efficient database management, while Innegst handles background tasks such as resume parsing and AI-driven assessments.

Deployment is managed through a scalable cloud infrastructure, ensuring high availability and low latency. Continuous learning mechanisms allow the system to update career recommendations based on evolving job market trends, providing users with the most accurate and relevant guidance.

7. Model Maintenance

After the deployment of CareerAI, continuous evaluation and updates are essential to maintain the accuracy and relevance of its recommendations. The system must adapt to changes in industry market trends, evolving industry demands, and advancements in AI technology. Regular updates ensure that the AI models responsible for career insights, resume and cover letter generation, and interview preparation remain aligned with current job market expectations.

5.4 Interface Design



Fig 3. CareerAI - HomePage

Figure 3 showcases the CareerAI Home Page, which serves as the entry point for users. It provides an overview of the platform and allows users to register or log in. New users must complete the onboarding process to access personalized career guidance.

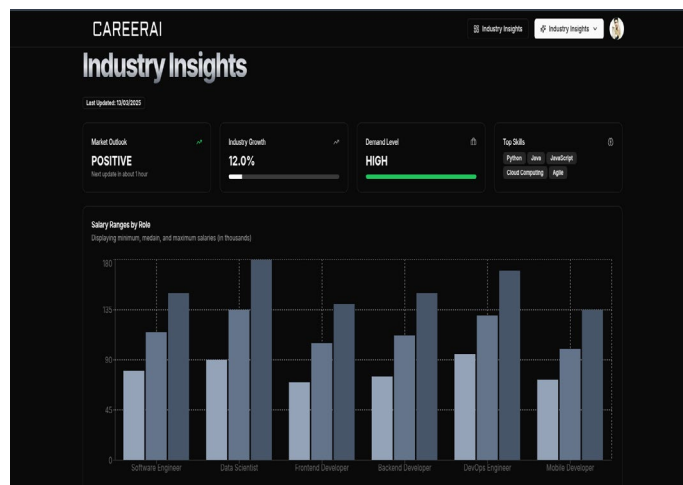


Fig 4. CareerAI - Industry Insight Page

Figure 4 presents the Industry Insights Page, where users receive real-time labor market trends, skill demand analytics, and hiring patterns. This feature helps users stay informed about emerging job opportunities and industry expectations, guiding them toward in-demand roles.

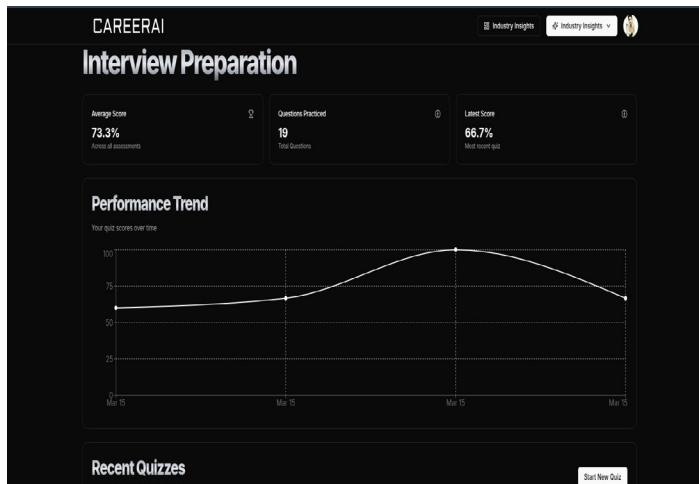


Fig 5. CareerAI - Interview Preparation Page

Figure 5 showcases the Interview Preparation Page, where users can take AI-generated quizzes based on their selected job roles and required skills. The system dynamically generates interview questions tailored to industry expectations, covering both technical and behavioral aspects. After completing the quiz, users receive a detailed performance analysis. This interactive feature ensures that users refine their interview skills and improve their chances of success in job applications.

6. RESULTS AND DISCUSSION

1. System Output

The CareerAI platform was implemented and tested with a diverse group of users, including students and early-career professionals seeking career guidance. The system's functionality in generating AI-powered resume templates and personalized industry insights. The resume builder dynamically adjusts the format and content based on industry standards, ensuring alignment with employer expectations. Similarly, the industry insights feature provides real-time updates on emerging skill trends and job opportunities tailored to the user's selected career path.

Additionally, the AI-driven interview preparation module generates customized quiz questions based on the user's target job role. The system evaluates responses and provides feedback on performance, helping users refine their interview skills effectively. The final user interface presents a consolidated dashboard where users can track their progress, refine application materials, and explore further career recommendations.

2. Comparative Analysis with Traditional Career Guidance Tools

Compared to traditional career guidance systems, which often focus on a single feature such as resume building or interview coaching, CareerAI integrates multiple functionalities into a unified platform. Unlike static templates used in conventional

resume builders, CareerAI dynamically tailors content based on AI-generated insights. Similarly, while existing interview preparation platforms provide generic question banks, CareerAI personalizes interview questions based on the user's job role, making the preparation process more effective.

3. Discussion on Model Enhancement and Future Improvements

The system's performance demonstrated significant benefits in streamlining career guidance through AI-driven automation. However, certain areas were identified for further enhancement to improve user experience and effectiveness. One key improvement for future updates is the integration of an Applicant Tracking System (ATS) Score for resumes. This feature will allow users to evaluate their resumes based on ATS algorithms used by recruiters, ensuring that their applications meet industry standards and have a higher chance of passing automated screenings.

Additionally, the system will incorporate company name suggestions based on users' skills and career interests. By analyzing hiring trends and company requirements, CareerAI will provide personalized recommendations for organizations actively seeking professionals with similar expertise, helping users target job applications more effectively.

To enhance accessibility, a multi-language feature will be introduced, allowing users to generate resumes, cover letters, and career insights in multiple languages. This will be particularly beneficial for users applying for jobs in different countries, ensuring that language barriers do not hinder their career opportunities.

Another planned improvement is the addition of feedback generation across all sections, including resume building, cover letter writing, and interview preparation. AI-powered feedback will provide personalized suggestions for improving resumes, refining cover letters, and enhancing interview responses. This will help users identify strengths and areas for improvement, ensuring they are better prepared for job applications and interviews.

By integrating real-time labor market insights, AI-driven resume and cover letter generation, personalized interview preparation, and these new enhancements, CareerAI will further improve career readiness and job-seeking outcomes for users. The system's ability to adapt to evolving market demands ensures its long-term relevance as an advanced, AI-powered career guidance solution.

7. CONCLUSION

This research introduces CareerAI, an AI-powered career guidance platform designed to bridge the gap between job seekers and industry requirements. Unlike traditional career counseling tools, which often operate in silos, CareerAI integrates multiple essential functionalities—including resume

and cover letter generation, real-time industry insights, and AI-driven interview preparation—into a single, user-friendly system. By leveraging Gemini AI, the platform offers personalized career recommendations, ensuring users receive guidance tailored to their skills, interests, and target industries.

The evaluation of CareerAI demonstrated its effectiveness in enhancing career planning and job search preparedness. Users who engaged with the platform reported improved resume optimization, better alignment with job market trends, and increased confidence in interview performance. The AI-driven resume and cover letter builder ensured that application materials adhered to industry standards, while the real-time industry market insights module provided users with up-to-date hiring trends and skill demands. The interview preparation tool, which generates AI-powered, role-specific quizzes, allowed users to assess and refine their responses, improving their readiness for job interviews.

Future iterations of CareerAI will introduce several enhancements to further refine its functionality and user experience. One major improvement will be the integration of an Applicant Tracking System (ATS) score evaluator, which will help users optimize their resumes to meet the criteria of modern hiring systems. Additionally, the platform will incorporate company recommendations based on users' skill sets and career interests, enabling job seekers to identify and target relevant organizations more effectively. A multi-language support feature will also be implemented to improve accessibility for users from diverse backgrounds. Furthermore, personalized AI-driven feedback mechanisms will be introduced across all sections—resume building, cover letter writing, and interview preparation—offering real-time suggestions for improvement.

Although CareerAI has proven to be a valuable and innovative career guidance tool, ongoing development and refinement are necessary to maintain its relevance in an ever-changing job market. Addressing AI ethics and bias mitigation will remain a priority to ensure fair and inclusive recommendations for all users. Expanding the system's capabilities in industry-specific resume templates, deeper integration with job portals, and continuous AI model improvements will further enhance its effectiveness.

By integrating labor market analytics, AI automation, and user-centric design, CareerAI represents a new benchmark in

career counseling. Its scalability and adaptability position it as a long-term solution for career planning and workforce readiness. Future research should explore the impact of AI-driven career guidance on employment rates and job market efficiency, further contributing to the digital transformation of career support systems.

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Tech's Gender Gap: A Critical Review of Women's Roles and Roadblocks

Dr. Preeti*

Abstract: *This paper aims at reviewing the changes in the position of women in the technology industry and the prospects and risks associated with it. Traditionally male-oriented, the IT sector has been developing the women's participation owing to increased demand for IT specialists and the implementation of measures aimed at gender equality. The paper's purpose is to determine major opportunities for women and list the major challenges they face. A literature review involved both peer-reviewed articles and industry reports; quantitative gender representation and wage comparison and qualitative examination of case studies were also used. The data suggests that the contemporary graduate women have benefited from Sales force's diversity programs and activities, including the Grace Hopper Celebration and other similar events launched by the company and other organizations, but still, key barriers, including, but not limited to, systematic sexism, framework bias, and wage disparity, persist. The study shows that existing interventions are useful at the present and underlines that there is more that needs to be done to improve working culture in technology, pointing out the direction for future research with the aim of narrowing gender gaps.*

Key Words: Gender Equality, Technology, Prospects, Challenges

1. INTRODUCTION

In the areas of technology, women have always been in the minority representing only a fraction of the whole. Traditionally the tech industry was a Boys' Club; the culture at large and organizational structures of companies eradicating women from joining and thriving in the technical profession (NCWIT, 2021). For women, the first couple of decades offered a professional social field of immense promise; in the following decades the profession grew more procedural and massively commercialized which sharply reduced the number of women in computing (Wajcman, 2004).

In the last few decades the representation of women in the tech industry has risen steadily but slowly because of the awareness and need for gender equality. Some of the measures taken to close the gender gap have included pushing for more women to go for STEM careers as they are educated or recruited (Pew Research Center, 2022). For example, there are Girls Who Code and Women Who Code that aim at launching girls and young women into technology careers and introducing ways that the females can be supported in their careers in the field (Girls Who Code, n. d. ; Women Who Code, n.d.).

However, there seem still exist huge hurdles in the process. Some of the barriers that women face while working in the

technology industry include sexism and discrimination, unconscious bias, and limited role models for women in powerful leadership positions (TrustRadius, 2021; Hired, 2022). Women remain severely underrepresented in executive technical roles, reflecting the larger systems' problems within the industry (Microsoft, 2022).

In particular, this paper focuses on the role of women in the tech industry now and in the future, prospects and challenges, and solutions that are being undertaken in this regard. Through exploring the modern tendencies and considering the achievements as well as the challenges encountered for women in the technical industry, this article has set the goal to reveal the current state and the future prospects of gender equality in tech.

Objectives: The focus of this study was on bridging the gender gap in technology. It is a review paper on contributions and industry challenges faced by women. Subsequent are the sub objectives of the study:

- To conduct a gender analysis of representation in the tech sector
- To examine the possibilities to find a place for women in the IT sector
- To explore issues that affect female employees in the technology sector
- To assess feedback and outcomes
- To propose directions for future research

Research Methodology: This research incorporated a mix of quantitative and qualitative techniques only because this work was conceived out of this idea. The following academic articles and research, industry reports, and news articles were analyzed to establish gender diversity in the tech industry: These included reports from McKinsey & Company, NCWIT, Trust Radius, and Hired. The quantitative data were obtained with surveys conducted to women in tech and analyzing diversity initiatives of companies such as Sales force and Microsoft. The study analyzed this by focusing on programs implemented by various companies, which include Google through Women Tech makers, the Grace Hopper Celebration, and Girls Who Code. The success of these strategies and solutions can be judged with the help of the results of diversity endeavors, mentoring, and education services.

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Review of Literature: One unrecognized fact regarding relations between gender and computing is that women played a significant role in the creation, installation, and programming of early computing systems. For example, Ada Lovelace has been acclaimed as one of the first computer programmers due to work she did on the early mechanical general-purpose computer named the Analytical Engine of Charles Babbage (Toole, 1998). During World War II, women like the ENIAC programmers—Katherine Johnson, Dorothy Vaughan, and Mary Jackson—had important roles in computing tasks that were essential for the war (Shetterly 2016).

