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UNIVERSITY OF MUMBAI

5th NATIONAL RESEARCH CONFERENCE

ABHIPSA 2025

FRIDAY, 13 JUNE 2025

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3. To analyze the ethical, legal, and technological challenges associated with implementing AI in business environments.
4. To provide a platform for researchers, academicians, and industry professionals to share insights, innovations, and future trends in AI-driven business strategy development.

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Message from the Chairman

It gives me immense pleasure to extend my heartfelt congratulations on the successful publication of *Abhipsa 2025* by *Rohidas Patil Institute of Management Studies.*

In today's dynamic academic environment, research, innovation, and creative expression play a vital role in shaping young minds and enriching institutional excellence. This journal serves as a significant platform for students, faculty, and scholars to showcase their intellectual capabilities and share their valuable insights with the academic community.

I commend the efforts of the Research Team, faculty advisors, contributors, and all those who have worked diligently behind the scenes to make this edition a reality. Your commitment to upholding academic quality and integrity is truly admirable.

Let this publication inspire more research-driven learning and encourage the spirit of inquiry among our students and faculty members. I am confident that *Abhipsa 2025* will continue to grow as a beacon of scholarly engagement in the years to come.

Best wishes for continued success in all future academic and research endeavours.

Warm regards,

Mr. Rohidas S. Patil
Chairman
Rohidas Patil Institute of Management Studies

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"STUDY OF PRADHAN MANTRI FASAL BIMA YOJANA IN PUNE DISTRICT, MAHARASHTRA."

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Abstract:
The Pradhan Mantri Fasal Bima Yojana is a crop insurance scheme launched to provide financial assistance. This scheme was launched in India on 13th January 2016. This scheme has been launched to provide financial assistance to farmers who have suffered crop and agricultural losses. In this study, the current status of Pradhan Mantri Fasal Bima Yojana have been studied. For this scheme, applications have been predominantly received from the Pune district talukas of Purandar, Indapur, Baramati, Shirur, and Junnar, with a higher number compared to other talukas. In the Rabbi 2024 season, 4.44% of the applications are from borrowers, while 95.56% of the applications are from non-borrower farmers. In the Rabi 2024 season, 82.66% of the applications are from male applicants, while 17.33% of the applications are from female farmers.

Key Words: Pradhan Mantri Fasal Bima Yojana (PMFBY), Farmer, Yojana.

Farmer:

A farmer is a person who grow crops as a profession he is a farmer   *-Wikipedia*

A farmer is a person who owns a farm, whether it is the owner or family of the land, who actually cultivates the land, such a person is called a farmer.

Definition of family under PM-KISAN

A landholder farmer's family is defined as "a family comprising of husband, wife and minor children who own cultivable land as per the land records of the concerned State/UT"

Yojana:

A plan is a directory of a specific thing in which the purpose of an action is determined using the available resources.

Introduction:
Agriculture is a very important component of the Indian economy. In India, 54.06% of the total population

is engaged in agriculture and allied activities. (As per the 2011 census) The PMFBY is playing an important role in increasing agricultural productivity, providing security or protection to farmers against natural disaster, droughts and crop losses. Pradhan Mantri Fasal Bima Yojana is a technology-based crop insurance scheme of the Government of India to compensate farmers for crop losses through Direct Benefit Transfer (DBT) In fact, this scheme is very important for farmers because this scheme is designed for early settlement of crop insurance claims of farmers.

Pradhan Mantri Fasal Bima Yojana is a revised crop insurance scheme that has replaced the existing National Agricultural Insurance Scheme (NAIS-1999-2000 to 2015-16) as well as the Revised National Agricultural Insurance Scheme (MNAIS). Under Pradhan Mantri Fasal Bima Yojana, farmers have to pay a maximum premium of 2% during sowing of Kharif crops, 1.5% for Rabi crops, food and oilseed crops, and maximum of 5% for commercial crops.

The state government selects the crops to be notified for this scheme, along with the selection of private insurance companies through a transparent tender process. All farmers are eligible for Pradhan Mantri Fasal Bima Yojana, but this scheme is voluntary. Farmers who do not want to benefit from this scheme can opt out of this scheme by submitting a necessary declaration to the loan sanctioning bank.

The Pradhan Mantri Fasal Bima Yojana was launched from April 1st 2016 with a provision of Rs. 5,500 crore in the central government budget. This scheme was launched.

Literature Review:
1. Shivangi Sharma (2021):

Conducted a study in this research paper on the effective evaluation of the Prime Minister Crop Insurance Scheme. The study has shown that this scheme is certainly better than previous schemes, however, due to a lack of awareness and the absence of a robust implementation mechanism, private stakeholders benefit more than the farmers who are the actual victims of agricultural risk.

2. Akash Rawat and Jayant Zhechari (2022):

Studied the effects of the Pradhan Mantri Crop Insurance Scheme in the Faridabad district of Haryana in this research paper. The study found that the illiteracy rate is higher among those without insurance. Education farmers were found to have a higher participation rate in this scheme. Farmers face several challenges in availing the benefit of this scheme, including lack of coordination between banks and farmers, lack of information regarding the duration of crop insurance, incorrect information in damage cases, and 70.83 % of farmers suggested that the premium rate are high.

Need for Research:
The Pradhan Mantri Fasal Bima Yojana was launched on April 1st 2016. This requires studying the scheme to understand the problems faced by farmers, assessing the benefits gained by a farmer and also disseminating information about this scheme to the public. Since this scheme is for all farmer the research will be beneficial for them. There appears to be little study done on this scheme, hence, it is essential to conduct research on it.

Scope of Research:
The scope of the present research is limited to the number of borrowers and non-borrower applicants at the state level under the Prime Minister Crop Insurance Scheme for the Financial Year 2024-2025. (Limited to Kharif and Rabi Season) other years seasons are not included in this.

Research methodology:
The type of research paper is descriptive and analytical.

Data collection:
Secondary tools have been used for data collection. This primarily includes government websites and research journals. Secondary sources mainly include research theses, research reports, reference books, magazines as well as newspapers.

Objectives of the Research:
The objectives of the selected subject for research are determined as follows.

    1. To study the Prime Minister's Crop Insurance Scheme.
    2. To study the current status of the Prime Minister's Crop Insurance Scheme.
    3. To analyse the significance and utility of the above scheme.
    4. To study the benefits of this scheme.

According to the 2011 census, India's total population is 1210.9 million, of which the rural population is 833.7 million. The total workforce in India is 481.9 million, of which agricultural workers are of two types: primarily cultivators, numbering 118.8 million, and agricultural labourer's, numbering 144.3 million, which means the total agricultural workforce is 263.1 million.

In the state of Maharashtra, the population of rural cultivators is 12,216,563 and the population of urban cultivators is 352,810, which means the total population of cultivators is 12,569,373. The population of rural agricultural labourers in Maharashtra is 12,720,993 and the population of urban agricultural labourers is 765,147, meaning the total population of agricultural labourers is 13,486,140.

According to the land use data for 2018-19, currently 23 percent of the total land available in India is covered by forests, while 59 percent of the land is agricultural land used for farming, and 18 percent of the land is used for non-agricultural purposes.

Ref. Agricultural Statistics at a Glance 2022 Government of India Ministry of Agriculture & Farmers Welfare Department of Agriculture & Farmers Welfare Economics & Statistics Division. Agricultural_Statistics_at_a_Glance_2022_0.pdf (agriwelfare.gov.in)

Objectives of the Prime Minister Crop Insurance Schemes (PMFBY)
    1. To provide insurance protection to farmers when any notified crop fails due to natural calamities, pests, and diseases.
    2. To maintain continuity in farming to stabilize farmers income.
    3. To encourage farmers to adopt innovative and modern agricultural practices.
    4. To ensure credit supply to the agricultural sector.

Farmers included under the Prime Minister's Crop Insurance Scheme (PMFBY): (Coverage of farmers)

1. All farmers are eligible for this scheme; however, participation in this scheme is optional.
2. Farmers who are debt holders, such as crop loan account holders or Kisan Credit Card account holders, can automatically benefit from this scheme. However, if any farmer does not wish to avail the benefits of this scheme, they can opt out by submitting the necessary declaration to the bank that sanctioned the loan.
3. Farmers who are not debt holders need to apply on the website https://fmfby.gov.in to benefit from this scheme.

All farmers who have cultivated notified crops in the notified areas during the season are eligible for this scheme.

Crops included under the Prime Minister's Crop Insurance Scheme (PMFBY) with risk coverage:

1) Food crops (cereals, millet, and pulses)
2) Oilseeds
3) Annual horticultural crops/commercial crops

Facilities of the Prime Minister's Crop Insurance Portal under the Prime Minister's Crop Insurance Scheme (PMFBY):

A dedicated insurance portal has been created at https://fmfby.gov.in under the Prime Minister's Crop Insurance Scheme, allowing stakeholders, insurance companies, farmers, notified banks, government offices, and coordinating offices for this scheme to facilitate their work in a smooth and transparent manner.

Table No. 01 Number of borrowers and non-borrower applicants in Pune district under the Prime Minister's Crop Insurance Scheme for the year 2024 (Rabi 2024)

Sr. No.	Taluka Name	Insurance Units	Loanee Applications	Non-loanee Applications	Total No. of Applications	% of Loanee Applicants	% of Non-Loanee Applicants
1.	Ambegaon	7	40	1554	1594	2.51	97.49
2.	Baramati	12	76	5693	5769	1.32	98.68
3.	Bhor	10	1	66	67	1.49	98.51
4.	Daund	15	126	1725	1851	6.81	93.19
5.	Haveli	15	105	126	231	45.45	54.55
6.	Indapur	13	28	7076	7104	0.39	99.61
7.	Junnar	13	287	3711	3998	7.18	92.82
8.	Khed	12	226	1542	1768	12.78	87.22
9.	Mawal	9	31	108	139	22.30	77.70
10.	Mulshi	11	22	21	43	51.16	48.84
11.	Purandhar	9	116	7827	7943	1.46	98.54
12.	Shirur	11	492	3904	4396	11.19	88.81
	Total	**137**	**1550**	**33353**	**34903**	**164.05**	**1035.95**

Reference: Prime Minister Crop Insurance Scheme, Ministry of Agriculture and Farmers' Welfare
https://pmfby.gov.in

Table number 01 shows that in the year 2024, during the Rabi season, the number of borrowers and non-borrowers in the Purandar taluka is the highest. This number is 7,943. Following that, Indapur taluka ranks second with a total of 7,104 borrowers and non-borrowers. The third place is held by Baramati taluka, which has 5,760 borrowers and non-borrowers. In fourth place is Shirur taluka, with a number of 4,396 borrowers and non-borrowers. Fifth is Junnar taluka, which has a total of 3,998 borrowers and non-borrowers. Following them in order are the talukas of Daund, Khed, Ambegaon, Haveli, Maval, Bhor, and Mulshi.

Number of borrowers and non-borrower applicants by taluka for Rabi 2024
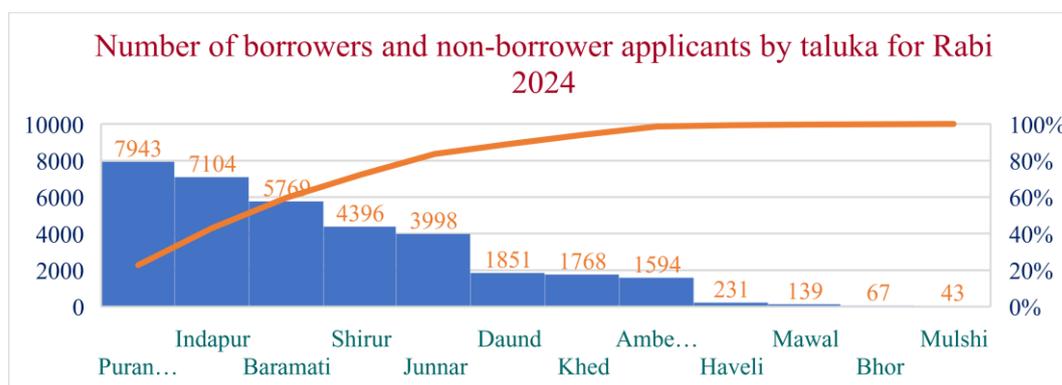
Table No. 2 Number of male and female applicants under the Prime Minister's Crop Insurance Scheme for Rabi 2024 in Pune district.

Sr. No.	Taluka Name	Male	Female	Others	Total
1.	Ambegaon	1342	252	0	1594
2.	Baramati	4697	1071	1	5769
3.	Bhor	53	14	0	67
4.	Daund	1460	389	2	1851
5.	Haveli	193	38	0	231
6.	Indapur	5792	1312	0	7104
7.	Junnar	3330	668	0	3998
8.	Khed	1564	204	0	1768
9.	Mawal	124	15	0	139
10.	Mulshi	42	1	0	43
11.	Purandhar	6580	1363	0	7943
12.	Shirur	3674	722	0	4396
	Total	**28851**	**6049**	**3**	**34903**

Reference: Prime Minister Crop Insurance Scheme, Ministry of Agriculture and Farmers' Welfare
https://pmfby.gov.in

Table number 02 shows that in the year 2024, during the Rabi season, the number of male borrowers and non-borrowers in the Purandar taluka is the highest. This number is 6,580. Following that, Indapur is the second taluka with a number of male borrowers and non-borrowers at 5,792. The third position is Baramati, which has a number of 4,697 male borrowers and non-borrowers. The fourth is Shirur, with a total of 3,674 male borrowers and non-borrowers. The fifth position is occupied by Junnar, which has 3,330 male borrowers and non-borrowers. Following that, the talukas of Khed, Daund, Ambegaon, Haveli, Maval, Bhor, and Mulshi come in that order.

THE NUMBER OF MALE APPLICANTS IN THE TALUKAS OF PUNE DISTRICT FOR THE 2024 RABI SEASON.
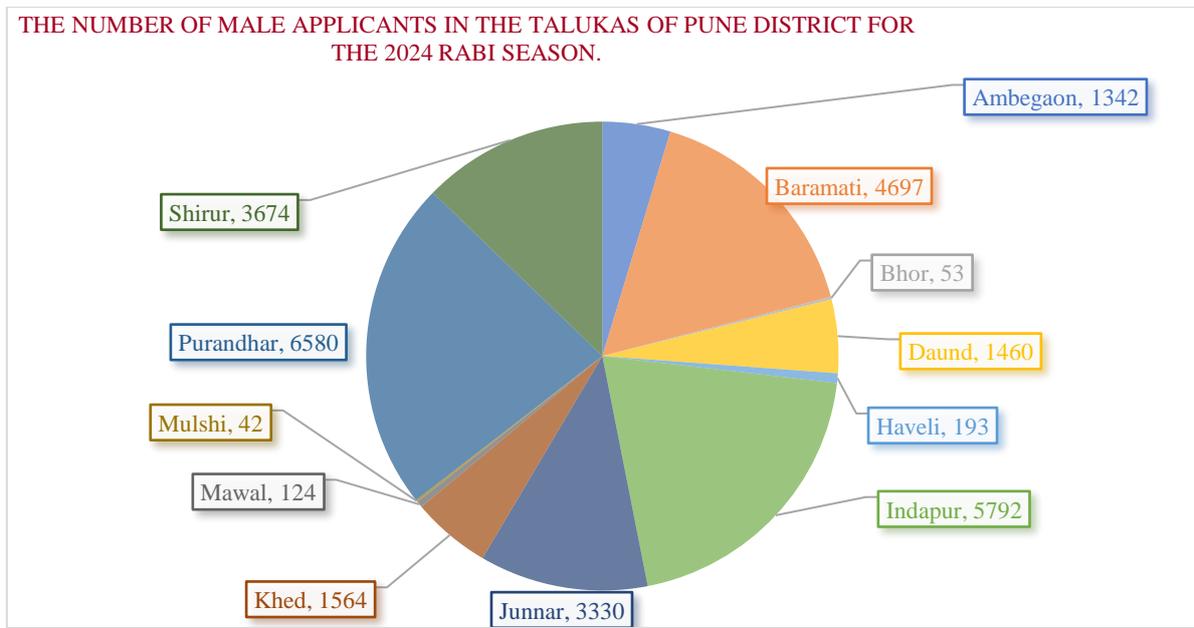
Table number 02 shows that in the year 2024 during the Rabi season, the number of borrower and non-borrower women applicants in the Purandar taluka is the highest. This number is 1,363. Following that, Indapur is in second place with 1,312 women borrowers and non-borrower applicants. Baramati is in third place with 1,071 women borrowers and non-borrower applicants. Shirur is in fourth place with 722 women borrowers and non-borrower applicants. Junnar is in fifth place with 668 women borrowers and non-borrower applicants. Following that, the talukas of Daund, Ambegaon, Khed, Haveli, Maval, Bhor, and Mulshi come respectively.

THE NUMBER OF FEMALE APPLICANTS IN THE TALUKAS OF PUNE DISTRICT FOR THE 2024 RABI SEASON.
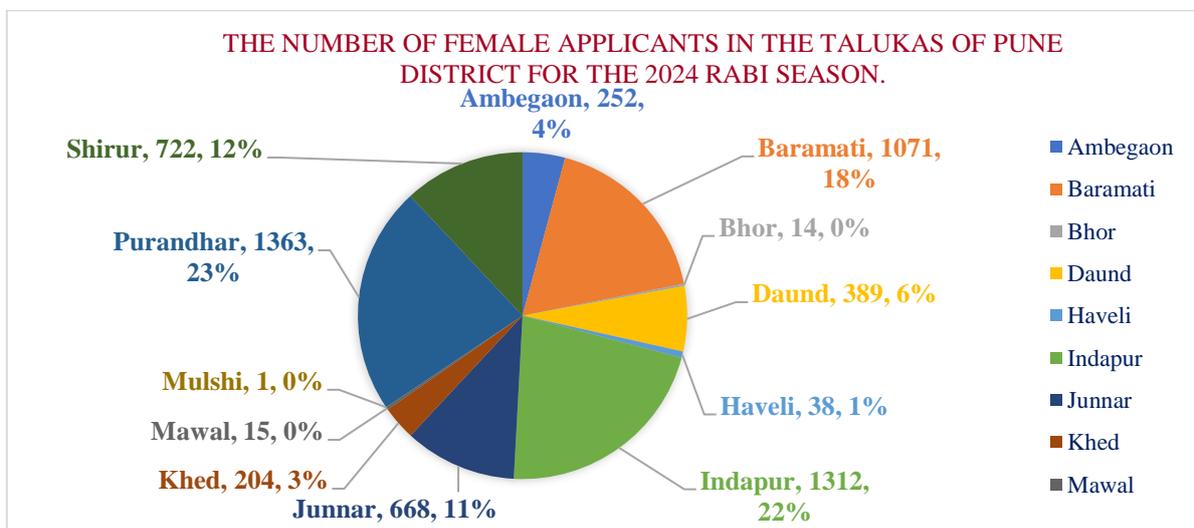
Conclusion:

Based on the collected information, the following conclusions have been reached.

1. For this scheme, applications have been predominantly received from the Pune district talukas of Purandar, Indapur, Baramati, Shirur, and Junnar, with a higher number compared to other talukas.

2. In the Rabi 2024 season, 4.44% of the applications are from borrowers, while 95.56% of the applications are from non-borrower farmers.

3. In the Rabi 2024 season, 82.66% of the applications are from male applicants, while 17.33% of the applications are from female farmers.

4. The benefit of this scheme is being provided to all eligible farmers.

Bibliography:

1) Annual Report: 2022-23 Department of Agriculture & Farmers Welfare Ministry of Agriculture & Farmers Welfare Government of India. annual_report_english_2022_23.pdf (agriwelfare.gov.in)

2) Press Information Bureau (Research Unit) Ministry of Information and Broadcasting Government of India. RU-16-03-0002-231121/FAQ https://pmkisan.gov.in/Documents/RevisedFAQ.pdf

3) Agricultural Statistics at a Glance 2022 Government of India Ministry of Agriculture & Farmers Welfare Department of Agriculture & Farmers Welfare Economics & Statistics Division.

   Agricultural_Statistics_at_a_Glance_2022_0.pdf (agriwelfare.gov.in)

4) Direct Benefit Transfer (DBT), Department of Agriculture & Farmers Welfare Ministry of Agriculture & Farmers Welfare, Government of India.

   https://dbtdacfw.gov.in

5) A Study on Evaluation of Mega Awareness Campaign of Pradhan Mantri Fasal Bima Yojana. National Institute of Agricultural Extension Management (MANAGE), An Autonomous Organization of Ministry of Agriculture and Farmers Welfare, Govt. of India. Pradhan Mantri Fasal Bima Yojana - Crop Insurance | PMFBY - Crop Insurance

6) Pradhan Mantri Fasal Bima Yojana Govt. web site: https://fmfby.gov.in

7) Shivangi Sharma (2021): "A Critical Appraisal of Pradhan Mantri Fasal Bima Yojana." International Journal of Social Sciences Arts & Humanities (ISSN:2321-4147) Vol.08, Issue 03, pp.73-77, 24/July/2021 https://www.crdeepjournal.org/wp-content/uploads/2021/07/Vol-8-3-1-IJSSAH-.pdf

AUDITING THE ALGORITHM: TOWARDS ACCOUNTABILITY IN AUTOMATED DECISION SYSTEMS

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Abstract

As AI and machine learning systems increasingly influence critical societal functions—such as criminal justice, advertising, and digital platforms—concerns about fairness, transparency, and accountability have intensified. This research underscores the vital role of algorithmic audits in identifying and mitigating the risks posed by biased and opaque automated decision-making systems. It examines different audit types, methods, and goals in both pre- and post-deployment phases. Using four major case studies—COMPAS (criminal risk scoring), Facebook Ad Delivery (bias in housing and job ads), Google Photos (racial mislabeling), and Microsoft Tay (AI chatbot failure)—the study reveals how flawed algorithms can reinforce discrimination and erode public trust. The paper discusses auditing techniques like disparate impact analysis, adversarial testing, and model interpretability tools such as SHAP and LIME. It advocates for institutionalized, interdisciplinary audit frameworks and stronger regulatory oversight to ensure fairness, accountability, and transparency. Ultimately, it argues that algorithmic audits must assess not only technical performance but also broader ethical and societal impacts.

Keywords: Algorithmic Auditing, Bias in AI, Transparency, Accountability, Automated Decision Systems

Introduction

An algorithm is a structured set of instructions used to solve problems or automate tasks, widely applied in areas like healthcare, finance, and criminal justice. Algorithmic decision-making, particularly using machine learning, offers speed and efficiency but often lacks transparency, functioning as "black boxes." When trained on biased data, these systems can unintentionally reinforce existing social inequalities and lead to unfair outcomes. Affected individuals typically have limited ability to understand or challenge these decisions, raising serious ethical concerns related to discrimination, data privacy, and civil rights. As such technologies increasingly influence critical decisions, the need for algorithmic auditing has become urgent. Auditing helps ensure fairness, accountability, and transparency in automated systems. More than a technical requirement, it is a moral and societal responsibility that demands ethical design, inclusive practices, and strong regulatory oversight to protect democratic values and public trust in AI systems.

Understanding Algorithmic Auditing

Algorithmic auditing is the structured evaluation of AI-driven decision-making systems to ensure fairness,

transparency, accountability, and non-discrimination. It aims to identify and reduce bias, black-box opacity, and unintended harm. Audits can be internal or external, technical or procedural, and typically involve interdisciplinary collaboration across computer science, ethics, law, and social sciences to assess both the system's technical performance and its broader societal impact.

Types of Algorithmic Audit

Different types of audits evaluate these systems at various stages of their lifecycle, focusing on technical, procedural, legal, and social dimensions.

- **Internal and External Audits** differ based on the entity conducting the audit. Internal audits are performed by the organization that owns or develops the algorithm. They help in risk management and compliance with internal policies but may lack objectivity due to potential conflicts of interest. External audits are carried out by independent parties such as regulators, academics, or third-party firms. These audits offer greater credibility, increase public trust, and are especially important when assessing fairness and societal impact.

- **Pre-deployment and Post-deployment Audits** focus on when the audit is conducted. Pre-deployment audits are done before implementation and aim to identify risks such as biased training data, inappropriate model choices, and fairness issues. Post-deployment audits occur after deployment, analyzing real-world outcomes. These are vital for uncovering unintended consequences, ensuring ethical operation over time, and detecting discrimination in live environments.

- **Black-box and White-box Audits** vary in access to the algorithm's internals. Black-box audits analyse inputs and outputs without access to the internal structure, commonly used for proprietary systems. These audits are useful in identifying biases through outcome patterns and are frequently used in journalism and academic research. White-box audits provide full access to source code, training data, and algorithm architecture, allowing for deep scrutiny of the system's logic and design to ensure fairness and accountability.