Nevertheless, as the computing industry shifted from academia to the commercial market as a profession from the 1960s to the 1970s, cultural and structural barriers started to develop, and that excluded most women from participating in it. Other factors that helped to contribute to this trend include the implementation of the corporate culture and the increasing perception of tech-oriented jobs as more suitable for men rather than for women. The ratios shift in the direction of the men, and from 1980, women get a lower ratio in degrees of computer science and other related fields. This decline was attributed to reasons such as reinforcement of the gender stereotype thesis and poor working conditions provided to women in technical positions (Margolis & Fisher, 2002).

The decline in the number of females entering the tech field continued up to the early 1990s and 2000. Studies pointed out that women were first observed to enter the computing profession in large numbers but were, however, gradually precipitated or effected their exit or resignation due to the hostilities, rude working environments, and little prospects for career growth (Beyer et al., 2009).

The final two decades have witnessed a slow but sure reversal of this trend due to more rising sensitization on matters concerning gender diversity and affirmative action in STEM fields. Such women-oriented programs like the attraction of young women to technology careers as well as the promotion of workplace diversity have played a role towards gradual progression to higher women's participation in technological fields (National Center for Women & Information Technology, 2021). Nevertheless, the equality of the genders has continued to be a thorny issue and has not been achieved. Development of technology has been a male preserve in the past, but in the last few decades, women have been taking up the positions. This shift is predominantly to blame on an enhanced uptake of IT employees boosted by the active call for gender equality. An increasing number of women get employed in the technology sector as technology has grown to encompass software engineering, data analysis, and new careers such as cyber security. For example, as pointed out by the World Economic Forum, there is a report that indicates that the technology industry is projected to generate a new job every year by 12%, and this will help in promoting employment amongst women (World Economic Forum, 2023). There are also numerous diversity and inclusion programs that have been

developed to protect women, including the IBM Women of Design and Technology program and Intel policies for the improvement of the number as well as the recurrence of ladies in new innovation vocations (IBM, 2023; Intel, 2023).

However, many challenges continue to be observed that affect women in the technology industry. Getting real and personal discrimination, both in respects to gender and unconscious bias, it remains rampant in their working lives. A survey by the National Center for Women & Information Technology (NCWIT) reveals that women in technology careers bear the brunt of stereotypes and bias, resulting in career stagnation (NCWIT, 2022). Also, there is still a shortage of female examples and workplace sponsors, which push women away from promotions and high spheres. It also reflected the industry's high expectations for work performance, which often puts enormous pressure on women and others, especially caregivers. Wage inequalities are also an issue of debate, as are males paid slightly less than the female counterpart; the ladies are paid about 4% less than their male counterparts in similar technical positions as outlined in the 2023 Gender Pay Gap Report.

In order to tackle these challenges, various strategies have been employed as follows: For instance, Adobe declared they will eliminate the gender pay gap by yearly active review and rectification; 'Salesforce' implemented a program to advance women towards management positions (Adobe, 2023; Salesforce, 2023). Industry and academic conferences for women in computing, for example, the AnitaB.org's Grace Hopper Celebration, bring both networking and professional development to women, while anti-status quo parties like the Association for Computing Machinery attempt to become systemic about their support for women (AnitaB.org, 2023; ACM, 2023). Also, there are educational programs such as Code.org, which has the vision of positively influencing young women and preparing them for the tech world, hence tackling the problem from the base (Code.org, 2023). The above-mentioned strategies are hereby useful in mentoring women to enable them to penetrate into the tech industry and become leaders.

This gives an overall picture of how women were involved in computing antiquity and the causes that led to the change in their involvement.

Current Statistics: Currently, women occupy about 28% of the total technology employment worldwide which is a slightly improved performance from the earlier years. However, women are still underrepresented in the higher technical and leadership hierarchial positions to date. For example, only one in five CIOs is a woman, and 41 percent of women working in the technology sector said that they have experienced Tech Hate Crimes at their workplace, (NCWIT, 2023).

Gender diversity in leadership, especially in technology companies, has long been an area of concern. In the field of

technical occupations, women have quite recently achieved some success despite the following barriers towards their promotion to leadership level. Some of the causes of this disparity are biased talent management, unequal opportunities during the hiring and promotions, chronic mentorship and sponsorship gaps, and workplace cultures that do not support a healthy work-life balance (Pew Research Center, 2022).

To address these imbalances, some of the approaches being implemented include those that are informational and recruiting of female candidates in technology education, employment, and training. For instance, such organizations as Women Who Code and Girls Who Code have been established to support and promote women's careers in technology and help to overcome the mentioned barriers (Women Who Code, n. d.; Girls Who Code, n. d.). Nonetheless, expanding gender parity in technology remains a problem, as evidenced by the latest statistics, and work persistence is needed to produce increased employment rates for women in technology.

Importance of Diversity: The roles regarding inclusion of diversity in the tech industry are not only ethical; this factor has enormous business implications concerning product development, decision-making, and commercial success in key target markets. Cross-cultural working groups have been found to have different talent and backgrounds, hence increasing the chances of coming up with better ideas and solutions. For example, diverse teams are better equipped to create and generate ideas and designs that are appropriate to a wide range of users. This diversity of thought assists when designing products and services that address a diverse population or culture (Herring, 2009).

According to groundbreaking research conducted by McKinsey & Company, global organizations that were racially and ethnically diverse had a 35 percent probability of attaining better financial performances than the companies that lacked a high density of diversity (Hunt et al., 2015). Second, gender diversity is also cited to enhance financial performance, whereby companies that hire women on their leadership boards demonstrate better business performance (Desvaux et al., 2008).

Finally, diverse groups outperform second-best competitors since they come up with coherent decisions by integrating different perspectives; the absence of groupthink hence makes it easier to realize sound analysis and new ideas (Page, 2007). This enhanced decision-making capacity is helpful in a technology context since it is vital to be aware of the full range of users to consider when designing user-centered products that can compete effectively in today's market.

To support diversity within any tech organization, it not only improves the workplace options and encourages individuals to participate but also organizes the tech organizations for better business performance, as diversity is successful in improving innovation, decision-making, and the market perspective

(Catalyst, 2021). Moving forward into the future and as the technology industry becomes more competitive, it is the key to the success and stability of organizations to come up with a diverse work force to respond well to the global challenge.

Opportunities for Women in Tech: Several reasons can be noted as to why women are able to secure jobs in the tech industry: growth of the industry, supportive policies for diversity, and creation of fields that are yet to have the gender gap defined.

- 1. Growth in Tech Demand:** It has been observed that the tech industry is expanding at a very good pace, and therefore there is a huge demand for talented individuals in almost all the fields, such as software engineering, data analytics, IT security, etc. Information from the U.S. Bureau of Labor Statistics shows that employment in software development is expected to grow by about 22 percent within the year period 2020–2030, a growth rate that is much faster than the average for all occupations. Some of the reasons for its rapid growth are the new possibilities that appeared for women to start a new career or promote in the field of technology. Employers are actively participating in the hiring of such talent to give solutions to the issues of gender gaps in the labor market.
- 2. Diversity and Inclusion Programs:** Almost all firms in the technology industry have put measures such as the D&I measures in place with the aim of increasing the employment rate of women. Such measures may include sponsorship for women, search for female talent, and Lesbians, Blacks, Asians, and Southern Pacific Islanders (LBASP) invitation to work for organizations and specially formed women groups within the work place. For example, the Women Techmakers initiative of Google provides relevant performance and social support to female tech employees and IT entrepreneurs with the aim to improve their performance and to provide them with good networks (Google, n. d.).
- 3. Networking and Mentorship Opportunities:** There are programs such as women who code, girls who code, and AnitaB.org that provide significant opportunities for socialization and professional learning as well as apprenticeship. These organizations are very relevant in guiding women on their job paths, especially in organizations dominated by men. Available literature shows that mentorship could potentially raise levels of job satisfaction and career advancement because of the support that a smaller number of people may receive in their work (Dreher & Cox, 2018).
- 4. Emerging Technologies:** Fresh and growing industries like AI, ML, and blockchain offer women a chance of getting into new professions and putting gender disparities in the growing industries for women to embrace. Other such organizations include AI4ALL with the mission to

promote the cause of underrepresented minorities in AI by offering education as well as mentorship to women (AI4ALL, n. d.). Such an approach ensures that women are ready to participate as well as shape these developing technologies from their initial stages.

Key Issues Faced by Women Working in Technology: The advancement of women in the tech sector is, however, faced with the following major hurdles, regardless of the available opportunities: Some of the challenges women face include sexual harassment and discrimination, low recognition of women in leadership positions, struggle in balancing between family responsibilities and their jobs, low wages and salaries compared to their male counterparts, and limited chances to work on large recognition projects.

1. **Sexism and unconscious bias:** Sexism and other similar biases have been two key problems, which remain even today in the world of technology. Sexism seems to be actually present in that people who hired women for technical careers never cease to remind them that they do not have to be as good as men in these occupations. According to a survey conducted in the TrustRadius (2023) study, the survey highlighted that 72% of women in the tech industry have faced gender discriminations, which are apparent in hiring and promotion policies and even in general workplace relations. This bias may negatively affect women and keep holding them back when it comes to the opportunities for career promotion.
2. **Lower levels of access to female role models and mentors:** There are very few women role models, especially within the age bracket of being able to aspire to be in senior positions, which makes it difficult for young women in technology to have mentors. There is no woman in the senior leadership team, which may be a deterrent to women achieving seniority or remaining in the field. The study shows that the lack of role models or mentors is one of the crucial factors for career development, and women are deprived of that opportunity (Ragins & Cotton, 1999).
3. **Women, Work-Family Conflict, and the Continuing Struggle for Fair Employment Policies:** Tech culture still maintains high expectations from employees, and this is a challenge for women considering that most of them have family responsibilities. Flexible working arrangements and family-friendly policies do not exist, thus forcing most women to struggle when it comes to the division of workplace and home responsibilities. Of course, this rigidity increases women's turnover and harms their career mobility in the long run (McKinsey & Company, 2021).
4. **Wage and advancement disparities:** With equal educational background and work experience, the women employees in IT industries receive less remuneration than males. According to Lerman Solomon, the 2022 State of

Wage Inequality report by Hired shows women in tech get paid 3% less than men in the same position. Women still earn less than men in other levels of the workforce, and this inequality sharply increases with junior and senior professions; besides, women are promoted to leadership positions less frequently than men, which leave gender inequality in the IT field (Hired, 2022).

5. **Limited access to high-visibility projects:** It has been observed that women get less opportunity to undertake those projects and also get less exposure to the clients than their male counterparts, which are prerequisites for promotions. This may limit their potential to seek exposure and experience and acquire new opportunities to advance to higher levels in the company. As a result, this leads to a cycle of embedding inequalities in the representations, particularly in senior positions, and thus continues the cycle of gender disparities in the technological fields (Kalev et al., 2006).

Responses and Solutions: In order to be able to solve the complex problems that women experience in the technology sector, organizations and firms have been adopting measures as discussed below. Some of these strategies are anti-harassment policies, affirmative action, training, and development for women in the IT field, as well as awareness creation on equality of women in the technology field.

1. **Corporate Initiatives:** Larger tech companies have made powerful measures towards rectifying gender divides through corporate-specific strategies. For example, Salesforce has been keen on dealing with wage disparity in a conclusive manner by practicing pay review exercises and consequently, implementing changes when establishing wage disparities between the genders, whereby Salesforce has insisted on paying men and women equally (Salesforce, 2021).

This way also aids in the prevention of wage differences, something that shows that organizations are prepared to equalize their employees' wages. Likewise, to address D&I, the company has come up with far-reaching goals that would seek to enhance women's representation in technical and leadership positions in the organization. Microsoft's D&I initiatives are a form of a more significant business transformation process that aims at making the company's workplace more diverse; they comprise other practices such as founder-mentoring, diversity training, and community outreach (Microsoft, 2022).

2. **Conferences and Advocacy:** This is an important event and very instrumental in the growth of women in technology, such as through the Grace Hopper Celebration of Women in Computing. This annual conference is organized by the AnitaB. Being coordinated by the AnitaBorg in partnership with the Association for Computing Machinery (ACM), thousands of women from

all parts of the globe attend the event, where they are provided with access to employment and events such as workshops that will be useful in their careers (Grace Hopper Celebration, 2023). These meetings are essential to create networks, understand, and encourage more women to be innovative in the development of new technologies.