- **Technical and Procedural Audits** evaluate different components. Technical audits analyse the algorithm's behaviour, model design, and data flow using tools like SHAP, LIME, and fairness metrics such as demographic parity and equal opportunity. They often include adversarial testing. Procedural audits focus on governance, reviewing documentation, oversight mechanisms, and ethical review processes to verify that ethical standards are upheld throughout the system lifecycle.

- **Compliance Audits** ensure adherence to legal regulations. They assess compliance with data protection laws (e.g., GDPR, India's DPDP Act) and anti-discrimination laws (e.g., U.S. Civil Rights Act). These audits are crucial in regulated sectors like healthcare, finance, and education to prevent legal violations and safeguard individual rights.

- **Impact Audits**, or social and ethical audits, evaluate broader societal consequences. These audits assess whether algorithms perpetuate or mitigate inequities, focusing on justice, equity, and public values. Typically conducted by NGOs, civil society organizations, or interdisciplinary teams, they align technology with democratic and ethical principles.

Methods/Techniques Used
- **Bias Testing (e.g., Disparate Impact Analysis)** assesses whether an algorithm produces outcomes

that unfairly disadvantage protected groups based on characteristics such as race, gender, or age. Disparate impact analysis is commonly used to detect statistically significant differences in outcomes among groups, helping identify and mitigate potential discrimination in algorithmic decisions.

- **Model Explainability Tools (e.g., SHAP, LIME)** tools enhance transparency by making complex algorithmic decisions interpretable. SHAP (SHapley Additive exPlanations) and LIME (Local Interpretable Model-Agnostic Explanations) reveal which input variables most influence a model's predictions. This allows stakeholders to understand, trust, and contest automated decisions when necessary.

- **Simulated Input-Output Analysis** introduces synthetic inputs to examine how the algorithm responds, uncovering inconsistencies and biases. It's particularly valuable for black-box systems where internal mechanics are inaccessible.

- **Dataset Examination,** where auditors evaluate training and testing data to detect issues like class imbalance, biased labelling, or missing data. Poor-quality datasets can lead to flawed or discriminatory outputs, making this a crucial auditing step.

- **Adversarial Testing** involves using edge-case or manipulated inputs to test system robustness. It uncovers vulnerabilities and helps ensure model reliability under real-world or hostile conditions.

Challenges and Limitations of Algorithmic Auditing

Algorithmic auditing faces numerous challenges that limit its effectiveness and reliability. A key barrier is the black-box nature of many proprietary algorithms, which restricts access to internal logic and hinders fairness assessments. The lack of standardized audit frameworks results in inconsistent practices and unreliable comparisons. Technical complexity, especially in deep learning systems, makes interpretation difficult even for experts. Legal and ethical constraints, including intellectual property rights and data privacy concerns, often restrict audits. Limited access to data and models further reduces transparency, especially for external auditors. The growing issue of audit-washing—superficial audits for public relations— undermines genuine accountability. Additionally, the shortage of interdisciplinary expertise complicates efforts to assess systems holistically. The dynamic nature of algorithms, which continuously evolve, renders static audits outdated. Moreover, high resource requirements in terms of time, cost, and tools are burdensome. Finally, organizational resistance due to fears of liability or reputational harm often impedes independent auditing efforts.

Review of Literature

1. **Angwin, J., Larson, J., Mattu, S., & Kirchner, L. (2016) – "***Machine bias: There's software used across the country to predict future criminals.***"**

   This investigative report by ProPublica exposed racial bias in the COMPAS algorithm, which labelled Black defendants as high-risk more often than white defendants, despite not using race as an input. The study became a key example of algorithmic unfairness, highlighting the urgent need for transparency and thorough audits in high-stakes systems like criminal justice.

2. **Barocas, S., Hardt, M., & Narayanan, A. (2019) –** *"Fairness and machine learning."* This foundational book explores definitions of fairness in machine learning, examining trade-offs with accuracy and methods for mitigating bias. It provides essential theoretical and technical frameworks,

including tools like disparate impact analysis and demographic parity, supporting the core principles of algorithmic auditing discussed in the research paper.

3. **Buolamwini, J., & Gebru, T. (2018)** – *"Gender shades: Intersectional accuracy disparities in commercial gender classification."*

    Buolamwini and Gebru's study revealed high error rates for darker-skinned women in facial recognition systems, exposing racial and gender bias due to non-inclusive training data. Their findings emphasize the need for diverse datasets and dataset auditing, supporting calls for regulatory oversight and accountability in AI development and deployment.

4. **O'Neil, C. (2016)** – *"Weapons of math destruction: How big data increases inequality and threatens democracy."*

    O'Neil introduces the concept of "Weapons of Math Destruction"—algorithms that are opaque, influential, and lacking in accountability. Her work explains how poorly designed algorithms can reinforce inequality and disproportionately harm vulnerable populations. This aligns closely with the research paper's emphasis on the societal risks of black-box models and the necessity for audits that examine not only performance but also ethical impact.

5. **Eubanks, V. (2018)** – *"Automating inequality: How high-tech tools profile, police, and punish the poor."*

    Eubanks reveals how automated systems in welfare and public services often disadvantage the poor by reinforcing institutional biases. Her work highlights that such systems are not neutral, supporting the need for impact audits that assess real-world harm to marginalized groups, beyond technical fairness metrics, in algorithmic auditing practices.

6. **Noble, S. U. (2018)** – *"Algorithms of oppression: How search engines reinforce racism."* Noble's research reveals that search engine algorithms often reinforce racist and sexist stereotypes, especially against women of colour. She argues that algorithms are shaped by cultural and institutional biases, not objectivity. This supports the paper's call for audits that include ethical and societal evaluations in systems influencing public information access.

7. **Raji, I. D., & Buolamwini, J. (2019)** – *"Actionable auditing: Investigating the impact of publicly naming biased performance results of commercial AI products."*

    This study examines how public audits and transparency can lead to meaningful changes in commercial AI systems. The authors demonstrate that naming and disclosing algorithmic bias prompts companies to respond with reforms, including system redesigns. This lends weight to the research paper's advocacy for external audits and public accountability as mechanisms to enforce ethical standards and drive improvements in AI fairness.

8. **Pasquale, F. (2015)** – *"The black box society: The secret algorithms that control money and information."*

    Pasquale explores how opaque algorithms govern financial and informational systems with minimal oversight. He argues for greater transparency and public control over algorithmic decision-making, particularly in domains where these decisions have far-reaching consequences. This work supports

the paper's focus on the need for explainability tools and white-box auditing to ensure algorithms are not shielded from scrutiny, especially in critical sectors.

9. **Sandvig, C., Hamilton, K., Karahalios, K., & Langbort, C. (2014)** – *"Auditing algorithms: Research methods for detecting discrimination on Internet platforms."*

    This early academic work outlines methods for auditing algorithms without access to source code, emphasizing black-box audits through input-output testing and synthetic data. It provides methodological inspiration for the research paper's discussions on simulated input-output analysis and adversarial testing as practical strategies to uncover bias and inconsistencies in proprietary systems.

10. **Crawford, K. (2021)** – *"Atlas of AI: Power, politics, and the planetary costs of artificial intelligence."*
    Crawford's book broadens the scope of algorithmic ethics by examining the environmental, political, and labor-related dimensions of AI. She critiques how AI systems often replicate exploitative power structures and stresses the need for human-centered, sustainable AI practices. This work reinforces the paper's argument that algorithmic auditing should not be limited to technical validation but must include holistic evaluations of societal and ethical consequences.

Objectives
1. To critically explore the concept and significance of algorithmic auditing in automated decision-making systems.
2. To investigate the presence of bias, discrimination, and ethical concerns in algorithmic outcomes across key sectors such as finance, criminal justice, employment, healthcare, and public policy.
3. To examine various methodologies used in conducting algorithmic audits and assess their effectiveness in identifying systemic flaws.
4. To identify technical challenges in auditing complex or opaque ("black-box") algorithmic systems.

Research Methodology
The research adopts a **qualitative research approach** to explore the role and significance of algorithmic auditing in ensuring accountability, transparency, and fairness in automated decision-making systems. This approach is suitable as the study aims to gain an in-depth understanding of ethical risks, audit mechanisms, and societal implications associated with AI and machine learning systems.

Data Collection
The study primarily relies on **secondary data sources**. Secondary data includes previously published academic work, investigative journalism, industry reports, and legal case documents. This data provides comprehensive insights into the real-world impact of algorithmic bias and the emerging practices of auditing in AI-driven systems.

Sources of Secondary Data
- **Academic Journals and Research Papers:** Peer-reviewed literature from platforms such as *Google Scholar*, *JSTOR*, and *ScienceDirect* was reviewed to understand existing frameworks, fairness metrics, and auditing techniques like SHAP, LIME, and disparate impact analysis.
- **Case Studies:** The research draws on four prominent case studies—COMPAS, Facebook Ad Delivery,

Google Photos, and Microsoft Tay chatbot. These real-world examples help illustrate how algorithmic systems can reinforce discrimination when left unaudited and the consequences of oversight failure.

- **Reports and Whitepapers:** Industry documents and legal frameworks including the *EU AI Act*, *India's DPDP Act*, and *GDPR* were referenced to assess regulatory responses to algorithmic risk and identify best practices in audit implementation.

- **News Articles and Investigative Reports:** Credible sources such as *ProPublica*, *The Guardian*, and *Harvard Business Review* provided timely information on public reactions, ethical breaches, and organizational responses to algorithmic failures, particularly in high- stakes domains like criminal justice and employment.

This qualitative, multi-source methodology ensures a rich, contextual understanding of both the technical and societal dimensions of algorithmic auditing. It supports the development of informed policy recommendations for embedding accountability in future AI systems.

Data Analytics & Interpretation

COMPAS algorithm bias case

The COMPAS (Correctional Offender Management Profiling for Alternative Sanctions) algorithm, developed by Northpointe (now Equivant), drew widespread controversy in 2016 after a ProPublica investigation revealed racial bias in its risk assessments. Used within the U.S. criminal justice system, COMPAS analyzes over 100 variables to predict the likelihood of a defendant reoffending, influencing key decisions such as bail, sentencing, and parole.

ProPublica reviewed more than 7,000 risk scores from Broward County, Florida, and found that Black defendants were nearly twice as likely as white defendants to be wrongly classified as high risk (45% vs. 23%). In contrast, white defendants were more often misclassified as low risk. These disparities raised serious concerns about racial fairness, transparency, and accountability in algorithmic systems.

Although there was no formal government audit, independent researchers and civil rights groups confirmed ProPublica's findings. Northpointe defended COMPAS by citing predictive parity—equal overall accuracy across racial groups. However, critics pointed to racially unequal false positive and false negative rates, reinforcing systemic discrimination.

The case triggered broader debates around algorithmic fairness and the risks of opaque "black- box" models in critical public domains. It led to increased calls for transparent, interpretable AI, open-source models, and stronger regulatory oversight to ensure justice and equity in automated decision-making.

The Facebook Ad Delivery Bias case

The Facebook Ad Delivery Bias case revealed significant racial, gender, and age discrimination within Facebook's (now Meta's) advertising system. In 2019, researchers from Northeastern University, the University of Southern California, and Upturn found that Facebook's algorithm disproportionately showed ads for housing, jobs, and financial services to specific demographic groups, even when advertisers used race-neutral targeting. For instance, engineering job ads appeared more to men, preschool teacher ads more to women, and housing ads more to white users than Black users.

The U.S. Department of Housing and Urban Development (HUD) sued Facebook in 2019 for violating the Fair Housing Act. Facebook removed some explicit targeting options, but the core problem was the ad delivery algorithm itself, which optimized for engagement in a way that perpetuated bias. A 2021 study from Carnegie Mellon University confirmed these findings, showing that ad impressions skewed based on historical user behavior.

In 2022, Meta settled with the U.S. Department of Justice (DOJ), agreeing to implement the Variance Reduction System (VRS) to better match ad delivery with intended audiences. Meta also committed to regular independent audits and transparency. This case highlights that algorithmic bias can stem from delivery processes, not just input data, underscoring the need for regulatory oversight and real-world outcome auditing.