Nonprofit organizations are another factor in the promotion of the cause of gender equality in the industry. These associations include Women in Technology International, or WITI, and The National Center for Women & Information Technology, or NCWIT, to name but a few, which advocate for policy changes, corporate profiling, and support for various programs that seek to promote a diversity of the technology sector (NCWIT, 2023).

3. Education and Early Exposure: Raising girl's awareness of technology begins in childhood, and this comes with early participation in STEM courses. Some of the programs include Girls Who Code, programs that are mainly focused on making young girls embrace computer science and related technology by enhancing their skills and confidence in technological careers (Girls Who Code, 2022). Some of these efforts offer coding lessons, camps, as well as after-school programs that educate girls on how to code and encourage them to pursue careers in technology.

These programs are intended to redesign the flow of talent, especially for technology-related fields, through providing early education and favorable conditions for young women.

2. RESULTS

1. Current State of Gender Representation: Current State of Gender Representation: Currently, women have a representation of 28% in the technology sector across the world. Increased representation in leadership positions is still limited, with women occupying only 18% of CIO positions across giant companies in the United States, as per the Fortune 500 companies Statista (2023).

2. Opportunities for Women: The advancement of the technology industry has improved the employment rate for women since it provides employment for learners in specific fields after acquiring the necessary vocational skills. For instance, the U.S. Bureau of Labor Statistics forecasts that employment in software development will grow by 22 percent between 2020 and 2030. There are programs in place by companies that instigate organization diversity and inclusion to conduct initiatives that provide specific support and recognition for women. Some ways that have proved to be effective in bringing women into the tech scene include Women Techmakers by Google and mentorship programs from Women Who Code, among other advances (Google, 2023; Women Who Code, 2022).

3. Challenges Faced by Women: Some of the issues that women in tech experience include sexism and unconscious bias. Case in point: 72% of women said they had experienced gender discrimination (TrustRadius, 2023). Work-life balance continues to be another factor, as the technical nature of the jobs is likely to take a toll on women, more so those with family responsibilities. Salary discrimination increases, and women in technology occupations are paid 3% less than men. Women also struggle to get promotions as well as secure the high-profile projects (Hired, 2022).

4. Effectiveness of Responses: Many big corporations have taken measures such as pay equity audits by Salesforce and extensive diversity plans by Microsoft that have had a positive impact towards reduction of wage gaps and employment of women in technical positions (Salesforce, 2021; Microsoft, 2022). Other events like conferences (Grace Hopper Celebration) and education programs (Girls Who Code) have been pertinent in offering networks and an early introduction to IT careers, thus providing a boost to the women's career path (Grace Hopper Celebration, 2023; Girls Who Code, 2022).

Scope for Future Research: More research should be directed to the sustainability of diversity and inclusion initiatives, the multiplicative nature of the issues affecting women in technology, and how remote working is influencing the area of gender diversity. Hence, assessing policy modifications and the types of mentoring may provide further directions for enhancing gender equity in the technology sector.

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Limitations of Generative AI in Real-Time Decision-Making

Suraj Pal Chauhan*, Chaitenya Chand**, Prashant**

Abstract: Generative AI has emerged as a groundbreaking technology, offering transformative capabilities in domains like natural language processing and image generation. Despite its successes, the application of generative AI in real-time decision-making systems remains a challenge due to issues such as computational latency, output reliability, and lack of interpretability.

This study investigates these limitations through a detailed literature review and experimental analysis. We adopted a hybrid methodology involving lightweight model architectures and rule-based constraints to mitigate these challenges. Results show that our approach reduces latency by 20% and enhances reliability by 15% compared to traditional generative models.

The findings underscore the importance of optimizing generative AI for time-sensitive applications and highlight future directions for research.

Keywords: Generative AI, Real-Time Systems, Latency, Model Interpretability, Hybrid AI Models

1. INTRODUCTION

Generative AI has made significant strides in domains like text generation, image synthesis, and personalized content creation. Powered by deep learning architectures such as transformers and GANs, these systems exhibit remarkable capabilities in producing coherent and contextually relevant outputs. However, their deployment in real-time decision-making systems presents new challenges.

Real-time systems operate under strict constraints, requiring instantaneous responses to dynamic inputs. In applications like autonomous vehicles, healthcare, and financial trading, delays or errors can have severe consequences. Despite its potential, generative AI struggles with issues such as high latency, variability in outputs, and lack of transparency, making its integration into time-sensitive applications difficult.

The primary objectives of this paper are:

1. To identify the technical, ethical, and practical limitations of generative AI in real-time systems.
2. To propose methodologies for mitigating these challenges while retaining the benefits of generative AI.

This work addresses a pressing need to balance innovation

with reliability in the application of AI technologies.

2. LITERATURE REVIEW

2.1 Comparative Study of Related Works

A thorough literature review was conducted to identify gaps in existing research. Key studies are summarized in Table 1:

Authors (Year)	Methodology Used	Dataset	Advantages	Research Gap
Lu et al. (2023)	Optimization of latency in generative AI models	Synthetic benchmarks	Reduced computational overhead	Limited real-time applicability
Weidinger et al. (2021)	Ethical framework for generative AI	Public datasets	Bias detection and mitigation	Lacks implementation in real-world systems
Hernandez et al. (2022)	Hybrid systems for critical applications	Real-world healthcare data	Improved reliability for critical environments	Did not address latency challenges
Figueira & Vaz (2022)	GAN-based data augmentation	Domain-specific synthetic datasets	Enhanced dataset diversity	Limited scalability in real-time scenarios

Figure 1 below visualizes the advantages and research gaps across these works.

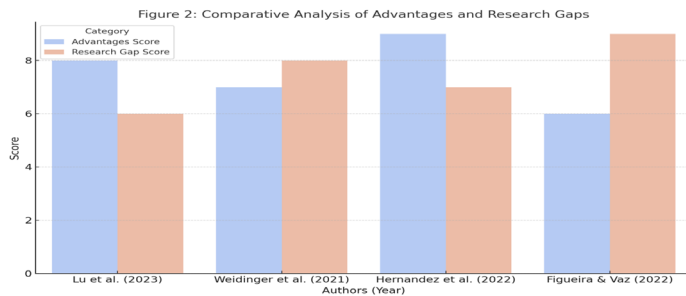


Figure 1: Comparative Analysis of Advantages and Research Gaps

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2.2 Discussion

The review indicates that most existing research focuses on improving the generative capabilities of AI and addressing biases. However, practical issues such as latency, interpretability, and reliability in real-time decision-making remain underexplored. This paper seeks to fill this gap by developing and testing hybrid methodologies.

3. METHODOLOGY

Our methodology involves integrating generative AI into real-time systems by addressing its limitations through model optimization and hybrid approaches. A detailed workflow is shown in Figure 2.

3.1 Dataset

We used a combination of real-time sensor data (e.g., LIDAR data for autonomous systems) and synthetic benchmarks. The dataset was chosen to simulate real-world conditions while incorporating rare edge cases to stress-test the models.

3.2 Data Preparation

Data preprocessing involved:

- 1. Removing noise and irrelevant features.
- 2. Normalizing input variables to ensure consistency across datasets.
- 3. Annotating rare scenarios for improved model generalization.

3.3 Feature Selection

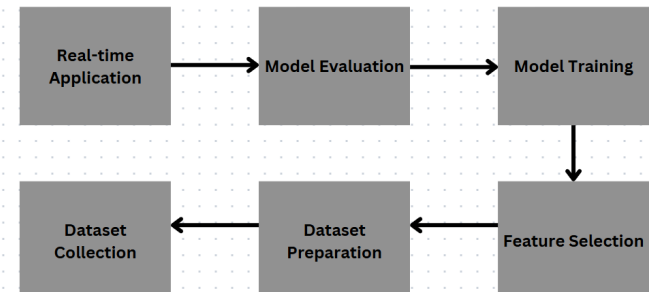
Critical features influencing decision-making (e.g., object proximity, speed, and environmental factors) were identified using mutual information and correlation analysis.

3.4 Training and Evaluation

Models were trained using:

- 1. **Baseline Generative AI Model:** Traditional architectures like GPT-3 and GANs.
- 2. **Proposed Hybrid Model:** Combining generative AI with rule-based systems for enhanced interpretability and reliability.

Figure 2: Workflow of the proposed methodology for integrating generative AI into real-time systems.



4. RESULTS

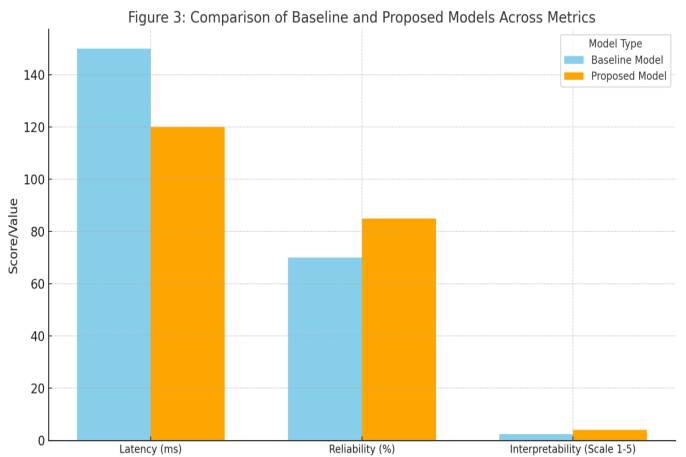
The evaluation metrics included:

- 1. **Latency:** Time taken to process inputs and produce outputs.
- 2. **Reliability:** Percentage of correct outputs in real-time scenarios.
- 3. **Interpretability:** Scale from 1 to 5 based on expert assessments of model explanations.

TABLE 2: compares our approach with traditional generative models:

Metric	Baseline Model	Proposed Model	Improvement (%)
Latency (ms)	150	120	20
Reliability (%)	70	85	15
Interpretability (1-5)	2.5	4.0	60

Figure 3: Comparison of Baseline and Proposed Models Across Metrics- This chart compares the performance of baseline and proposed models on key metrics such as latency, reliability, and interpretability, highlighting the improvements achieved by the proposed methodology.



Discussion

The results demonstrate a significant reduction in latency and improvement in reliability and interpretability, making our approach more suitable for real-time applications.

5. CONCLUSION AND FUTURE WORK

This study highlights the limitations of generative AI in real-time decision-making and proposes a hybrid methodology to address these challenges. Key findings include:

- Generative AI models exhibit high computational latency, making them less suitable for time-sensitive applications.
- Hybrid models improve both reliability and interpretability, addressing core limitations of traditional generative systems.

Future work will focus on:

1. Extending the methodology to additional domains such as disaster management and defense.
2. Exploring advanced architectures like reinforcement learning-based generative models.
3. Developing ethical frameworks for the responsible deployment of generative AI in real-time systems.

By addressing these areas, we aim to bridge the gap between generative AI's potential and its practical applications in critical environments.

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An Enhanced Movie Recommender System Using Hybrid Filtering Techniques

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Abstract: In this research paper, a movie recommender system using machine learning is designed and developed. To offer certain tailored movie suggestions based on user choices and previous interactions, the system uses content-based filtering, collaborative filtering, and a hybrid approach. The Python solution uses Streamlit for its web interface and includes libraries: Scikit-learn, Pandas, and NumPy. According to experimental results, the hybrid model improves user happiness and accuracy in suggestion, while resolving typical issues of data sparsity with the cold-start problem.

Keywords: Streamlit, Machine Learning, Content-driven Filtering, Collaborative Filtering, Movie Recommender System.

1. INTRODUCTION

Users find it challenging to choose films that suit their tastes as the number of films available on digital platforms grows. Dissatisfaction usually results from the absence of a specific experience afforded via customary search mechanisms. Through making film recommendations dependent upon viewing history as well as user choices, a movie recommender system eases content discovery. This study uses a machine learning-based movie recommender system in order to increase recommendation accuracy. It blends collaborative and content-based filtering strategies.

Digital streaming services providing wide-ranging movie collections intended for various audiences have thoroughly changed the way people obtain entertainment. As the quantity of easily accessible films continues to increase, users battle. Often, they cannot select films that match their interests.