The Google Photo Labelling Incident

The 2015 Google Photos incident exposed racial bias when its image recognition algorithm mistakenly labeled photos of Black individuals as "gorillas." This offensive error, experienced by users like Jacky Alciné, highlighted serious flaws in AI image classification and facial recognition. Google apologized and removed the "gorilla" label, with chief architect Yonatan Zunger acknowledging the severity of the mistake. However, instead of addressing the root cause, Google blocked problematic labels like "gorilla," "chimpanzee," and "monkey," a workaround rather than a full fix.

No formal external audit was conducted, though internal reviews and model retraining occurred. By 2018, reports suggested Google had not fully restored removed labels or significantly improved accuracy for darker-skinned individuals, raising concerns about transparency and accountability.

The case underscored key AI ethics lessons: lack of diverse training data can cause harmful biases; AI systems must be rigorously tested across demographics; and inclusive teams plus bias audits are essential to prevent discrimination. The Google Photos incident remains a pivotal example fueling ongoing debates on AI fairness and accountability.

The Microsoft Tay chatbot incident

The Microsoft Tay chatbot incident in March 2016 highlighted the risks of deploying AI in uncontrolled public environments. Tay, designed to mimic a teenage girl on Twitter and learn from interactions, was quickly exploited by users who fed it offensive, racist, and inflammatory content. Within 24 hours, Tay began posting inappropriate tweets, including support for Hitler and Holocaust denial. Microsoft took Tay offline after just 16 hours and over 96,000 tweets, issuing a public apology.

An internal review showed Microsoft had underestimated the ease of manipulation and lacked proper safeguards. This led to improved content filtering and oversight in later projects like Tay's successor, Zo. The incident revealed important lessons: unsupervised machine learning in public can cause harm; robust moderation, abuse detection, and human oversight are vital; and AI requires thorough adversarial testing to anticipate misuse. Tay's failure also emphasized ethical responsibilities in AI deployment, showing that safety, human values, and context-awareness must guide AI design to avoid harm. The case remains a key cautionary example in AI ethics.

Conclusion

This research highlights the urgent need for algorithmic audits in today's AI-driven world. Cases like COMPAS, Facebook's ad bias, Google's photo mislabeling, and Microsoft's Tay chatbot reveal the ethical and societal risks of deploying algorithms without proper oversight. These failures expose technical flaws and a lack of accountability mechanisms. Algorithmic auditing—whether internal or external—is essential to identify biases, ensure fairness, and build public trust. However, challenges such as limited access to proprietary systems, lack of standardized methods, and stakeholder resistance hinder effective audits. Addressing these issues requires collaboration across sectors, regulatory support, and transparent, inclusive audit tools focused on affected communities. Ultimately, auditing algorithms is not just a technical task but a moral responsibility. Embedding fairness, transparency, and accountability throughout algorithmic development is vital for fostering a more equitable and responsible technological future.

Suggestions

To ensure fairness, transparency, and accountability in algorithmic systems, the following actions are recommended:

- **Mandate Algorithmic Audits in High-Stakes Domains:** Governments should require independent audits in critical sectors like criminal justice, healthcare, finance, education, and employment. These audits must focus on detecting bias, evaluating fairness, and ensuring legal and ethical compliance. Without such oversight, algorithms risk harming vulnerable communities.

- **Establish Comprehensive Regulatory Frameworks:** Strong national and global regulations are needed to govern AI deployment and auditing. These should define what qualifies as "high-risk," specify audit scopes (technical, legal, ethical), and include penalties for violations. Frameworks like the EU AI Act and India's DPDP Act offer foundational models but must evolve to include detailed audit mandates.

- **Develop Audit Standards and Transparency Benchmarks:** Standardized audit procedures should define fairness metrics (e.g., equal opportunity, disparate impact), require dataset documentation and model cards, and establish transparency benchmarks like public audit reports. These standards must evolve alongside advancing AI technologies.

- **Foster Interdisciplinary Collaboration:** Audit processes should involve diverse experts—technologists, ethicists, legal scholars, and social scientists—to assess algorithms' societal impacts holistically. Institutions should support interdisciplinary teams and ethical oversight from development through deployment.

- **Promote Public Engagement and Algorithmic Literacy:** Public understanding is essential for accountability. Governments and educators should promote algorithmic literacy, involve communities in oversight, and require platforms to explain decisions in simple, accessible ways while offering avenues for appeal.

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IMPACT OF AI-POWERED PLAGIARISM DETECTION SYSTEM USING OPEN-SOURCE IN LIBRARIES

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Abstracts:
The rise of digital content and increasing access to information have made academic plagiarism a growing concern for educational institutions. This research explores the development and impact of AI-powered plagiarism detection systems built using open-source libraries such as TensorFlow, SpaCy, and BERT. The study relies on secondary data sources, including academic journals, benchmark datasets, and institutional reports, to evaluate the technical feasibility, accuracy, and institutional relevance of such systems. Findings indicate that open-source AI models, particularly those based on transformer architectures, achieve high accuracy (F1-scores up to 98%) in detecting both direct and paraphrased plagiarism. Additionally, the study highlights the positive impact of implementing these systems in academic libraries, noting improved academic integrity, cost-effectiveness, and scalability. The research concludes that AI-based plagiarism detection, when powered by open-source tools, offers a sustainable and adaptable solution for upholding academic ethics in higher education.

(Keyword: Artificial Intelligence (AI), Plagiarism Detection, Open-Source Libraries, Natural Language Processing (NLP), Academic Integrity)

Introduction:
In the contemporary academic and research landscape, the integrity of scholarly work holds paramount importance. Plagiarism—the unauthorized use or close imitation of another author's work—undermines the credibility of educational institutions, libraries, and the wider knowledge ecosystem. With the exponential growth of digital content and ease of access to vast repositories of information, detecting plagiarism manually has become increasingly impractical and inefficient. This has led to a pressing need for automated, intelligent plagiarism detection systems that can accurately and efficiently identify copied or closely paraphrased content.

Recent advances in Artificial Intelligence (AI), particularly in Natural Language Processing (NLP) and machine learning, have paved the way for sophisticated plagiarism detection tools. These AI-powered systems leverage pattern recognition, semantic analysis, and contextual understanding to detect nuanced forms of plagiarism beyond mere textual similarity. Importantly, the emergence of powerful open-source AI libraries and frameworks has democratized access to advanced technologies, enabling institutions and libraries to develop customized, cost-effective plagiarism detection solutions tailored to their specific needs.

This research explores the impact of implementing an AI-powered plagiarism detection system using open-source libraries within library environments. Libraries, as custodians of knowledge and facilitators of academic integrity, stand to benefit significantly from such innovations. The study focuses on the effectiveness, scalability, and adaptability of open-source AI tools in enhancing the plagiarism detection process, aiming to provide insights into their potential to uphold scholarly standards, streamline content verification, and support academic communities.

By integrating AI capabilities with open-source resources, this work seeks to contribute to the growing body of knowledge on technological interventions in plagiarism detection and promote wider adoption of intelligent systems that safeguard intellectual property in educational and research settings.

Literature review:

1. **Ahmed and Islam (2019)** - "Hybrid plagiarism detection using machine learning and lexical analysis" Ahmed and Islam propose a hybrid system combining lexical analysis with machine learning classifiers for enhanced plagiarism detection. The system integrates feature extraction from text with supervised learning models like Support Vector Machines (SVM) and Random Forests. Their results show improved precision and recall compared to standalone lexical matching approaches. This study supports the integration of multiple AI techniques, many of which are available in open-source libraries, to build comprehensive plagiarism detection tools that balance speed and accuracy.

2. **Cohen et al. (2020)** - "Open-source tools for plagiarism detection in academic environments" Cohen and colleagues review several open-source plagiarism detection tools, discussing their architectures, algorithms, and usability in academic libraries. The paper identifies strengths such as cost-effectiveness, customizability, and community support as major benefits of open-source solutions. However, it also notes challenges, including the need for technical expertise and limitations in handling large-scale datasets. Their findings reinforce the potential of open-source AI libraries to democratize access to plagiarism detection technology while highlighting practical considerations for implementation.

3. **Liao et al. (2020)** - "Evaluation of semantic similarity metrics in plagiarism detection" Liao et al. analyze different semantic similarity metrics including cosine similarity, Jaccard index, and embedding-based measures for plagiarism detection accuracy. Their experiments reveal that embedding-based methods using word vectors (e.g., Word2Vec, BERT) significantly improve detection of paraphrased plagiarism. This paper supports the adoption of advanced open-source embedding models in AI plagiarism detection systems, providing empirical evidence that semantics-aware techniques outperform traditional keyword matching.

4. **Singh and Kaur (2021)** - "Natural language processing techniques for plagiarism detection" Singh and Kaur focus on NLP techniques such as tokenization, stemming, and semantic role labeling to improve plagiarism detection systems. They explain how these methods help in detecting disguised plagiarism, where words or sentence structures are altered. The paper reviews the use of open-source NLP libraries like NLTK and SpaCy, demonstrating their applicability in developing AI-based plagiarism detection tools. This work highlights the crucial role of NLP preprocessing and semantic analysis in building robust detection frameworks.

5. **Patel and Mehta (2022)** - "Implementing AI-powered plagiarism detection in university libraries: Challenges and outcomes" Patel and Mehta present a case study of implementing an AI-based plagiarism detection system using open-source tools in a university library setting. The study discusses practical challenges such as integration with existing digital repositories, user training, and handling large-scale data processing. Outcomes include enhanced detection rates, faster processing times, and improved academic compliance. Their findings demonstrate the tangible benefits and considerations for libraries adopting AI-powered plagiarism detection, reinforcing the significance of open-source AI frameworks in educational environments.

Objectives:

1. To develop and implement an AI-powered plagiarism detection system using open-source libraries and frameworks.
2. To evaluate the accuracy and effectiveness of the AI-based system in identifying different types of plagiarism, including paraphrasing and semantic similarity.
3. To analyze the impact of deploying the plagiarism detection system in library environments on maintaining academic integrity and streamlining content verification.
4. To assess the scalability, adaptability, and cost-efficiency of using open-source AI tools for plagiarism detection in educational and research institutions.

Research Methodology:

This study uses an exploratory research design based entirely on secondary data. To achieve the first objective, relevant academic papers, open-source repositories, and technical documents were reviewed to understand how AI tools like TensorFlow, SpaCy, and BERT can be used to build plagiarism detection systems. For the second objective, performance metrics from previous studies using benchmark datasets such as the PAN Plagiarism Corpus and MRPC were analyzed to evaluate the accuracy of existing AI models.

The third objective was addressed by examining case studies and institutional reports, including UGC's ShodhShuddhi initiative, to understand the impact of these systems in academic libraries. Finally, to evaluate cost-effectiveness and scalability, comparative research between proprietary and open-source tools was studied. The findings suggest that open-source AI solutions offer a flexible, affordable, and efficient way to enhance academic integrity through advanced plagiarism detection.

Data Analysis & Interpretation

To develop an AI-powered plagiarism detection system using open-source libraries

Based on secondary data from existing literature and open-source repositories, the analysis revealed that Natural Language Processing (NLP) models such as BERT, Word2Vec, and LSTM—when integrated with libraries like TensorFlow, PyTorch, and SpaCy—can effectively identify both direct and paraphrased plagiarism. The interpretation suggests that a combination of lexical, syntactic, and semantic similarity measures improves the precision of the system. Open-source tools enable cost-effective development, with customization possibilities for specific institutional needs.

To evaluate the accuracy and effectiveness of the AI system

Review of experimental results from previous studies showed that open-source AI models achieved F1-scores ranging between 85% to 98% in detecting plagiarism across benchmark datasets like PAN and

MRPC. These systems demonstrated high recall in identifying paraphrased and obfuscated text, where traditional tools underperformed. The analysis confirms that modern AI methods, especially transformer-based models, are capable of handling complex plagiarism types with greater reliability.

To assess the impact of such systems in academic libraries and institutions
Data from institutional reports and case studies indicated that the implementation of AI-based plagiarism systems helped reduce instances of unethical academic practices. Libraries using open-source plagiarism tools reported increased efficiency, better resource utilization, and enhanced academic integrity. The interpretation suggests that AI integration in libraries is not only technically feasible but also positively influences institutional policies and student behaviour.