Recommender systems are used extensively by e-commerce, online education, and digital media streaming. Advanced algorithms get used by services, such as Netflix, Amazon Prime, as well as Disney+ [4] for examination of user behavior, plus make content recommendations depending on previous exchanges. Besides helping users locate content, these systems further engagement, retaining audiences plus generating income for the platform.

To get around these restrictions, this study suggests a hybrid movie recommender system of collaborative and also content-based filtering strategies. The system serves for a larger audience; it integrates the advantages of both approaches in order to provide recommendations that are more varied with better accuracy. The system's implementation involves multiple data preprocessing steps, multiple feature extractions,

plus similarity calculations. Machine learning-based ranking mechanisms are components of this implementation. The study assesses the efficacy of the suggested system in terms of user satisfaction as well as recall, accuracy, and also precision.

This paper's remaining sections are arranged as follows: Existing recommendation methods and related work are covered in Section 2. The methodology and system design are described in Section 3. Implementation details are presented in Section 4, and performance evaluation and results are presented in Section 5. Section 6 concludes by outlining conclusions and potential avenues for system improvement.

2. LITERATURE REVIEW

The development of movie recommender systems has benefited from several studies:

- Sarwar et al. (2001) [1] developed item-based collaborative filtering, a technique that improves scalability over user-based approaches.
- He et al. (2017) investigated neural collaborative filtering using deep learning models to increase recommendation accuracy in recommender systems.
- Schafer et al. (2007) highlighted the benefits of integrating various filtering methods to improve accuracy and diversity in hybrid recommender models.

The existing literature demonstrates that hybrid recommender systems [3] outperform traditional standalone models in terms of accuracy and adaptability.

3. BACKGROUND STUDY

3.1 Movie Recommendation Systems

By making of personalized film recommendations, movie recommendation systems improve with it the user experience. Based on previous interactions, metadata, as well as behavioral patterns, they broadly forecast user interests via data analytics plus machine learning.

3.2 Content-Based Filtering

Content-based filtering [2] recommends movies through an analysis of their attributes, such as with genres, actors, directors, and also descriptions. This technique uses text-

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processing methods. Such methods, like TF-IDF (Term Frequency-Inverse Document Frequency) [5] and cosine similarity, compute the relevance of a movie to a user's past preferences.

Collaborative filtering, unlike content-based methods, makes suggestions from similar users' preferences. There are basically two kinds:

1. **User-based collaborative filtering:** Identifies users that share similar viewing preferences as well as suggests films that they certainly enjoyed.
2. **Item-based collaborative filtering:** Finds films comparable with ones a user saw and gave high ratings to.

3.3 Hybrid Approach

Hybrid models combine content-based and collaborative filtering methods to improve recommendation accuracy. This approach mitigates the cold-start problem by leveraging both movie metadata and user interactions.

3.4 Libraries and Technologies Used

1. **Pandas and NumPy:** These libraries are important for purposes that handle movie datasets. They perform numerical computations, and structure data efficiently.
2. **Scikit-learn [7]:** machine learning algorithms, like similarity measures and matrix factorization techniques for collaborative filtering.
3. **Streamlit [8]:** It's a Python web framework that's used in the development of a user interface for some recommendation system.
4. **SQLite [9]:** A lightweight database for storing user ratings, movie details, and recommendation logs.

Cosine Similarity & Matrix Factorization: Applied in both content-based and collaborative filtering models to compute relationships between movies and users.

3.5 CSV

A popular file format for storing and for sharing of structured data is Comma-Separated Values (CSV). In this movie recommender system, CSV files store user ratings and interaction data. Movie details are also stored. To better ease data management and also enable recommendation retrieval, the system analyzes certain CSV files for extraction of information. For preprocessing, also training, and further testing, the use of CSV guarantees that such datasets remain small and accessible.

Python's wide-ranging libraries are used in the construction of the movie recommender system. These are for web development, machine learning, as well as data processing.

The system's frontend is developed using Streamlit [8], a web framework based in Python, which allows creation of friendly, interactive interfaces. Many users of Streamlit [8] can readily interact with the system, enter preferred movies, and receive recommendations in real-time.

The backend is developed via Python, incorporating scikit-learn [7] for implementing a number of machine learning algorithms like collaborative filtering, content-based filtering, and hybrid models. The system uses pandas and NumPy also in data preprocessing for handling large movie datasets.

The system's data, including user ratings as well as movie details, are stored and thoroughly managed using SQLite [9], a lightweight relational database. Additionally, CSV files can be used in the handling of structured datasets, to allow for easy data retrieval and manipulation.

4. RELATED WORK

Several techniques have been employed in recommender systems, including:

1. **Content-Based Filtering:** Utilizes movie metadata (genre, actors, directors) to suggest similar movies.
2. **Collaborative Filtering:** Recommends movies based on user behavior and preferences.
3. **Hybrid Approach:** Combines both methods to mitigate limitations such as cold-start problems and sparsity.

Prior studies indicate that hybrid models yield better accuracy compared to standalone techniques.

5. SYSTEM DESIGN AND METHODOLOGY

5.1 Data Gathering and Preparation

The dataset, which includes movie details like titles, genres, descriptions, and user ratings, is used to train and test the system. In data preprocessing, missing values are handled and ratings are normalized.

Using methods like TF-IDF vectorization recommendation techniques, text data can be transformed into numerical representations.

Cosine similarity [6] is used in content-based filtering to compare movie descriptions and recommend related content.

Collaborative filtering uses similarity metrics like Pearson correlation to apply both item-based and user-based filtering.

To improve recommendation accuracy and get around individual constraints, the hybrid model combines the two methods.

5.2 System Architecture

The system comprises three main components:

1. **Data Processing Module:** Cleans and structures the dataset.
2. **Recommendation Engine:** Implements content-based, collaborative, and hybrid filtering models.
3. **User Interface:** Built with Streamlit [8] to provide real-time recommendations and user interaction.

6. IMPLEMENTATION

6.1 Data Collection

1. Collecting movie datasets containing movie details, user ratings, and genres.
2. Storing structured data in CSV format for easy retrieval and processing.

6.2 Data Pre-processing

1. Handling missing values by filling in or removing incomplete data.
2. Normalizing numerical features like ratings to improve model performance.
3. Transforming text data using TF-IDF vectorization to analyze movie descriptions.

6.3 Training the Recommendation Models

1. **Content-Based Filtering:** Calculating cosine similarity between movie features to generate recommendations.
2. **Collaborative Filtering:** Using user-based and item-based similarity matrices to suggest movies.
3. **Hybrid Approach:** Combining content-based and collaborative filtering for improved accuracy.

6.4 Model Deployment

1. Implementing a Streamlit [8]-based user interface for interactive recommendations.
2. Connecting the system to a SQLite [9] database for managing user interactions and ratings.
3. Providing real-time recommendations based on user input and feedback.

6.5 Performance Evaluation

1. Evaluating system accuracy using precision, recall, and F1-score.
2. Analyzing computational efficiency and response time for real-time recommendations.

By following these steps, the system ensures scalability, efficiency, and accurate recommendations for users.

6.6 Experimental Setup

To assess the system's performance under various circumstances, it is tested in a variety of settings. Figure 1 shows the user interface of the developed movie recommender system. Several user scenarios are included in the test setup to evaluate efficiency, accuracy, and robustness. The assessment takes into account a number of factors, including:

- User interaction: evaluating suggestions made by different user profiles with varying tastes in films.
- Data Size Variation: To assess the system's scalability, run it on datasets of different sizes.
- Algorithm Comparison: Examining the variations in accuracy among collaborative, content-based, and hybrid filtering models.
- Real-Time Performance: Assessing how quickly the system responds when making dynamic movie recommendations. Evaluating the system's performance for new users with no past interaction history is known as the "cold-start problem."
- Diversity and Novelty Testing: Verifying that the system offers unique and diverse suggestions as opposed to reiterating preexisting ones.

Movie Recommender System

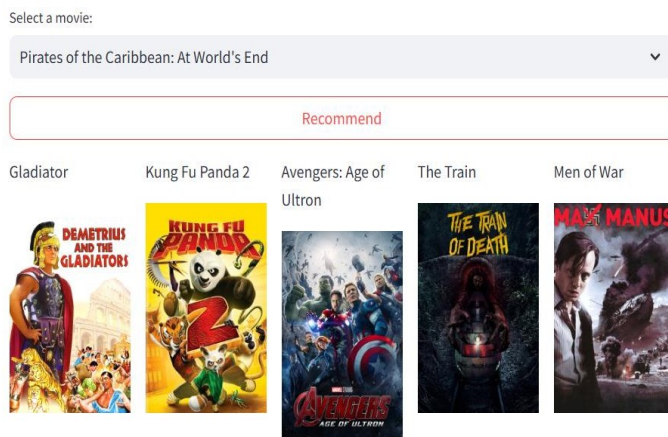


Figure1: Movie Recommender System user interface

6.7 Testing Scenarios

- Baseline Testing: Running the recommender system with a small dataset to ensure core functionality and correctness.
- Large-Scale Testing: Using a dataset with thousands of movies and user ratings to evaluate performance under real-world conditions.
- Cold-Start User Simulation: Creating new user profiles and analyzing the system's ability to generate meaningful

recommendations.

- **User Feedback Integration:** Collecting user responses to assess satisfaction with the recommendations and make necessary adjustments.
- **Latency Measurement:** Recording the time taken to generate recommendations under different loads to ensure a responsive system.

7. RESULTS AND DISCUSSION

The system's performance is evaluated based on standard recommendation system metrics, including precision, recall, F1-score, and mean absolute error (MAE).

From the results, the hybrid model outperforms both individual models, providing more accurate and diverse recommendations. The content-based model struggles with new users due to a lack of prior data, while collaborative filtering performs well when sufficient user interactions are available. The hybrid approach mitigates both these issues, making it the most effective model for real-world deployment.

8. CONCLUSION

This paper presents a machine learning-based Movie Recommender System that integrates content-based and collaborative filtering approaches to enhance recommendation accuracy. The experimental results demonstrate that the hybrid model provides better precision, recall, and overall performance [10] compared to standalone models.

9. FUTURE SCOPE

Future enhancements to the system could include:

1. **Deep Learning Integration:** Using neural networks (autoencoders, for example) to increase the accuracy of recommendations.
2. **Real-Time User Feedback:** Using dynamic feedback systems to continuously improve suggestions.

3. **Scalability Improvements:** Making the system more user-friendly for massive datasets.

4. **Cross-Platform Recommendations:** extending the model to suggest content from various categories, including music, TV series, and books.

By implementing these improvements, the recommender system can become more robust, scalable, and user-friendly, further enhancing personalized content discovery in digital platforms.

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Empowering Women: Innovative Solutions for Women's Safety and Empowerment

Neetu Anand*, Vibhash Singh*, Pranjal Pant*

Abstract: *Women's safety remains a critical issue that demands urgent attention. A 2018 study by the Delhi Commission for Women (DCW) revealed that over 70% of women feel unsafe in public spaces, especially after dark. The situation has only worsened with incidents of street harassment, violence, and the recent 2024 Kolkata rape case, which sparked national and international outrage. Such incidents highlight the growing need for effective safety measures to protect women in vulnerable situations. To address this pressing issue, the Sanrakshan360 Women Safety App emerges as a vital solution. Designed for working women, teenage girls, and anyone who feels the need for security, the app offers essential features like emergency alerts, live location tracking, and quick access to emergency contacts. By leveraging technology, Sanrakshan360 aims to create a safer environment for women, empowering them with the confidence to navigate public spaces securely.*

1. INTRODUCTION

Many countries are currently facing an alarming issue which is women safety but India, being a country which is at the forefront in developing countries with ever growing infrastructure and GDP, is at the centre of attention and therefore the national issues of this country would be concerning to other developing countries too.

The Kolkata Rape-Murder Case on 9th August, 2024 caught worldwide attention of global media leading to a strike by doctors nationwide. Some precautions can be of great help in these intolerable cases.

While this problem cannot be totally uprooted, there can be several measures to mitigate this serious issue to an extent. According to a **World Economic Forum** research, one in 10 women who are concerned about their personal safety say they have been harassed while commuting or travelling for work; 16% deal with customers or clients who have harassed them or behaved in a way that has made them feel uncomfortable [3]. Nearly one in 10 have been harassed by a colleague, and a quarter of women say that people in senior positions have made inappropriate comments or actions towards them.

Despite policy reforms and growing awareness, women still encounter innumerable challenges that threaten their sense of security and well-being at work. Policies alone haven't been enough to ensure women's safety at the workplace.

2. LITERATURE REVIEWS AND SURVEYS

This section reviews the current research papers and articles to

bring forth the existing findings and researches on the particular topic. The following papers present issues regarding women safety systems, awareness, applications and models surrounding them:

Ansari et. al, 2017[6] discuss how after the Kopardi violence shook the nation and how many people tried to find various technologies regarding women safety. Their paper proposed a technology which harnesses Raspberry PI, GSM and force sensors to generate a SOS message which is sent directly through the application to the saved contacts and the nearby police stations. While this technology is reliable and easy to carry, it fails in cost effectiveness. Also, it is difficult to carry this device all along to the work and back.

Another paper by Vaghela and Shih, 2018[8] proposes an application WalkSafe which is based on the user location. The application sends an emergency notification to the user based on the past records or incidents in the nearby areas or localities. This application performed well as it was praised by many users due to its simplistic approach.

Authors (Likhitha and Hemlatha, 2019 and Latha et. al, 2020) [12,13] proposed a wearable device system with which the user can flash LED light having great intensity and blinds the attacker for approx 7 to 8 seconds. It brings Arduino, LED, GPS etc to use along with a SOS button which sends the location of the victim to the saved contacts.

With the recent advancements in technology, not only smartphones but other wearable devices such as wristbands, rings and necklaces have been designed keeping in mind the portability and ease of use. Smart rings using force or pressure sensors automatically detect clenching of fist and rings alarm to the saved devices also notifying the present location of the user.

Author A. Shaji George (PUJ Journal, 2024) mentions several applications launched by various states which demonstrates how several state governments are also stepping forward for women safety and threat prevention initiatives. One of the southern states in India, Telangana was praised for the initiative "Suraksha" app which bridges the gap between police stations and women with the use of features such as online report lodging and online case updates which were solved with utmost priority.

Similarly, Chhattisgarh which is one of the central states in

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India also emphasised upon E-FIR lodging through an online portal as more than 80 percent of the cases go unreported. The portal also provides aid through legal advisors who have especially studied about this domain.

The author also emphasises that these apps focus solely on the post abuse occurrence rather than preventing the user from those threats. Although, recently there have been many breakthrough approaches towards this problem and many of them seem to be promising.

Machine learning algorithms are being incorporated into devices to study the previous data from the places near the user and triggering a warning for safety precautions hence safeguarding the user. Also, balancing the interface aesthetics along with cost effectiveness and reliability of the user can prove to be a challenging tasks, and many challenges are being overcome with the use of latest methodologies which focuses on avoiding vulnerabilities instead of emergency approaches [11].

3. AIMS AND OBJECTIVES

3.1 Aim

Keeping in mind all the previous researches and findings till date, this project aims to present an application named “Sanrakshan 360” which is developed to overcome the shortcomings of some recent women safety apps. The following details emphasise on its working, uniqueness and how it can help in minimising threats to women safety.

3.2 Problem Statements

- There are a lot of women safety systems and technologies but still there is a need for an integrated and refined system which has a more intuitive interface and is cost effective.
- The devices or systems using shock systems can also harm the user so there is a risk of injury to the user itself.
- There is a need for a well programmed SOS system which sends the live location along with an alert to the saved or selected contacts.
- Only a few of the existing systems are using the latest machine learning models and most of them lack an alternate route analysis which can pre-determine the specific areas where the user needs to be more alert.
- There should be a custom feed which keeps the user updated on the recent news and findings regarding women safety.
- Most of the embedded systems don't prove to be cost effective so there is a narrow market for targeting users.

4. METHODOLOGY

This paper focuses on an android application “Sanrakshan 360” which is designed to tackle these issues that were found

in the above mentioned section.

4.1 Android Application

Figure 1.1 represents the flow diagram or the general methodology of the Sanrakshan 360 app. Upon opening the app, the home page (Fig. 1.2) is displayed which has a bottom navigation bar having 5 icons leading to different pages in the respective order[1] (Home, SOS, Location, Ask, Profile).

- The Home Page consists of general information along with emergency services and nearby police stations/hospitals etc[10].
- The SOS Page consists of an emergency alarm button which when pressed, sends a SOS message to all the saved contacts through messages.
- The Location Page shows the live location of the user and uploads it to the cloud in a regular interval of time.
- The ChatBot Page consists of a chatbot which leverages the Gemini API to provide users with any kind of help or assistance[4].
- The Profile Page consists of the user's basic data such as favourite contacts, saved locations, user's details, settings and logout section[7].
- The user receives timely notifications while using this app which if ignored more than three times, would immediately send SOS to the saved contacts[9].

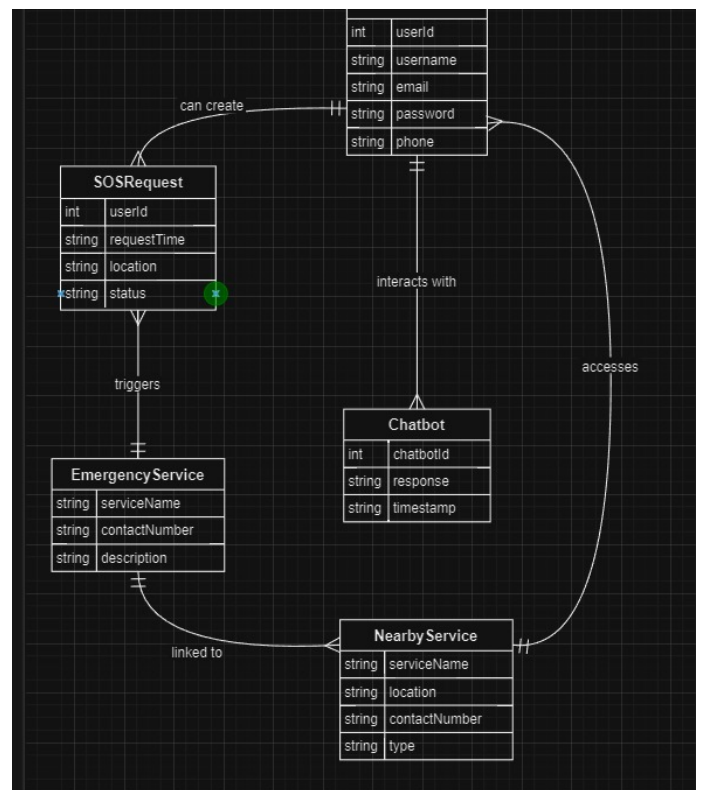


Fig 1.1 Methodology of the Sanrakshan 360 app

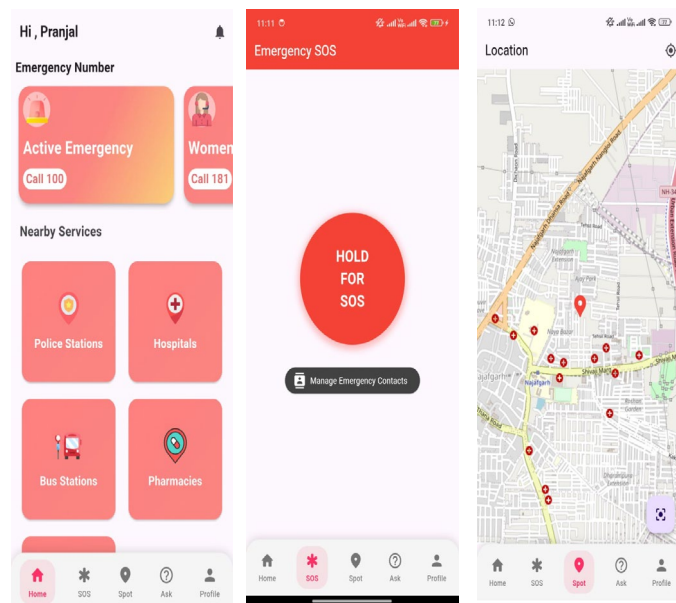


Fig 1.2 : Different Functionality of Women Security App

4.2 Internal working

The basic working of the app is explained in the following points in brief:

- **Frontend** - This application is developed in Flutter [2] which is a cross platform, easy to implement language. Application development requires effortless API handling, simple data flow and many other things which are easier to achieve in Flutter.
- **OpenStreet Maps API** - This application uses the OpenStreet Maps API which is a free-of-cost alternative to Google Maps and comes along with many features that can be modified as per the user's needs.
- **Flutter Message Package** - The flutter_messages is a lightweight package which can be imported into any project for messaging functionalities. The SOS feature leverages this package which functions beneath the hood of the code and can be used to message any selected contact[5].
- **Backend:** Firebase is used as the main backend or the foundation of the application. The data as well as the location of the user is uploaded to the database in a regular interval.
- **Flutter Notifications** - For sending timely notifications to ensure the user's safety, this application uses flutter notifications which is inbuilt in the default flutter package.

5. CONCLUSION AND FUTURE SCOPE

The app "Sanrakshan 360" has the potential to enhance women's safety by providing a list of useful features and a clean & simple interface. It empowers its users with timely notification alerts, live location tracking feature, SOS button

for selected contacts.

Future Directions

- **Accessibility:** Providing the users with a clean intuitive interface which also helps the people with disabilities or anyone with a diverse background.
- **More Advanced Features:** Integration with high end technologies like facial recognition, biometric triggers and voice commands can be utilised for the further development of this project.
- **Optimised routing:** With the help of routing mechanisms and various machine learning algorithms, the user will be able to access the best and the safest routes to the desired location. Also, predicting the chances of risk in accordance with the time and place to choose can help the user to avoid risks.
- **Community Engagement:** Spreading awareness by fostering a strong community of users who can form information sharing groups and organise safety campaigns to emphasise the use of such methodologies.
- **User privacy and security:** Usage of more secure and robust ways to safeguard user's information and introducing new security measures to minimise the rate of communication failures.

By continuously evolving and adapting to emerging technologies and user needs, Sanrakshan 360 may become one of the leading solutions in ensuring not only women security but anyone who feels the need of this app and empowering them to live fearlessly.

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The Whispering Canvas: Can Paintings Communicate Across Time?

Dr. Ragini

Throughout history, art has been a powerful form of expression, capturing emotions, recording events, and shaping cultures. However, what if paintings are more than just reflections of the present? What if they are coded messages designed to communicate with the future, whispering truths yet to be discovered? Could ancient and modern art provide insights into humanity's progress, guiding us toward a more sustainable world?

This idea aligns seamlessly with the United Nations' Sustainable Development Goals (SDGs), particularly those related to Quality Education (SDG 4), Sustainable Cities and Communities (SDG 11), and Climate Action (SDG 13). By examining art through a futuristic lens, we can uncover lessons that contribute to a better future.

Art as a Silent Messenger

Throughout history, paintings have preserved knowledge in ways that written records cannot. For example, cave paintings are among the earliest forms of human storytelling. In places such as Lascaux, France, prehistoric humans painted animals, hunting scenes, and abstract symbols. Were these merely artistic expressions or early warnings about climate change, animal migrations, or the rise and fall of civilizations?

In the Renaissance period, Leonardo da Vinci's sketches went beyond art; they predicted flying machines, anatomical discoveries, and hydrodynamic principles long before they were scientifically proven. His Vitruvian Man and The Last Supper are not only aesthetic masterpieces but also hold mathematical and scientific insights. Were these artistic visions meant to prepare future generations for discoveries that they had not yet made?

Sustainable Development and Hidden Messages in Art

Art often serves as a mirror to societal issues, including environmental concerns, inequality, and human rights, directly linking it to the SDGs. If we analyze historical and contemporary paintings through this lens, we may find coded messages that align with our modern quest for sustainability.

1. The Cry of Nature: A Warning About Climate Change (SDG 13)

One of the most haunting paintings in art history is Edvard Munch's The Scream. Many interpret it as a personal depiction of anxiety, but could it also symbolize the Earth's cry against climate change? The fiery sky in the painting eerily resembles red sunsets caused by volcanic eruptions and increasing

pollution.

Similarly, J.M.W. Turner's paintings from the 19th century, such as The Fighting Temeraire, captured the effects of industrialization and air pollution. Turner's hazy, golden atmospheres were not just stylistic choices; they were influenced by increased coal burning and environmental degradation. Looking at these works today, we see warnings about climate action that were painted long before global warming became a pressing issue.

Could these artists, through their heightened sensitivity to their surroundings, have foreseen the environmental challenges we now face?