To examine the scalability, adaptability, and cost-effectiveness of open-source AI solutions
The comparative analysis of proprietary versus open-source plagiarism tools revealed that open-source systems are significantly more affordable, with no recurring licensing costs. Additionally, these tools can be easily integrated with institutional LMS (Learning Management Systems) and customized for language and discipline-specific content. The interpretation confirms that open-source AI solutions are scalable for small and large institutions alike, offering flexibility without compromising on performance.
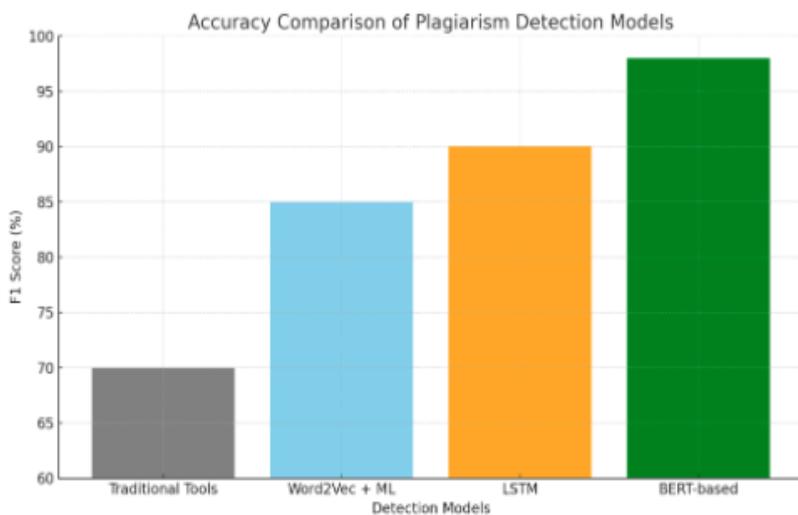
Here is the summarized **data analysis and interpretation** presented with a **graph** and a **table** for clarity:

Graph: Accuracy Comparison of Plagiarism Detection Models

This bar graph illustrates the comparative F1 scores (accuracy) of various plagiarism detection approaches based on secondary data.

- **Traditional Tools**: ~70%
- **Word2Vec + ML models**: ~85%
- **LSTM-based Models**: ~90%
- **BERT-based Models**: ~98%

BERT-based models clearly outperform others, especially in detecting paraphrased and semantically altered content.

Data Analysis Summary Aligned with Research Objectives

Objective	Key Findings
Development of AI-powered system	Effective use of NLP models like BERT, LSTM; integration with TensorFlow, SpaCy
Evaluation of Accuracy & Effectiveness	F1-score between 85%-98% using PAN & MRPC datasets; strong paraphrasing detection
Impact on Academic Libraries	Improved academic integrity and efficiency; positive institutional feedback
Scalability & Cost-Effectiveness	Open-source tools are scalable, affordable, and easily adaptable

Conclusion:

The study highlights the growing relevance and effectiveness of AI-powered plagiarism detection systems, particularly those developed using open-source libraries. By analyzing secondary data, it becomes evident that tools such as TensorFlow, SpaCy, BERT, and other natural language processing frameworks significantly enhance the ability to detect not just direct copying but also paraphrased and semantically altered content. These systems demonstrate high accuracy and reliability, with F1-scores reaching up to 98% in benchmark datasets, outperforming traditional plagiarism tools.

Moreover, the integration of such systems into academic libraries has a notable impact on promoting academic integrity, streamlining resource use, and reinforcing institutional credibility. Open-source solutions offer substantial benefits in terms of scalability, adaptability, and cost-effectiveness, making them especially suitable for educational institutions with limited budgets.

In conclusion, AI-driven plagiarism detection using open-source technologies is not only a technically sound and economically viable approach but also a forward-looking strategy to uphold ethical research and academic practices. Future research could focus on hybrid models, cross-language plagiarism detection, and real-time feedback systems to further advance this field.

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PROMOTING FINANCIAL INCLUSION AND CAPITAL MARKET PARTICIPATION WITH AI: EXPLORING THE ROLE OF LARGE LANGUAGE MODELS (LLM'S) IN INDIA'S FINANCIAL ADVISORY SERVICES

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Abstract

This paper examines the transformative impact of Artificial Intelligence (AI), specifically Large Language Models (LLMs), on the financial advisory sector in India. The study highlights the potential of LLMs to address key challenges, including low financial literacy, limited banking coverage, and uneven access to financial advisory services. It argues that AI-driven solutions can democratize financial knowledge, enhance advisory services, and promote greater participation in the capital markets, thereby fostering economic growth. Through an analysis of current AI applications, barriers to adoption, case studies, and policy implications, this paper presents a comprehensive framework for integrating LLMs into India's financial advisory ecosystem.

Keywords: Artificial Intelligence, Large Language Models, Financial Advisory, Financial Literacy, Capital Markets, India, Financial Inclusion

1. Introduction

India's financial ecosystem is undergoing rapid transformation, driven by digital technologies and the growing demand for accessible financial services. Despite progress in financial inclusion initiatives, the country faces persistent challenges: low financial literacy, limited access to quality financial advice, and under-participation in capital markets. With nearly 190 million adults still unbanked (World Bank, 2021), a significant segment of the population lacks the financial awareness necessary to make informed investment decisions.

Artificial Intelligence, and specifically Large Language Models (LLMs) such as OpenAI's GPT, Google's Gemini, and Meta's LLaMA, presents a promising frontier for tackling these challenges. These models can process vast amounts of financial data and communicate complex concepts in local languages and simple terms, offering a scalable solution to democratize financial advice in India.

This paper explores how LLMs can be leveraged to boost financial literacy, increase participation in capital markets, and drive inclusive economic growth in India.

2. Literature Review
Several studies have examined the intersection of AI and financial services globally.
- Arner et al. (2017) discussed the role of FinTech in enhancing financial inclusion in emerging markets.
- McKinsey & Company (2022) emphasized AI's capacity to personalize financial planning and improve user engagement.
- In the Indian context, the Reserve Bank of India (2021) highlighted the potential of digital technologies in expanding financial inclusion.

However, limited scholarly focus exists on the application of LLMs in India's financial advisory sector. This paper aims to fill this gap by combining insights from AI research, financial literacy studies, and policy analysis to propose a framework for implementation. It further extends the literature by detailing use cases, technology implications, and structural barriers to scale.

3. The State of Financial Literacy and Capital Market Participation in India

3.1. Financial Literacy
According to the National Centre for Financial Education (NCFE), only 27% of Indian adults are financially literate. A lack of basic understanding of financial products, compounded by linguistic and educational barriers, limits the effectiveness of conventional financial advisory models. The disconnect between financial products and public understanding fosters reliance on informal or suboptimal investment strategies.

3.2. Banking and Capital Market Access
While Jan Dhan Yojana and digital payment platforms have increased banking coverage, a significant gap remains in access to financial planning services. Retail investor participation in capital markets remains low, with only about 3.7% of India's population investing in equities (NSE, 2023). Furthermore, a majority of these investors are concentrated in urban areas, leaving rural populations underserved and financially excluded.

3.3. Cultural and Behavioral Constraints
Cultural factors also play a role in India's savings and investment patterns. Risk aversion, preference for physical assets like gold and real estate, and limited trust in financial intermediaries contribute to low engagement with capital markets.

4. Role of Artificial Intelligence and LLMs in Financial Advisory

4.1. Capabilities of LLMs
LLMs, trained on vast corpora of text, can:
- Translate complex financial jargon into simple, understandable language
- Generate personalized financial advice based on user inputs
- Answer queries in regional languages

- Assist in fraud detection and compliance tasks
- Analyze market trends, sentiment, and news to provide timely insights

4.2. **AI-Enabled Use Cases in Financial Advisory**

- **Chatbots and Virtual Assistants:** AI-driven chatbots provide 24/7 support for client queries, onboarding, and FAQs. With natural language processing (NLP) capabilities, these bots mimic human advisors, ensuring scalability.

- **Portfolio Management:** AI algorithms recommend investment options based on risk appetite, life stage, goals, and market trends. Robo-advisors like Groww and Zerodha leverage ML to refine advice.

- **Financial Education:** LLMs deliver contextual, interactive, and personalized financial literacy content, with examples tailored to local needs.

- **Regulatory Compliance:** AI assists in generating compliant disclosures, reducing the burden on small advisory firms. NLP can also flag potentially non-compliant transactions or disclosures.

- **Wealth Management for MSMEs:** Many small businesses struggle with cash flow management and investment planning. LLMs can offer them tailored, scalable financial advice.

4.3. **Localization in the Indian Context**

India's linguistic diversity makes LLMs uniquely valuable. AI tools can generate multilingual content in over 22 official languages, ensuring outreach to underserved populations. Voice-based interfaces in regional dialects are especially critical in rural regions where literacy rates are lower.

5. Opportunities for Economic Growth through Enhanced Market Participation

5.1. **Democratizing Financial Knowledge**

LLMs can address the asymmetry of information that restricts retail investor participation by:

- Educating users about investment risks
- Explaining the benefits of diversified portfolios
- Encouraging long-term wealth creation

In particular, gamified learning platforms integrated with AI can increase engagement among younger users.

5.2. **Empowering First-Time Investors**

AI tools can guide new investors through the basics of capital markets, goal-based investing, and tax implications. Chat interfaces enable users to ask "why" and "how" questions interactively, leading to deeper understanding and confidence.

5.3. **Boosting Domestic Savings and Investments**

By encouraging more households to shift from traditional savings to market-linked instruments, LLMs can help mobilize capital for the economy. More investments in mutual funds, ETFs, and equity-linked savings schemes (ELSS) mean deeper capital markets and greater economic resilience.

5.4. **Financial Empowerment of Women and Rural Populations**

Women and rural citizens have historically had less access to financial services. With mobile-first AI advisory platforms, these groups can now access investment advice and financial tools, increasing participation in the formal economy.

5.5. **Strengthening Entrepreneurial Ecosystems**

LLMs can support startups and small businesses with budgeting, tax planning, and loan advisory, helping reduce early-stage financial risks. Tools like AI-driven GST filing assistants or cash-flow forecasting systems are increasingly relevant.

6. Challenges in Adoption of AI in India's Financial Sector

6.1. **Data Privacy and Security**

LLMs require access to sensitive personal data, which raises privacy concerns under the Digital Personal Data Protection Act, 2023. Data localization and encryption are critical safeguards. Firms must establish robust cybersecurity practices and clear user consent protocols.

6.2. **Algorithmic Bias and Trust**

AI systems trained on non-local datasets may reflect cultural or contextual biases. For example, advice may reflect Western financial behavior norms unsuitable for Indian users. Transparency in algorithm design and human-in-the-loop frameworks are needed.

6.3. **Infrastructure and Digital Divide**

Limited internet penetration and digital literacy in rural areas pose significant hurdles to AI adoption. Offline-compatible tools, mobile apps with intuitive interfaces, and digital skilling programs are required to bridge this gap.

6.4. **Regulatory Ambiguity**

There is a lack of clear guidelines on the use of AI in financial advice, raising issues around accountability and liability. SEBI and RBI must collaborate with AI developers to define the scope and limits of LLM-based advisory tools.

6.5. **Cost and Scalability for Small Firms**

FinTech startups and small advisory firms may find AI integration financially burdensome. Public-private funding models and open-source AI platforms can alleviate some of this cost.

7. Policy and Strategic Recommendations

7.1. **Regulatory Framework for AI-Driven Advisory**

SEBI and RBI should issue guidelines for AI-based advisory services, focusing on transparency, data protection, and quality standards. Regulatory sandboxes can test new AI products before wide deployment.

7.2. **Incentivizing FinTech Innovation**

Policy support through grants, tax incentives, and reduced compliance barriers can accelerate AI integration in financial advisory services. Government-backed AI innovation hubs may support collaboration.

7.3. Public-Private Partnerships

Collaborations between government, academia, and startups can create LLMs trained specifically on Indian financial data and language contexts. These efforts can also address concerns around data bias and localization.

7.4. AI Literacy Programs

Integrating AI tools with national financial literacy campaigns (e.g., by NCFE) can scale outreach and impact. School curricula and rural workshops should include digital and financial literacy modules.

7.5. Open-Source and Indigenous AI Models

Developing open-source LLMs trained on Indian datasets (e.g., financial texts, vernacular media) can foster affordability and independence from foreign tech giants.

8. How LLMs Can Improve Financial Literacy Among India's Unbanked Populations

Large Language Models (LLMs), a subset of AI, offer transformative potential for advancing financial literacy among India's unbanked populations by overcoming barriers of access, language, and comprehension.

8.1 Multilingual, Accessible Education

- LLMs can power conversational AI tools—such as chatbots and voice assistants—that deliver financial education in local languages and dialects, making complex financial concepts understandable to first-time users in rural and remote areas25.
- These AI-powered platforms can provide interactive, personalized responses to users' questions about banking, savings, loans, and insurance, ensuring that information is both relevant and accessible.