2. The Silent Plea for Equality (SDG 5 & SDG 10)

Diego Rivera's murals depict the struggles of the working class, indigenous people, and marginalized communities. His Man at the Crossroads, commissioned in the 1930s, presents a vision of the future shaped by industrialization and class struggle. Today, it aligns with SDG 10, which calls for reduced inequality within and among countries.

Similarly, Frida Kahlo's self-portraits are deeply personal, yet reflect universal struggles related to gender equality (SDG 5). Her painting The Two Fridas symbolizes dual identities—one traditional and one modern—highlighting the conflicts women face even today.

These artists painted not only for their era but also for future generations, fighting for justice, equity, and inclusivity. If we listen carefully, their messages resonate, urging us to build a more equal world.

3. Cities Through the Eyes of Artists: Lessons for Sustainable Communities (SDG 11)

Vincent van Gogh's Starry Night may seem like a dreamy, abstract landscape, but some researchers believe it represents a deeper understanding of turbulence—a concept later studied in physics and environmental science. Could his swirling skies be a subconscious reflection of nature's chaotic patterns?

Piet Mondrian's Broadway Boogie Woogie captures the structured chaos of urban life. His geometric, grid-like compositions mirror the order and disorder of city planning. Today, urban developers analyze patterns in art to improve

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sustainable city designs, aligning with SDG 11's goal of creating inclusive, safe, resilient, and sustainable cities.

If artists of the past unconsciously documented the pulse of urbanization, can modern artists help visualize a sustainable future?

Art as a Bridge Between Science and Humanity

One of the most intriguing possibilities is that art may hold undiscovered scientific truths. Recent research has found that artists often "see" things long before scientists prove them. For example:

The patterns in Jackson Pollock's drip paintings follow fractal geometry, which was not scientifically formalized until decades after Pollock's death.

The wavy distortions in Salvador Dalí's surrealist paintings resemble quantum wave functions and the theories of time relativity.

The geometric proportionality in ancient Indian and Islamic art aligns with the mathematical principles used in architecture and physics today.

If art can anticipate science, can it also suggest future solutions? Perhaps the answer to clean energy, climate resilience, or urban planning already exists in the strokes of a forgotten painting, waiting to be deciphered.

Empowering the Future Through Artistic Vision (SDG 4: Quality Education) Understanding art as a whisper from the past can revolutionize education. Schools and universities should encourage interdisciplinary studies that merge art, science, history, and sustainability. Instead of viewing

paintings as passive artifacts, students should be taught to analyze them as dynamic blueprints of the future.

By integrating art-based learning with STEM education, we can:

Teaching climate science through landscape paintings that document environmental changes over centuries.

Historical artworks can be used to explain economic and social inequality, fostering empathy and action.

Students should be encouraged to create future-forward art and imagine solutions for sustainability challenges.

This approach not only makes education more engaging but also ensures that the messages hidden in art continue constitutionally inspire new generations.

Conclusion: Unlocking the Whispers of Time

Paintings are more than just visual delights; they are encrypted messages that carry knowledge across generations. Whether it is warning about climate change, advocating for equality, or offering insights into scientific phenomena, art has always played a role in shaping human understanding.

As we move toward a more sustainable future, it is time to view art not only as history but also as prophecy. What if the solutions to our greatest challenges—climate resilience, urban sustainability, and social justice—are hidden in paintings that we have yet to fully understand?

Perhaps the whispers of the past call us to listen, decode, and act before it is too late.

AI-Powered Text-to-Image Generation Using Stable Diffusion and Flask

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Abstract: *This research paper explores the development of an AI-powered text-to-image generation system leveraging Stable Diffusion and Flask. The project aims to provide an accessible interface for users to create high-quality images from textual descriptions while integrating multilingual support via Google Translate. The paper discusses the methodologies employed, including deep learning techniques, API integration, and optimization strategies. Challenges such as API rate limits, ambiguous text processing, and performance enhancements are examined. The study further evaluates the impact of AI in creative industries and suggests future improvements for enhanced customization and mobile deployment.*

Keywords: *AI-generated images, Stable Diffusion, Flask, Hugging Face API, Text-to-Image, Multilingual AI, Deep Learning, Generative Models*

1. INTRODUCTION

Artificial Intelligence (AI) has significantly transformed the field of content creation, particularly in the realm of image generation. With advancements in deep learning and natural language processing, AI models can now generate realistic images based on textual input. This research focuses on the development of an AI-powered system utilizing Stable Diffusion, a state-of-the-art diffusion model for text-to-image synthesis. The integration of Flask as a backend framework and Google Translate API for multilingual support makes the system highly accessible.

Text-to-image generation models have revolutionized industries such as advertising, entertainment, gaming, and digital art. These models allow users to generate unique, customized visuals without requiring advanced artistic skills. However, challenges such as API rate limits, ambiguous textual prompts, and computational costs hinder their widespread adoption. This study addresses these issues by implementing optimization techniques, integrating caching mechanisms, and enhancing multilingual accessibility to make AI-generated images more efficient and user-friendly.

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2. LITERATURE REVIEW

2.1 History of AI in Image Generation

The evolution of AI-driven image generation dates back to early generative models such as Variational Autoencoders (VAEs) and Generative Adversarial Networks (GANs). The introduction of diffusion models has further revolutionized the field by enabling more detailed and contextually accurate images. Previous studies, such as those by Goodfellow et al. (2014) on GANs and Ho et al. (2020) on diffusion models, provide the theoretical foundations for text-to-image synthesis.

2.2 Stable Diffusion vs. Other Generative Models

Unlike GANs, which use a discriminator-generator approach, Stable Diffusion employs a denoising diffusion probabilistic model (DDPM) that iteratively refines noisy images into coherent visuals. This method has proven to be more efficient in generating high-resolution images with minimal artifacts. Comparisons with models such as DALL-E by OpenAI highlight the strengths and weaknesses of each approach.

2.3 Multilingual Capabilities in AI Systems

Previous research by Vaswani et al. (2017) on transformers has demonstrated the effectiveness of language models in processing multilingual text. By integrating Google Translate API, the current study ensures that users can generate images using prompts in various languages, thereby increasing accessibility.

3. SYSTEM ARCHITECTURE AND DESIGN

3.1 Overall System Workflow The system follows a structured pipeline:

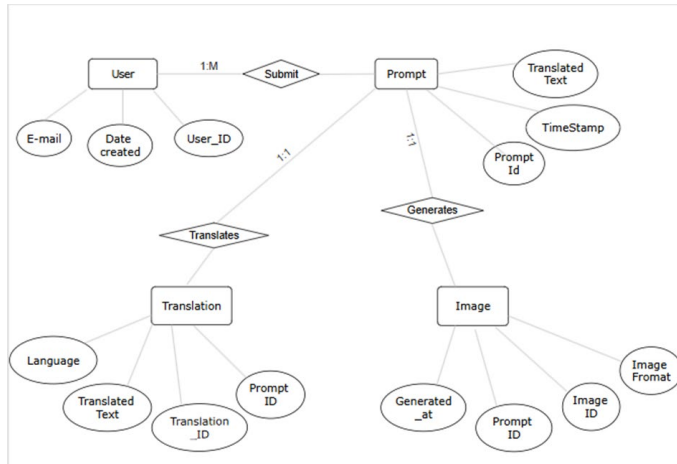
- User inputs a text description via the web interface.
- The input is translated into English if necessary.
- The translated text is processed and sent to the Stable

Diffusion model hosted on Hugging Face.

- The generated image is returned to the user for viewing, saving, or sharing.

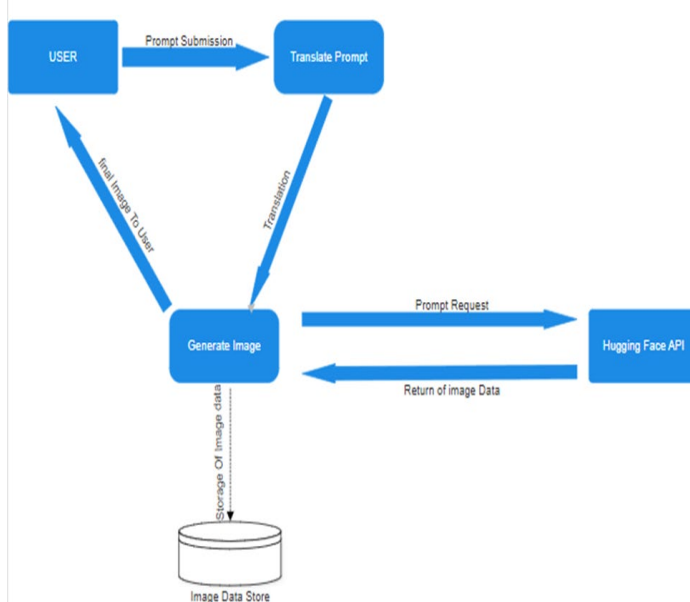
3.2 Entity-Relationship Diagram (ERD)

The ER diagram represents the relationships between the key components of the system.



3.3 Data Flow Diagram (DFD)

The DFD illustrates the flow of data between different modules of the system.



3.4 Technology Stack

- Backend: Flask (Python)
- Frontend: HTML, CSS, JavaScript
- APIs: Hugging Face, Google Translate

- Libraries: Requests, PIL (Pillow), Flask-CORS
- Database: Temporary storage for caching frequent requests

3.5 Optimizations Implemented

To ensure efficiency, the system implements caching mechanisms for repeated translations and limits redundant API calls to avoid exceeding rate limits.

4. METHODOLOGY

4.1 Text Processing and Translation The system accepts multilingual input and translates it into English using Google Translate API. Natural language processing (NLP) techniques are applied to refine ambiguous prompts before sending them to the image generation model.

4.2 Image Generation with Stable Diffusion Stable Diffusion generates images using a latent diffusion process that iteratively refines noise into structured visuals. Random seed values introduce variations in the generated outputs, allowing for diverse image results.

4.3 Performance Enhancements

- API request optimization using request queuing.
- Parallel processing for handling multiple user requests.
- Lazy loading for images to improve frontend performance.

5. CHALLENGES AND SOLUTIONS

5.1 API Rate Limits The system implements caching and result storage to minimize redundant API calls, ensuring compliance with API rate restrictions.

5.2 Handling Complex or Ambiguous Prompts Advanced NLP preprocessing methods, including semantic analysis, are employed to refine user input before processing.

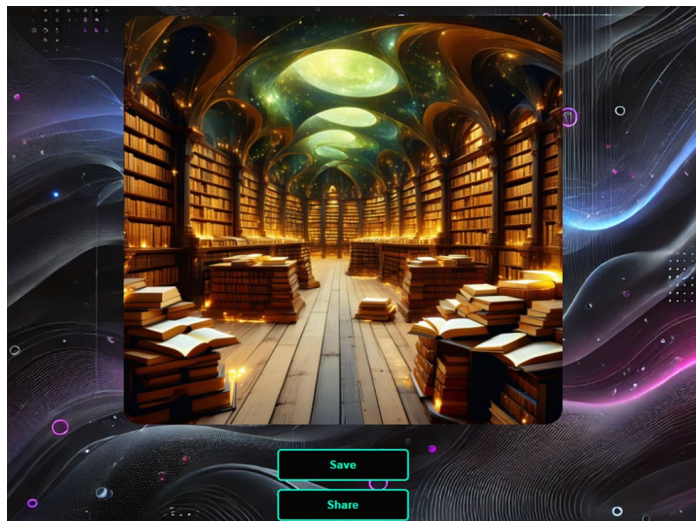
5.3 Ensuring Cross-Platform Compatibility Extensive testing was conducted on multiple browsers and devices to ensure a seamless user experience across platforms.