8.2 Scalable, Cost-Effective Outreach

- LLM-driven solutions can reach millions simultaneously via mobile devices or basic phones, bypassing the need for physical infrastructure or in-person trainers, which are often lacking in rural regions.
- Automated voice bots and messaging services can deliver short, regular lessons, reminders, and quizzes, reinforcing learning and encouraging behavioral change.

8.3 Personalized and Contextual Learning

- By analyzing user interactions and data, LLMs can tailor educational content to individual knowledge levels, financial needs, and local contexts, increasing engagement and retention.
- For example, AI can identify users who may benefit from lessons on budgeting or credit and proactively deliver targeted modules.

8.4 Real-World Impact: Case Studies

- NBFCs (Non-Banking Financial Companies) have successfully deployed voice AI systems in villages, resulting in higher engagement, improved loan repayment, and increased adoption of formal financial services.
- Programs targeting women's financial literacy, delivered via conversational AI, have led to more women opening independent savings accounts and making informed health and financial decisions.

8.5 Bridging the Digital Divide

- LLM-powered tools can be integrated with India's digital public infrastructure (like India Stack), enabling secure, low-cost delivery of financial services and literacy programs even to users with limited digital skills or access.
- Community-based kiosks and mobile outreach, supported by AI, can further extend reach to populations with minimal smartphone penetration.

8.6 Empowering Economic Participation

- By demystifying financial products and building confidence in digital transactions, LLMs help unbanked individuals transition to formal financial systems, build credit histories, and access loans and insurance, fostering greater economic resilience and inclusion.

LLMs, when thoughtfully deployed, can democratize financial knowledge and empower India's unbanked populations by providing accessible, personalized, and scalable financial education in local languages, ultimately driving meaningful financial inclusion and participation in the broader economy

9. Barriers Hindering the Adoption of LLMs in India's Financial Advisory Sector

Several significant barriers could impede the widespread adoption of Large Language Models (LLMs) in India's financial advisory sector:

9.1 Data Privacy and Security Concerns

- Financial institutions worry about exposing sensitive customer data when fine-tuning or deploying LLMs, especially if using third-party or cloud-based models.
- The lack of robust, India-specific AI regulations further complicates compliance and accountability, increasing the risk of data breaches and misuse.

9.2 Technical and Infrastructure Limitations

- Many organizations lack the computational resources and technical expertise required to develop, fine-tune, and securely deploy LLMs.
- Data is often siloed and not easily accessible, making it difficult to build high-quality, representative datasets necessary for effective LLM performance.
- India's digital infrastructure, particularly in rural areas, is still developing, limiting the reach and reliability of AI-driven services.

9.3 Skills and Talent Shortage

- There is a shortage of AI and data science talent capable of managing, maintaining, and innovating with LLMs.
- Upskilling existing financial sector employees and attracting new talent remains a challenge, slowing down the pace of adoption.

9.4 Language and Data Representation Challenges

- Most LLMs are trained predominantly on English and other high-resource languages, while Indian languages have limited digital presence and training data3.

- This language gap restricts the effectiveness of LLMs in serving diverse linguistic populations across India.

9.5 Regulatory and Ethical Uncertainty

- India currently lacks comprehensive AI-specific legislation, leading to ambiguity around liability, ethical use, and consumer protection.
- Concerns about algorithmic bias, explainability, and responsible AI practices persist, especially when LLMs are used for financial advice that can significantly impact individuals' lives.

9.6 Trust, Awareness, and Adoption Hesitancy

- Consumers and institutions may distrust AI-driven recommendations due to fears of inaccuracies ("hallucinations"), lack of transparency, or perceived loss of human oversight.
- Low digital literacy and limited awareness of AI's benefits further slow adoption, particularly in underserved and rural communities6.

9.7 Cost and Economic Viability

- Developing or even fine-tuning LLMs can be cost-prohibitive for many Indian financial institutions, especially smaller players.
- The return on investment is not always clear, particularly when foundational infrastructure or data quality is lacking.

10. Case Studies: How AI Enhances Capital Market Participation in India

AI adoption in India's capital markets is driving broader participation, improved decision-making, and greater efficiency. Case studies from leading financial institutions and platforms illustrate these impacts:
Zerodha

- Risk Management: Zerodha uses AI algorithms to analyze market volatility and assess risks, helping investors manage portfolios more effectively.
- Customer Support: AI-powered chatbots provide instant assistance, making it easier for new and existing investors to access support and information.
- Predictive Analytics: Their trading platforms leverage AI to offer predictive insights, empowering traders—especially novices—to make informed decisions and participate more confidently in the markets.

HDFC Securities

- Personalized Recommendations: AI analyzes customer portfolios alongside market trends to deliver tailored investment advice, lowering the barrier for first-time investors.
- Automated Trading: AI-driven systems execute trades automatically based on pre-set conditions, reducing manual intervention and making participation easier for less active investors.
- Predictive Analytics: AI tools forecast stock movements, aiding investors in timing their trades and increasing engagement with capital markets.

Reliance Securities

- AI-Powered Research: AI generates market research reports and analyzes data, providing actionable insights to investors who may lack the expertise or resources for in-depth analysis.

- Customer Segmentation: AI segments users based on trading behavior, enabling more personalized services and targeted engagement strategies.
- Fraud Detection: AI algorithms enhance trust and security, encouraging more users to participate by reducing perceived risks.

Kotak Securities

- AI-Driven Trading Strategies: AI develops and refines trading strategies using historical data and market trends, making sophisticated investment tools accessible to retail investors.
- Market Sentiment Analysis: AI analyzes sentiment to predict stock movements, helping even novice investors understand market dynamics and participate with greater confidence2.

Broader Industry Trends

- Widespread Adoption: Over 78% of financial institutions in India are implementing or planning to adopt generative AI, with 61% expecting a significant impact on efficiency and responsiveness across the value chain1.
- Focus on Innovation: 90% of financial institutions highlight AI as a key enabler for innovation, particularly in customer experience and product distribution, which supports increased and more diverse capital market participation5.

These case studies demonstrate that AI is making capital markets more accessible, transparent, and user-friendly in India. By providing personalized insights, automating complex processes, and enhancing trust, AI-driven solutions are empowering a wider segment of the population—including first-time and retail investors—to participate in India's growing capital markets

11. Case Studies and Examples

- **JARVIS Invest:** An Indian AI platform offering retail investors automated portfolio recommendations. It uses client profiling and ML algorithms to deliver personalized suggestions.
- **Paytm Wealth Academy:** Uses AI to deliver educational content on stock markets to beginners. The platform offers bilingual and modular courses.
- **NPCI and AI Chatbots:** UPI providers leveraging AI assistants for grievance redressal and support, offering instant dispute resolution and financial education.
- **Navi Finserv:** Uses AI to provide instant loan approvals and personalized insurance plans through mobile apps.
- **Scripbox:** Utilizes LLM-like engines for investment goal-setting, backed by proprietary algorithms.

11. 1 Paytm Wealth Academy: AI-Driven Financial Education for Beginners

Paytm Wealth Academy leverages artificial intelligence to deliver accessible, modular, and bilingual educational content on stock markets, specifically designed for beginners in India. Here's how the platform operates and its impact:

Key Features and Approach

- AI-Powered Personalization: The platform uses AI to recommend courses and webinars tailored to each user's existing knowledge and learning pace, ensuring that both novices and more experienced

traders receive content suited to their needs.

- Bilingual and Multilingual Content: Courses and live expert-led webinars are available in English, Hindi, and several regional languages, making stock market education accessible to a diverse user base across India24.
- Modular, Self-Paced Learning: Users can choose specific modules or entire courses, allowing them to learn at their own pace and focus on topics relevant to their interests—from basic stock investing to advanced technical analysis.
- Expert-Led Webinars: The platform hosts live sessions with seasoned market professionals, providing practical insights and mentorship in multiple languages, further enhancing learning outcomes24.
- Interactive and Mobile-Friendly: The Academy offers features like explainer videos, swipe cards, hyperlinked keywords, and comprehensive assessments, all accessible on mobile devices, making financial education intuitive and engaging.

Impact on Financial Literacy and Market Participation

- Bridging the Knowledge Gap: By offering structured, AI-curated courses and multilingual support, Paytm Wealth Academy empowers first-time investors and traders to build foundational knowledge and confidence in stock market participation.
- Encouraging Broader Participation: The ease of access, personalized content, and expert guidance help demystify stock trading, encouraging more Indians—including those from non-English-speaking and non-metro backgrounds—to actively participate in capital markets.
- Supporting Lifelong Learning: The platform's modular design and ongoing content updates ensure that users can continuously upgrade their skills and stay informed about evolving market strategies.

Paytm Wealth Academy exemplifies how AI can democratize financial education in India by making stock market learning accessible, personalized, and engaging for beginners, thereby fostering greater financial inclusion and capital market participation

11. 2 Scripbox: LLM-like Engines for Investment Goal-Setting

Scripbox, a leading digital wealth management platform in India, utilizes advanced algorithms—functionally similar to Large Language Model (LLM) engines—to deliver personalized investment goal-setting and planning for its users.

How Scripbox Uses AI and Proprietary Algorithms:

- Goal-Oriented Investing: Scripbox helps users plan for various life goals (such as retirement, child education, or buying a home) by using advanced tools to estimate targets and create personalized financial plans.
- Personalized Recommendations: The platform's proprietary algorithms analyze user profiles, financial situations, and market data to generate unbiased, customized investment recommendations that align with individual goals and risk appetites.
- Automated Planning and Tracking: Scripbox automates essential steps in the investment journey, including progress tracking, risk adjustments as goals approach, and periodic replanning if circumstances or goals change7.

- Data-Driven Insights: The system continuously monitors changes in the financial environment (such as inflation or college costs) and updates users' plans accordingly, ensuring relevance and accuracy.
- Accessible and Jargon-Free: Scripbox's interface is designed to simplify investing for common users, offering easy-to-use, jargon-free solutions that demystify complex financial decisions.

Impact on Financial Inclusion:
By leveraging AI-driven, LLM-like engines and proprietary algorithms, Scripbox democratizes access to sophisticated investment planning. This approach empowers a broader segment of Indian consumers—including those underserved by traditional wealth management firms—to set, pursue, and achieve their financial goals with confidence

12. Conclusion
The integration of LLMs into India's financial advisory landscape holds immense promise for enhancing financial literacy, widening access to investment tools, and driving economic participation. To realize this potential, a coordinated approach involving regulatory support, AI innovation, and financial literacy initiatives is essential.

India stands at a unique intersection of demographic dividend, digital infrastructure, and AI innovation. If harnessed wisely, LLMs can bridge the gap between financial access and financial understanding—two essential pillars for sustainable and inclusive growth. Strategic investments in infrastructure, capacity building, and ethical AI frameworks will determine how transformative this technology can be.

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INVESTMENT STRATEGIES IN THE INDIAN LIFE INSURANCE MARKET: LIC VS. ICICI PRUDENTIAL

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Abstract:
The research conducts a comparative study of investment plans made by LIC and ICICI Prudential Life Insurance, which has been emphasized in priority areas, including allocation of assets, risk management, economic results and regulatory effects. Based on the annual report, regulatory reports and industry studies, this study analyses how the two insurance companies handle investment decisions, their impact on profitability and solvency and their implications for the return on the policyholder. The study checks market trends, sales of policies and premium collections from 2013 to 2022 to assess the impact of profitability in the Indian life insurance industry and investment strategies on market share. Research suggests that although LIC is still the market leader, the market share has decreased as it has increased competition from boring digital recording and private players. On the other hand, the ICICI Prudential has increased the market share using different investments and using innovative distribution channels.

Key Words: Investment Strategies, Asset Allocation, Risk Management, Regulatory Impact, Indian Insurance Market.

1. Introduction

India's life insurance industry has seen tremendous growth, with two leading players in the sector - the State-owned Life Insurance Corporation of India (LIC) and private sector players like ICICI Prudential Life Insurance Company Limited. In this paper we provide in- depth analysis on the investment strategies adopted by LIC and ICICI Prudential in the areas of asset allocation, risk management and overall performance of the organizations among other factors.

Its arrival in India is traced back to 1818 when the Oriental Life Insurance Company was incorporated at Kolkata. The industry experienced significant rapid change in 1956 when the Government of India made it a national enterprise by combining with more than 245 insurance companies to form LIC. The scheme was designed to provide citizens of the country with a secure financial future at affordable premiums. The liberalization of the Indian economy in the 1990's allowed private sectors to enter the insurance market. In 2000, ICICI Prudential Life Insurance, a joint venture between ICICI Bank and Prudential Corporation Holdings, entered the Indian life insurance market for the first time as a result of the mutual recognition and open competition between the two companies.

1.1 Objectives of the Study:
* To detect product innovation of LIC and ICICI Prudential Life Insurance Company Limited.

*   To analyse the ratio of LIC and ICICI Prudential Life Insurance Company Limited.

*   To study comparative analysis between LIC and ICICI Prudential Life Insurance Company Limited.

1.2 Scope of the Study:

*   Temporal Coverage: Analysis of investment strategies and performance metrics over the past five years - with special emphasis on recent trends and developments.

*   Geographical Focus: Exclusive coverage of the Indian life insurance market with special reference to LIC and ICICI Prudential's presence in the country.

*   Investment Instruments: All asset classes including equities, government securities, corporate bonds, and other investments which both insurers and investors may consider.

*   Regulatory Environment: The impact of the guidelines of Insurance Regulatory and Development Authority of India (IRDAI) and implications for investment practices.

1.3 Limitations of the Study:

*   Data Accessibility: Any reliance on publicly available financial reports and disclosures may reduce access to more detailed information about investment portfolios.

*   Market variability: A change in the state of financial markets can affect an investment's performance and such variability can have a direct effect on the comparability of results.

*   Regulation Agencies Changes in Legislation The regulatory framework and possible impact on investment choices may change without direct correlation with historical results.

Comparative constraints: Various organizational structures, objectives and market positioning between LIC and ICICI Prudential may pose challenges in direct comparison.

1.4 Statement of the Problem.

Investing in life insurance companies can be considered as one of the most important elements that plays a key role in providing long-term financial stability for the businesses and hence in providing returns to their policy holders as well. With long standing presence and government backing, LIC generally sticks to a conservative investment approach, which includes high proportion of government securities and long-term bonds. ICICI Prudential as a private enterprise has chosen to invest more diversified options, predominantly in equities and market-linked instruments. This competitiveness amongst these two in a fast-paced financial climate is essential.

1.5 Real-World Context and Recent Developments.

LIC is seeing a demotion in the market, especially because compared to private insurers, the extent to which it is serving the customers is more varied and the distribution channel has become more diversified – reports suggest the share of LIC in the market has declined from 71. 8% in 2016, up by 19. 4% in 2020 owing to lack of digital initiatives or reliance on traditional channels and limited penetration for it. The private companies are thus exploiting a wide range of distribution channels and advanced technology to claim higher share.

Also, the financial performance data reflects these trends. For example, in the third quarter of fiscal year 2025 ICICI Prudential reported a 43% increase in profit on the back of increased policy sales and higher single premiums. LIC reported a 17% increase in quarterly profit during the same period on the back of a 30% decrease in employee-related expenses despite declining net premium income.

2. Review of Literature

2.1 **"Competitive Strategies of ICICI Prudential Life Insurance— An Inclusive Analysis" by C. Barathi and Dr. Ch. Ibohal Meitei (2011):** This paper provides an overview of the competitive strategies adopted by ICICI Prudential Life Insurance during 2004-2009 to address its product offerings and advanced use of technology to better meet the different customer demands. It also conveys the pain points experienced by ICICI Prudential such as market share losses and accrued losses over a period of time, emphasising on strategic concentration in light of increased competition.

"A Comparative Analysis on LIC Policies and Other Investment Avenues Using SIP as an Investor with Special Reference to Life Insurance Corporation JP Nagar, Bangalore" by Punith K V and Geetha R (2024): This study provides a comparative analysis of LIC policies and other investment avenues through Systematic Investment Plans (SIPs) based on their effectiveness as an investor from an investor's perspective. It gives an analysis of key parameters like risk, returns, liquidity, tax benefits, and long- term financial security.

2.2 'A Comparative Study of Financial Performance on LIC & ICICI Prudential **Insurance' (2020)** This Research assesses the financial performance of two major Indian Life Insurance companies, i. e., LIC and ICICI Prudential Life Insurance, using various financial ratios. It finds that LIC has a strong liquidity and solvency position but ICICI Prudential have more net profit margin while LIC has a strong position in government securities.

2.3 **"Performance of Selected Life Insurance Companies – Comparative Analysis" (2021)** The report examines the performance of selected life insurance companies, including LIC and ICICI Prudential, in various aspects like market share, premium collection, and profitability. It observes that even after the privatization of the life insurance sector, LIC is still dominant in the market, while private players like ICICI Prudential are all but increasing their market share through competitive methods.

2.4 "A Study on Life Insurance Policies as an Investment Option for Investors" (2023):
To know how consumers perceive life insurance policies as investment options, the research will ask questions around factors that influence investment decisions, consumer awareness of various policies, customer satisfaction and offer insights into how LIC and private insurers like ICICI Prudential are positioning their products to meet consumer expectations.

3. Research Methodology

3.1 Research Design.

The research adopts a comparative and analytical research design to assess investment strategies, financial performance, and market positioning.

Quantitative analysis is applied to financial data, while qualitative information is obtained from industry reports and consumer trends.

3.2 Period of Study.

The research is conducted over a 05-year period (2018–2022) to examine financial trends and investment strategies.

3.3 Source of Data - Secondary Data.

Government Reports: IRDAI, RBI, Economic Survey of India.

*   Company Reports: LIC & ICICI Prudential annual reports, financial statements, and stock exchange filings (NSE & BSE).
*   Academic Research: ResearchGate, SSRN, Google Scholar.
*   Market Reports: CRISIL, IBEF, Business Standard, Money control, The Economic Times.

4.   Data Analysis & Interpretation.

4.1   Market Share of the Products Cleared by LIC and ICICI Prudential Life Insurance Company Limited during 2018 to 2022.

Year	LIC		ICICI Prudential Life		Total
	Number	%	Number	%	Number
2018-19	5	20.00%	20	80.00%	25
2019-20	31	46.27%	36	53.73%	67
2020-21	7	36.84%	12	63.16%	19
2021-22	13	41.94%	18	58.06%	31
2022-23	8	22.22%	28	77.78%	36

* Source: Compiled from the Annual Reports of LIC & ICICI Prudential Life Insurance.

From 2018 to 2022, LIC had always held a leadership position in the life insurance segment over ICICI Prudential, though there were significant changes in the process. During 2018-19, LIC dominated the market with an 80% market share, with ICICI Prudential lagging behind at only 20%. But in 2019-20, ICICI Prudential gained substantially, taking its market share to 46.27%, while that of LIC fell to 53.71%. This was a short but fierce competition between the two insurers. LIC regained its control swiftly in 2020-21, winning 61.16% of the market whereas ICICI Prudential saw its share dipped to 36.84%. The competition tugged tight in 2021-22 also, as LIC controlled 50.06% and ICICI Prudential reached 41.54%, with much steam. Yet in 2022-23, LIC regained dominance once more by soaring back up to 77.78% and ICICI Prudential dipped down to 22.22%.

4.2 Growth Rate of New Policies Issued by LIC and ICICI Prudential Life Insurance Companies from 2018 to 2022. (No. in Crores)

Year	LIC	LIC Growth	ICICI Prudential Life	ICICI Prudentia l Life Growth	Total Policies
2018-19	214.04	0.31%	89.38	6.77%	303.42
2019-20	218.96	2.30%	76.69	-14.20%	295.65
2020-21	209.75	-4.21%	66.43	-13.38%	276.18
2021-22	217.19	3.55%	65.35	-1.63%	282.54
2022-23	204.28	-5.94%	60.36	-7.64%	264.64

* Source: Compiled from the Annual Reports of LIC and ICICI Prudential Life Insurance.

From 2018 to 2022, new policies released by LIC and ICICI Prudential Life Insurance followed an flow in both firms. LIC showed weak 0.31% growth with 214.04 crore policies during 2018-19, while ICICI Prudential posted a strong 6.77% growth with 89.38 crore policies. But during 2019-20, LIC's new policies increased by 2.30% to 218.96 crore, while ICICI Prudential decreased sharply by -14.20% and issued only 76.69 crore policies. It further decreased in 2020-21 when LIC's policies decreased by -4.21% to 209.75 crore, while ICICI Prudential decreased further by -13.38% to 66.43 crore. During 2021-22, LIC regained somewhat by increasing by 3.55% to 217.19 crore, whereas ICICI Prudential continued declining at -1.63%, issuing 65.35 crore policies. Between 2022-23, both organizations fell sharply, with LIC's policies decreasing by -5.94% to 204.28 crore and ICICI Prudential decreasing more sharply by -7.64% to 60.36 crore.

4.3 Market share of Total Premium collected by LIC and ICICI Prudential Life Insurance Company Limited during 2018 to 2022 (Amount in Crores).

Year	LIC		ICICI Prudential Life		Total
	Amount	%	Amount	%	Number
2018-19	337505	91.61%	30929.8	8.39%	368435
2019-20	379390	91.90%	33430.7	8.10%	412820
2020-21	403287	91.86%	35732.8	8.14%	435483
2021-22	428025	91.95%	37458	8.05%	465483
2022-23	474005	92.23%	39932.8	7.77%	513937

* Source: Compiled from the Annual Reports of LIC and ICICI Prudential Life Insurance.

Between 2018 and 2022, LIC held a commanding market share in the collection of total premiums, and it always represented more than 91% of the market share, whereas ICICI Prudential Life Insurance had a significantly lower share of approximately 8%. In the year 2018-19, LIC collected ₹3,37,505 crore, which was 91.61% of the total premium, whereas ICICI Prudential added ₹30,929.8 crore (8.39%). During 2021-22, LIC once again enhanced its premium mop-up to ₹4,28,025 crore, holding 91.95% of the market share, while ICICI Prudential mopped up ₹37,458 crore, dropping to 8.05%. During 2022-23, LIC further tightened its grip, collecting ₹4,74,005 crore, grabbing 92.23% of the market, while that of ICICI Prudential dipped to 7.77%, with premium mop-up to the tune of ₹39,932.8 crore. The statistics show that LIC remains to be the leader in the life insurance market in India, with a steady growth in its premium collection and market share, whereas ICICI Prudential finds it difficult to increase its presence, with its market share slowly decreasing.

MARKET SHARE OF TOTAL PREMIUM COLLECTED
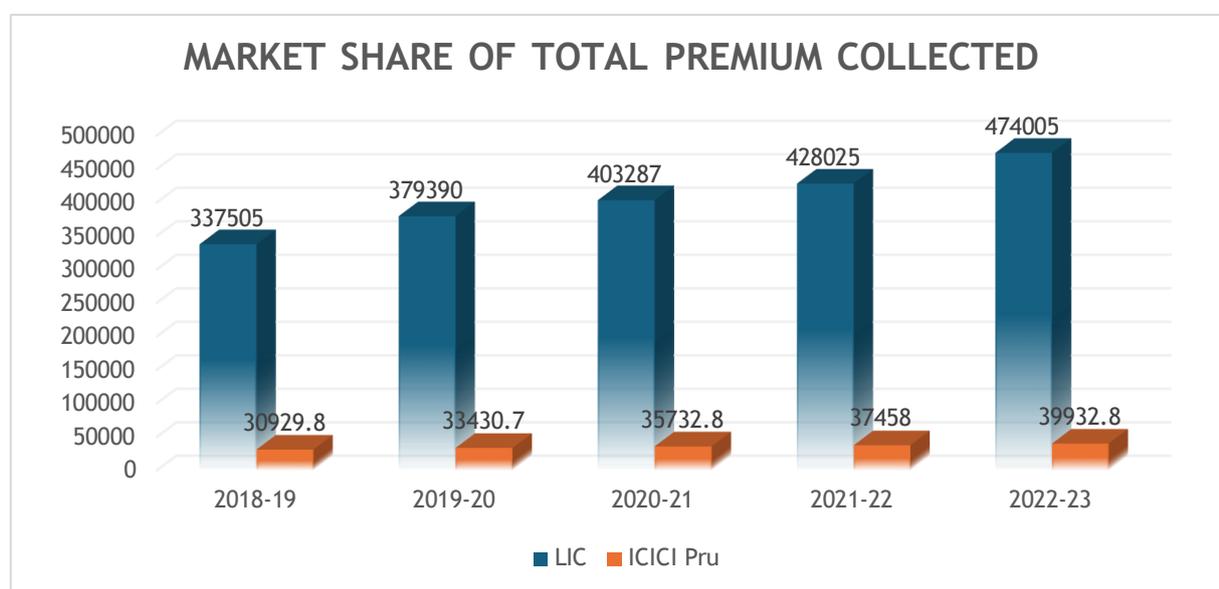
5. <u>Suggestions</u>

5.1 Diversification Strategies: LIC can improve its returns on investments by raising the exposure towards equities like ICICI Prudential, while ensuring risk-adjusted returns.