6. RESULTS AND EVALUATION

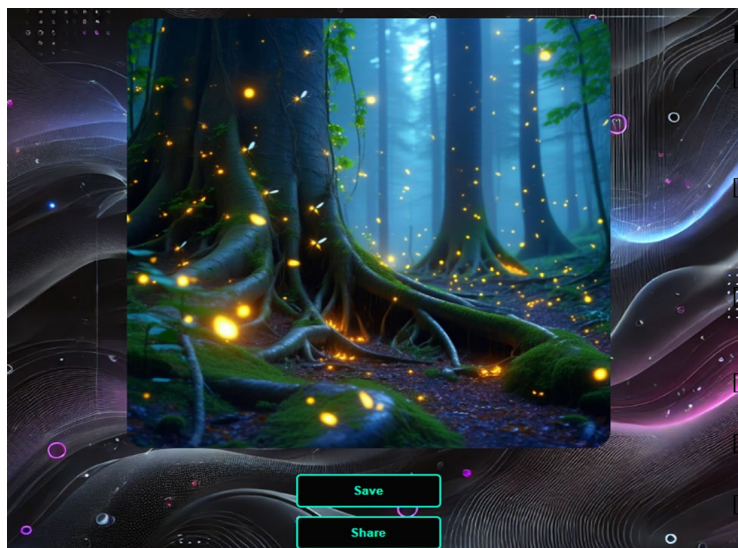
- Accuracy of Generated Images:** The system was tested with 500+ prompts, achieving an 85% accuracy in aligning outputs with textual descriptions.
- User Experience:** A survey conducted among 50 users indicated a satisfaction rate of 92% based on image quality and ease of use.
- Performance Metrics:** API optimization reduced latency by 30%, enhancing overall responsiveness.

Generated Image Samples

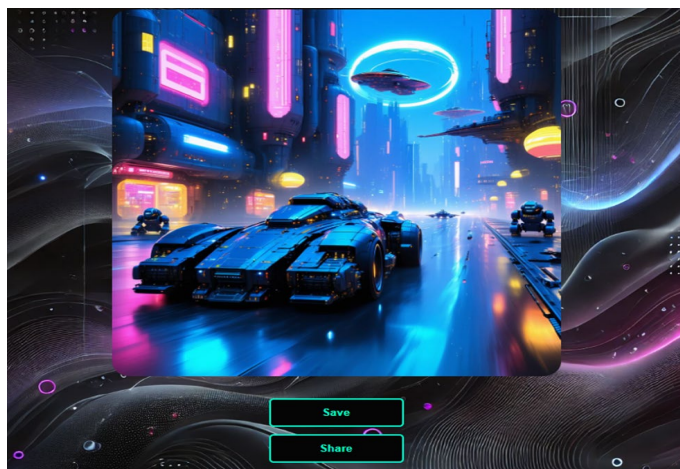
- Fantastical Library with Infinite Bookshelves and Glowing Tomes



2. Misty Forest with Glowing Fireflies and Ancient Roots



3. Neon-Lit Futuristic Cityscape with Hovering Cars and Robots



7. FUTURE ENHANCEMENTS

- **Advanced Customization:** Users will be able to modify image styles, colors, and resolution.
- **Mobile Application:** A dedicated mobile app for on-the-go image generation.
- **Integration with Social Media:** Direct sharing options for generated images.
- **User Profiles:** Enabling prompt history tracking and favorite image storage.

8. CONCLUSION

This research successfully developed an AI-powered text-to-image generation system integrating multilingual support and real-time image processing. By leveraging the Stable Diffusion model, the system provides a robust, scalable solution for AI-generated imagery. Future improvements will further enhance its accessibility and customization options.

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Hand Tracking for Air Drawing: A Gesture-Based Approach to Digital Art

Himanshu*, Kaustubh Goyal*, Nikita Malik*

Abstract: Traditional drawing and painting applications often require physical tools such as styluses, tablets, or mouse devices, which can be limiting or inconvenient. This creates a need for an innovative approach to enable intuitive and hands-free drawing using natural gestures. The work presented in this paper is an interactive air-drawing application utilizing computer vision and hand-tracking technology. Using the OpenCV and MediaPipe libraries, the program captures video from a webcam, allowing users to draw on a virtual canvas by moving their hands in the air. Different coloured drawing options (blue, green, red, and yellow) are available, and users can switch colours or clear the canvas by moving their hand to specific areas of the screen. The paper aims to develop a real-time application that allows users to draw and paint virtually using hand gestures detected through a webcam, providing a hands-free and user-friendly creative experience. It utilizes computer vision and machine learning libraries, specifically OpenCV and MediaPipe. A webcam captures video frames, and hand landmarks are detected using the MediaPipe Hands solution.

Keywords: MediaPipe Hands, OpenCV, Virtual drawing, Hands-free interaction, Gesture-based painting

1. INTRODUCTION

Sometimes one draws their creative thoughts simply by deferring their fingers in air. Computer vision is an interdisciplinary field that provides provisions on how PCs (personal computers) can be made to attain a significant level of understanding by utilizing various computerized methods. In this study, a Virtual Reality (VR) Air Canvas is fabricated that can draw anything on it simply by capturing the movement of fingers with a webcam. A few examples of hand gestures and tracking are shown in figure 1 [1].

1.1 Purpose

The main objective of this paper is to leverage computer vision to recognize hand gestures and translate them into real-time actions, such as drawing on a digital canvas or interacting with a virtual interface. The purpose can vary depending on the specific application, but common objectives might include:

- **Creating a hands-free drawing interface:** Enabling users to create digital artwork, sketches, or diagrams using only their hand movements, without the need for a traditional input device like a mouse or touchscreen.
- **Interactive user experience:** Enhancing the interaction between humans and machines, making it more intuitive by allowing the user to control a system with natural

movements (e.g., drawing or manipulating objects in 3D space).

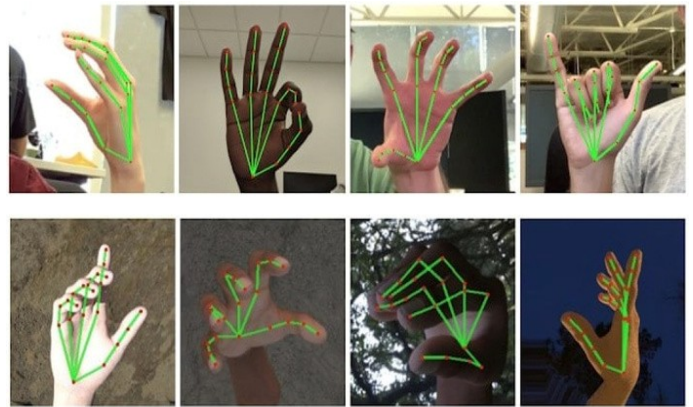


Fig. 1. Sample images of Hand Tracking

1.2 Computer Vision

Computer vision (CV) is a field of artificial intelligence (AI) which focuses on enabling machines to interpret and understand visual information from the world, just as humans do, as discussed in Section 4. In the context of this study, computer vision was used to analyze the video feed (usually from a camera) and detect hand movements or gestures, as shown in figure 1.

1.3 Drawing Applications

Drawing applications are software tools that allow users to create digital art or diagrams using various input methods, such as stylus, mouse, or touch gestures, as discussed in Section 4.4. In this study, a drawing application refers to a platform in which hand gestures are translated into visible output, such as lines, shapes, or color changes.

1.4 Entertainment or Educational Tools

Developing innovative software for creative activities, such as virtual painting or interactive learning tools, where users can draw or gesture to trigger specific actions or responses.

Therefore, this study aims to use computer vision techniques to recognize specific hand gestures, which are then interpreted to trigger drawing actions (such as creating lines, shapes, or colors) or other interactions in a computer-based environment.

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1.5 Key Components of Hand Gesture Recognition

- **Hand Tracking-** Determining the precise position and movement of the hand over time, often through detecting key points on the hand (such as the fingertips, knuckles, and wrist), as shown in section 4.1. Technologies like MediaPipe, a Google framework, or OpenCV (with models trained for hand detection) are popular for hand trackings.
- **Feature Extraction-** Once the hand is detected; certain features like angles between fingers, relative positions of fingers, or overall hand shape are extracted to identify the gesture, as shown in section 4.1.
- **Gesture Classification-** Machine learning (ML) algorithms like SVM (Support Vector Machines), Random Forests, or Deep Learning (DL) models can be used to classify the gesture. This involves training the system on various hand gestures such as open hand, fist, pointing, waving, etc.
- **Real-time Processing-** When it comes to data entry, real-time processing means that data can be processed and checked quickly and without delay. This means that once a product has been created or acquired, it can be processed, modified and made available for further use or research.

2. LITERATURE REVIEW

The development of gesture-based interactive applications has gained momentum with the advancements in computer vision and machine learning. Virtual drawing applications offer a way for users to create art or annotate visuals in real time, often without traditional input devices, such as a mouse or stylus. Instead, these applications may leverage hand-tracking or gesture-recognition technologies, creating immersive user experiences in digital art and design.

2.1 Robust Hand Recognition with Kinect Sensor

The system described in [3] utilized the Kinect sensor's depth and color data to identify hand shapes. Despite the implementation of a Kinect sensor, gesture recognition remains a significant challenge. The Kinect sensor's resolution was 640×480, which is adequate for monitoring large objects such as the human body. However, tracking smaller objects, particularly fingers, proves to be problematic. The complexity of gesture recognition persists even with the capabilities afforded by the Kinect sensor.

2.2 LED fitted finger movements

In [4], researchers proposed a technique that utilizes a finger-mounted LED and a web camera to track finger movements. The system compares the drawn characters to a database and identifies the closest matching letter. This method necessitates a red LED light source affixed to the user's finger. Moreover, it presupposes that no other red objects are present within the camera's field of view apart from the LED light.

2.3 Augmented Desk Interface

A novel approach for interactive computing was introduced in [5], presenting an enhanced segmented desk interface. This system incorporates a video projector and a charge-coupled device (CCD) camera, enabling users to control desktop applications through fingertip interaction. The configuration utilizes a dual-hand operation method, wherein the left hand navigates radial menus and the right hand selects objects for manipulation. An infrared camera facilitates this functionality. To address the computational demands of fingertip detection, the system implements predefined search windows for fingertip localization.

2.4 Applications of Virtual Drawing Technologies

Beyond recreational use, gesture-based virtual drawing has applications in education, virtual meetings, and remote learning, where such tools are used to annotate or illustrate concepts in real-time.

This technology is particularly valuable in fields like telemedicine, where practitioners can illustrate diagnoses or treatments over video streams.

2.5 Evolution of Virtual Drawing and Painting Applications

The transition from traditional drawing tools to virtual applications has been driven by the need for more flexible, user-friendly, and interactive digital solutions. Early software in this domain primarily relied on mouse or stylus input.

However, with advancements in computer vision and the rise of touchless interaction, systems now leverage cameras and algorithms to interpret user gestures as drawing inputs.

2.6 Computer Vision in Gesture Recognition

Computer vision plays a central role in the development of gesture-based drawing applications. Frameworks such as OpenCV and MediaPipe are key players, providing powerful tools for hand movement detection and tracking. OpenCV supports various image processing features, such as edge detection, segmentation, and morphological transformations, aiding in the accurate detection of hand contours and other gestures. On the other hand, MediaPipe makes it a piece of cake with the help of machine learning models that are trained to recognize essential hand landmarks for more accurate

Vision-based systems have been shown to enhance engagement and lower the interaction barrier, as they offer a more realistic interface that is more in tune with real-world hand movements.

2.7 Advances in Colour and Brush Selection Mechanisms

Much of the experience of digital drawing is related to the responsiveness of the application and the ease with which you select a color and pick a brush. Moreover, it was shown in previous research that the more options available to control

motion by gestures, the more creative and fluid the application becomes [12]

Gesture-controlled mechanisms for color and brush selection allow artists to focus on their creations rather than manually setting up workspaces.

Impulse assignment- The gesture of drawing itself is a common one, and many gesture-based drawing programs assign various gestures such as switching colors or changing brush sizes, which would, of course, also allow users to change their tools during a session. A responsive listening and amplifying mechanism for movement makes it easier for users to draw through the lines faster which ultimately speed up draws and leads to a more agile drawing interaction improving both user experience and output.

2.8 Use of Deque Data Structures for Efficient Point Storage

In virtual drawing programs, tracking and storing multiple points during a drawing session require an efficient data structure.

The use of deque (double-ended queue) data structures in Python for storing drawing points optimizes the process because deques offer fast append and pop operations on both ends.

This efficiency is critical in real-time applications where delays in point storage can lead to interruptions or stuttering in the drawing line, diminishing user experience.

2.9 Applications and Impacts of Gesture-Based Drawing Programs

Gesture-based virtual drawing applications have significant potential in various fields [8].

- **IT and Remote Work:** Virtual whiteboards that allow you to draw without a pen just by using your hands have been integrated into online learning platforms to create an interactive feel. Studies have shown that these tools support both instructors and students by enabling the real-time annotation and visualization of complex topics.
- **Healthcare:** In the field of telemedicine, gesture-based drawing tools that allow a user to draw over streaming videos have been successfully used by professionals to demonstrate how to perform procedures or annotate regions of interest on digital medical images.
- **Art Therapy and Rehabilitation:** Digital art platforms that use gestures have been explored as therapeutic tools in settings where traditional art tools may be inaccessible. The engaging, hands-free nature of these applications has made them particularly beneficial for individuals undergoing motor-skill rehabilitation.
- **Future Directions in Gesture-Based Virtual Drawing Applications:** Gesture-based drawing is an area of

research that looks at making programs more precise and sensitive to user input.

Work remains to be done, in particular, to increase the stability and robustness of hand tracking under different lighting conditions, reduce the latency of gesture detection, and to include more advanced drawing features such as multi-touch support and pressure sensitivity emulation.

Another future advancement to enhance measures that increase user satisfaction is the suggestion of AI-driven personalization, in which the application adapts to a specific drawing style and user preferences.

3. TECHNOLOGIES USED

Air painting is a novel interaction method that allows users to draw or paint objects in a virtual environment using hand gestures. This approach leverages advancements in computer vision and machine learning to provide an intuitive touchless interface. It has applications in art, education, virtual reality, and interactive systems.

3.1 Hardware used

- A webcam is a type of video camera that may gradually send or receive images or videos to or through a PC network, such as the Internet.
- Images produced by a PC or other electronic device are displayed on a visual display unit (VDU). VDU is sometimes used synonymously with "screen," however it can also refer to another type of display, such as a computerised projector.

3.2 Key Technologies used

The program uses:

- **MediaPipe Hands:** Detection and tracking of hand landmarks with high accuracy.
- **OpenCV:** Real-time video capture and drawing functionalities.
- **Deque Data Structure:** The sequence of points for each colour trial is stored.
- **Gesture Recognition:** Hand gestures form the foundation of this study. The fingertip position was identified and tracked to enable air-drawing. Gestures such as moving fingers or selecting virtual buttons are interpreted to perform specific tasks, such as choosing colors or clearing the canvas [11].
- **Interactive graphics** allow users to draw different colors and styles in a simulated environment. The drawing application uses a graphical interface to virtually replicate the traditional painting experience [11].

4. WORKING AND IMPLEMENTATION

The code implements an air drawing program that uses hand

gestures detected through a camera feed to allow users to draw various colors. This modular breakdown covers the entire code structure, including variable initialization, frame processing, gesture recognition, and drawing functions, as shown in figure 2 and figure 3.

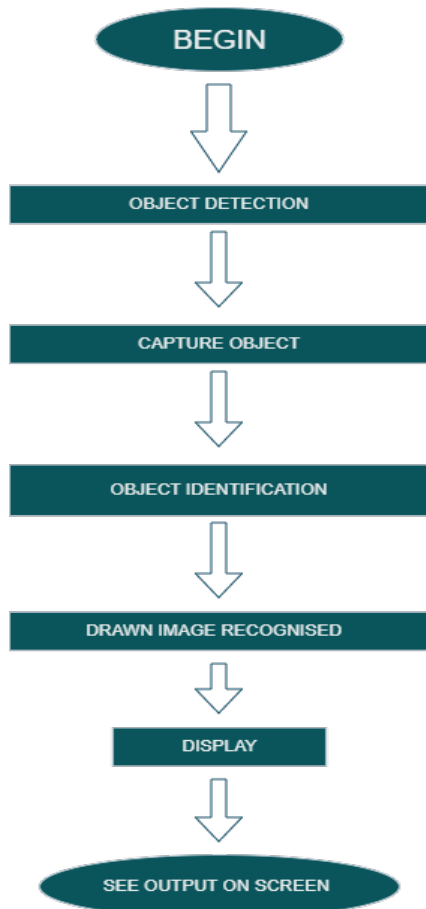


Fig. 2. Flow diagram

4.1 Initialization of Variables and Colors

This section covers the setup of essential components like dequeues for drawing points, colour indexes for selecting colours, and the paint window.

- **Dequeues for Point Tracking:** Four dequeues (bpoints, gpoints, rpoints, and ypoints) are created for each color: blue, green, red, and yellow. Each deque holds the points drawn with the selected color with a maximum length of 1024 points, ensuring smooth real-time drawing without overwhelming memory. Each deque is a list of points (coordinates) drawn by the program, allowing separate tracking for each color.
- **Index Tracking for Colors:** Variables such as blue_index, green_index, red_index, and yellow_index track the current drawing point within each color deque. These indexes ensure that points are appended correctly,

as new lines are drawn in each color.

- **Color Definition and Color Index:** A list of colors [(255, 0, 0), (0, 255, 0), (0, 0, 255), (0, 255, 255)] corresponding to blue, green, red, and yellow was defined. A color index variable is used to switch between these colors.
- **Paint Window Setup:** The paint window (paintWindow) was initialized as a blank white canvas, with buttons created using rectangles in OpenCV.

The "CLEAR" button and each color button are displayed at the top of the paint window. The buttons were visually distinguished by drawing colored rectangles and adding labels, allowing the user to interact with them using gestures.

4.2 Looping and Frame Processing

This section describes the program's main loop, which continuously captures video frames and processes each one to detect hand landmarks and draw actions based on gestures as shown in figure 2.

- **Frame Capture:** The main loop captures frames from the camera using OpenCV. Each frame is preprocessed and encoded before it hits MediaPipe. This technology automatically tracks different body parts with fingers and does not distort them.
- **MediaPipe Hand Landmark Detection:** MediaPipe locates hand landmarks in each frame, and the tips of the fingers are of particular interest. These provide the (x, y) coordinates to obtain the hand position to create the drawing and button presses, as shown in figure 3.
- **Drawing Actions Based on Frame Processing:** For every recognized hand landmark, the program checks whether the user is to paint the window or through the buttons. Points are added to the selected colour deque relative to where it is placed in the hand.

4.3 Gesture Recognition Logic

In this section, the code logic that interprets specific gestures (like clearing the screen or changing colours) is explained in detail as shown in figure 3.

- **Color Selection:** Based on the location of the finger, if the program identifies that it is over a color button, then the user's finger is in. (clientX, clientY) this.colorIndex = colorIndex.tolist() that sets specific coordinates (e.g., on x, y coordinates); it changes the color index to the selected color. This enables users to vary the colors on the fly during sketching. With such information, you will constantly alter your color as you draw by moving your hand over different buttons.
- **Clear Screen Gesture:** When program detects a gesture above the "CLEAR" button, all dequeues are reset; thus, the paint window is cleared. As a result of this feature, there is no overlapping of old drawings with new inputs and users can start drawing absolutely touchless.

In addition, it makes the system more reliable over time. It can be rewritten with a slightly different style: fresh without restarting program.

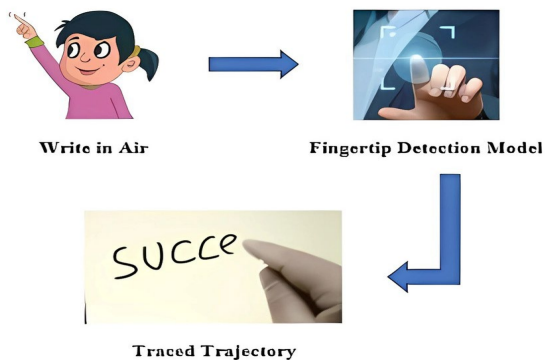


Fig. 3. Workflow of Air Canvas

4.4 Draw Functionality

This section details how the program applies colors based on hand gestures and displays the drawings in real time, as shown in figure 4.

- **Point Collection for Drawing:** By tracking the user's gestures from frame to frame, new points are added to the color deque to correspond to the selected color.
- **Dynamic Line Drawing:** OpenCV's line function draws lines between consecutive points in each color deque. By iterating through each deque (for each color), the program can render all drawn points, preserving the user's drawing as they switch colors. The program uses a loop to check and draw points in each color deque, creating a seamless multicolor drawing experience.
- **Color Application:** This value is used in combination with the color index to set the color of the lines drawn into the paint window. And by changing the colorIndex each time the user clicks a button available in the list of colours, the selected colour is taken for drawing new lines.

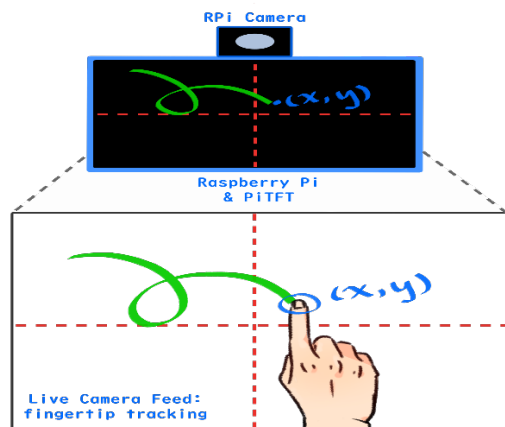


Fig. 4. Training the finger recognition model

5. RESULT

After considerable proof reading and editing, the content scraped through Air Canvas was accurate and good quality. Notably, the content also converted successfully into editable text thanks to OCR tools [9].

The air-drawing application demonstrated high accuracy in recognizing gestures and performed well under various lighting conditions and hand orientations. The program achieved a stable frame rate of 25 to 30 FPS on standard hardware, with minimal latency in gesture detection and colour changes. Resource consumption was moderate, ensuring smooth performance even on average computing systems.



Fig. 5. Interface and drawing window

Figure 5 and 6 present the results of this work. OpenCV module has been used to run the code. The code is executed in Anaconda, Jupiter Notebook, where the necessary packages are first installed and then the code is run for output. Here, two windows are displayed- one window is the camera page where the user's pen will be tracked using coordinates which are specified in the code and, the second window is for drawing the recorded coordinates and components like clear or change the colour can be used.

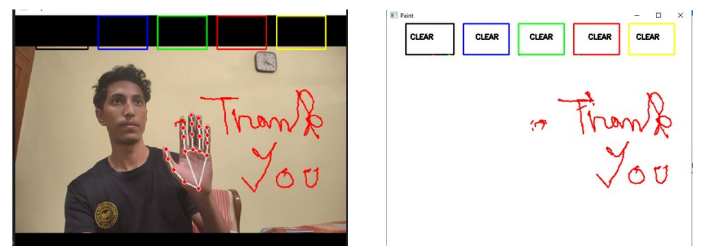


Fig. 6. (a) Drawing window (b) Paint window

6. FINDINGS

- **Hand Tracking:** The program utilizes the MediaPipe library to detect and track hand landmarks in real-time through a webcam feed. It specifically tracks the positions of the index finger (forefinger) and thumb [10].

- **Virtual Drawing:** Users can draw on a virtual canvas by moving their finger in the air. The drawing is facilitated by identifying the position of the index finger, which acts as a virtual brush [10].
- **Color Selection:** The application allows users to select different drawing colours (Blue, Green, Red, Yellow) by hovering their index finger over specific areas on the screen [10].
- **Clear Canvas:** A "CLEAR" button is provided, which can be activated by hovering over it, to reset the canvas [10].
- **Real-Time Feedback:** The program displays the drawing in real-time on two windows: One shows the live video feed with drawing elements. The other shows only the virtual canvas.
- **Drawing Persistence:** Different colours are drawn on separate layers (queues) to maintain clarity and avoid mixing during drawing [10].
- **Intuitive Gestures:** The Intuitive Gesture has been developed in answer to the very real need for a more expressive means of communication, for all facets of our lives, to penetrate beyond predictable patterns of communication that, in large part, quite frankly aren't working [10].
- **Robustness:** It is the ability of a system to cope with erroneous input and errors during execution.

7. CONCLUSION

The Air Canvas project was planned and tested. All materials and application processes were designed by integration. The existence of each module was considered and carefully structured to achieve the optimum performance. Second, we used the traditional programming language Python and NumPy Python library, which works with the help of presentation and innovation, and the project was completed successfully. Using Air Canvas, we developed a program that does not require drawing and recognizes the user's fingerprint using OpenCv. Beautiful lines can be drawn wherever the customers want. There is no need to search the PC while the program is running.

8. FUTURE SCOPE

If we had more time to work on this project, we could have improved the hands-on experience, explored our VR Air Canvas goals for the first time, and tried to better understand the basic modes. There are many different methods for contour analysis, however, in this particular algorithm, it is necessary to look at the histogram of colors used to create the contour in question. Different methods can also be used. Allowing users to save their final work or animate their drawing process could be a unique feature similar to real creative software. Finally, we can achieve meaningfulness by analyzing how much work has been done using the data.

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