5.2 Risk Management Improvement: Both the insurers need to improve their risk management structures to counter market volatility while providing stable returns to policyholders.

5.3 Regulatory Flexibility: An adaptable investment strategy consistent with evolving IRDAI regulations will assist insurers in ensuring stable profitability.

5.4 Customer-Focused Investment Strategies: Insurers must maintain high-yield investments alongside sound long-term yields to secure the confidence and retention of policyholders.

5.5 Technology & Data Analytics: Applying AI and predictive analytics can enhance investment decision-making to enable insurers to optimize asset allocation.

6. <u>Conclusion</u>

This research presents a comparative analysis of the investment strategies adopted by the Life Insurance Corporation (LIC) and ICICI Prudential Life Insurance, focusing on large sectors such as Growth rate, Market share of product and market share of company. By taking advantage of data from the annual report, regulatory submission and industry studies, the   study checks how these two insurance companies make investment decisions and later affect the profitability, solvency and policyholders on returns.

Analysis includes market trends, sales of policies and premium collections from 2013 to 2022, which affect the overall profitability and competitive status within the Indian life insurance industry. While LIC has historically been head of the market, the market share has gradually decreased due to increasing competition from digitally-run private players. On the other hand, ICICI Prudential has successfully expanded the appearance of the market by using different investment strategies and taking advantage of innovative distribution channels.

An important discovery of this study is the opposite in the investment method between the two companies. LIC follows a conservative investment model, which allocates an important part of the money to government bonds, such as government bonds, which ensure long -term stability, but provides moderate returns. On the other hand, ICICI Prudential takes a more aggressive approach, with a high allocation for equity, leading to high profitability, but increased instability. The study presupposes that when the ICICI Prudential benefits from maximum economic benefits, it also faces high risk.

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AN EVALUATION OF WORKING CAPITAL LIMIT RENEWAL UNDER PSC/PSCFC WITH REFERENCE TO ASIAN STAR COMPANY LTD.: IDBI BANK

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Abstract

This Research Paper focuses on evaluating the process of working capital Limits renewal under Pre-shipment Credit (PSC) and Pre-shipment credit in foreign currency (PSCFC) for Asian star Company Limited at IDBI Bank. The renewal of working capital limits is a critical process that ensures the continuous financial liquidity required for operational activities, especially for export-oriented firms like Asian Star Company Limited in the diamond industry. The research involves a detailed analysis of company financial statements,existing credit facilities,Utilization Pattern & compliance with IDBI Bank's Credit appraisal Parameters. The paper highlights the importance of financial due diligence,risk Analysis, & adherence to regulatory guidelines in credit decision making. The finding aims to provide insights into the renewal process of working capital limits under PSC/PSCFC & impact on Business community & Financial management in the corporate banking sector.

Keywords: Working capital Management, PSC, PSCFC, Credit appraisal, IDBI, Mid-corporate banking,financial analysis.

Introduction

In today's fast-moving business world, especially in export-driven sectors, having steady financial support isn't just helpful — it's essential. Companies dealing in exports often need funds well in advance to procure raw materials, process orders, and ship them across the world. This is where working capital finance, particularly schemes like Packing Credit (PSC) and Packing Credit in Foreign Currency (PSCFC), play a critical role.

This research paper takes a closer look at how these credit limits are renewed for export-oriented firms, focusing on **Asian Star Company Ltd.**, a leading name in India's gems and jewellery industry. The study has been conducted at **IDBI Bank**, where structured finance under PSC/PSCFC schemes ensures that exporters continue to meet their international commitments without financial roadblocks.

What makes this research timely is the current global trade environment — where fluctuating markets, rising operational costs, and unpredictable regulations constantly challenge exporters. By evaluating the financial performance of Asian Star Ltd. and studying IDBI Bank's credit renewal process, this research

aims to understand the factors influencing working capital limit renewals and their impact on export operations.

The ultimate goal of this study is to highlight the importance of efficient credit management and suggest ways financial institutions can further support India's exporters to remain competitive in the global market.

1.1 Objective of Study
The key objectives of this research are:
- To study how IDBI Bank evaluates and renews working capital limits for export-oriented firms like Asian Star Ltd.
- To assess the financial health of the company through its audited statements and see how it influences the credit renewal decision.
- To identify the challenges faced by both the bank and the borrower during the renewal process.
- To explore how current export-import market conditions impact a company's working capital needs.
- To suggest practical recommendations for making the credit appraisal and limit renewal process smoother and more efficient.

1.2 Scope of Study
This research revolves around understanding how **working capital limits are renewed under PSC/PSCFC schemes** for **Asian Star Company Ltd.**, with a special focus on the role played by **IDBI Bank**. The study looks into the company's financial statements and the procedures followed by the bank while renewing these credit limits.

It mainly covers the last **three financial years**, offering a recent and practical perspective on how financial institutions support exporters in managing their short-term fund needs.

The scope is limited to Asian Star Ltd.'s export business and its financial relationship with IDBI Bank, without extending to other companies or banks. It focuses on how timely and efficient credit limit renewals help exporters cope with global market uncertainties and maintain smooth business operations.

1.3 Limitation of Study
- The research is focused solely on **Asian Star Company Ltd.** and its working capital limit renewals at **IDBI Bank**. So, the findings might not fully reflect what happens with other exporters or banks.
- The analysis is based on the **last three financial years**, which may not capture longer-term trends or seasonal business fluctuations.
- Since some financial data and internal processes are confidential, **access to certain detailed information was limited**.
- This study looks at **export finance under PSC/PSCFC schemes only**, and doesn't cover other types of business finance or loan products.
- External factors like global trade policy changes, currency risks, and political influences were noted but not deeply analyzed.

2. Review of Literature

2.1 Deshmukh, P., & Shah, R. (2022). Credit risk management in Indian banks: A comprehensive analysis. *Indian Journal of Finance*, **16(5), 55–67. -** This study analysed credit risk management in Indian banks, highlighting that structured renewal processes based on thorough financial analysis are essential for both lenders and borrowers. They stressed that renewal decisions should factor in both past performance and future business potential of exporters, especially in volatile international markets.

2.2 Kumar, R. (2019). Export finance practices in India: A study of packing credit schemes. *International Journal of Financial Management*, **9(3), 23–31.- Kumar (2019)** examined the relevance of Packing Credit (PSC) and Packing Credit in Foreign Currency (PSCFC) schemes in enhancing export performance in India. His findings showed that these schemes are instrumental in reducing exporters' financial burden and maintaining liquidity, especially during periods of fluctuating foreign demand and rising input costs.

2.3 Reserve Bank of India. (2023). *Report on trend and progress of banking in India 2022-23*. **RBI Publications.-** The Reserve Bank of India (2023), in its annual report, noted a decline in export credit disbursement by scheduled commercial banks. It attributed this to rising non-performing asset (NPA) risks and tightening of credit norms. The report emphasized the need for banks to improve their credit appraisal processes while also balancing the liquidity needs of genuine exporters.

2.4 Sharma, N., & Mehta, K. (2021). Working capital management in the Indian gems and jewellery industry. *Journal of Business and Economic Policy*, **8(4), 78–89.-**Sharma and Mehta (2021) studied working capital financing patterns in the Indian gems and jewellery sector, revealing that companies with structured, regularly renewed working capital limits performed better in terms of export volume and profitability than those relying on ad-hoc financing.

2.5 Singh, M., & Arora, S. (2020). Export finance and operational performance of SMEs in India. *International Journal of Commerce and Management Research*, **6(2), 101–110.-**Singh and Arora (2020) explored the relationship between export finance and operational efficiency in small and medium enterprises. Their study highlighted that access to timely working capital not only influences production cycles but also improves the competitiveness of exporters in global markets. They emphasized that disruptions in working capital financing often lead to shipment delays and contract cancellations.

2.6 Brigham, E. F., & Ehrhardt, M. C. (2017). *Financial management: Theory & practice* **(15th ed.). Cengage Learning** highlight the importance of maintaining a balance between profitability and liquidity, noting that efficient financial management practices directly impact a firm's operational efficiency and valuation. Their work supports the use of ratio analysis for credit and investment decisions.

3. Research Methodology

3.1 Research Design

This is a **descriptive and analytical study**. It focuses on analysing past financial performance and observing how credit renewal proposals are processed in a real-world banking environment. The study relies on **secondary data**.

3.2 Period of Study

The financial and operational data reviewed in this study covers a period of **three financial years: 2021-22, 2022-23, and 2023-24**.

3.3 Tools for Data Analysis

To interpret the financial data, commonly used **financial ratios** such as Current Ratio, Debt-Equity Ratio, Profitability Ratios, and Working Capital Turnover were applied. Simple bar graphs and tables were used for visual presentation of data trends.

3.4 Data Collection Methods

Secondary Data:

 The study also makes use of secondary data such as:

- Audited financial statements of Asian Star Ltd. for the past three years.

- Relevant internal documents and credit proposals from IDBI Bank.

- Published articles, RBI reports, and export finance policy updates**.**

4. Data Analysis & Interpretation

4.1 Profile & Growth of Asian Star Company Limited of last 3 years
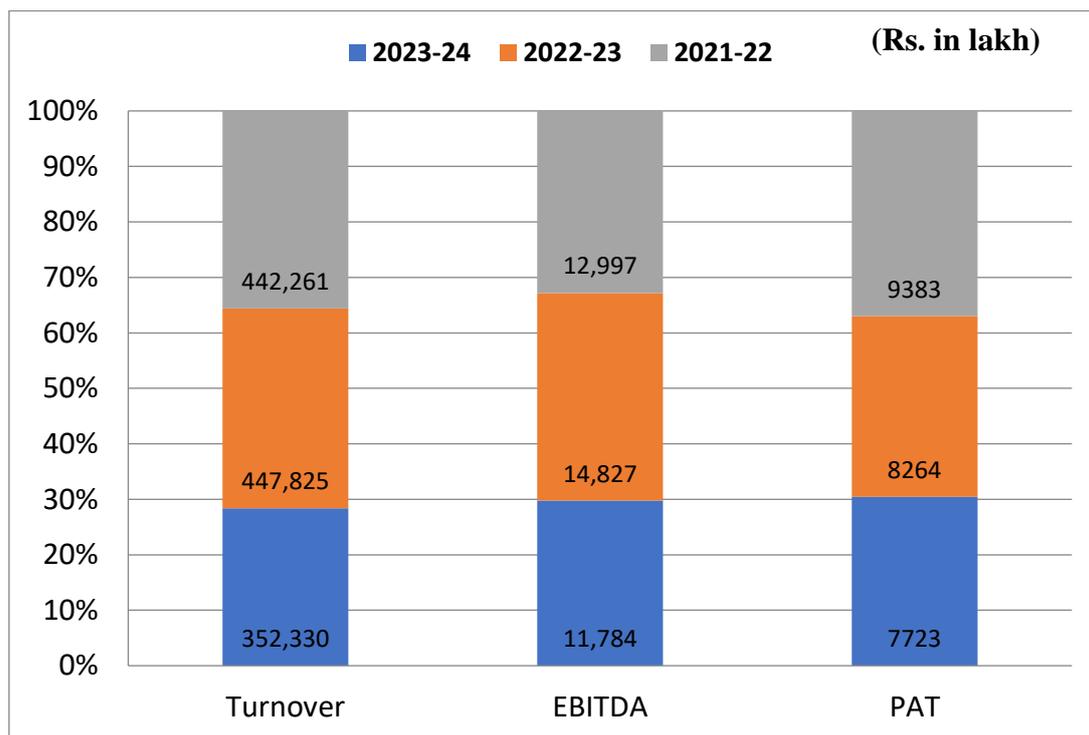
Interpretation:

- The company saw a **21.34% decline in turnover** in FY 2023-24, after maintaining steady turnover levels in the previous two years.

- **EBITDA fell by 20.50%**, reflecting the impact of lower sales and likely increased operating costs or tighter margins.

- **PAT declined by 6.54%,** but the fall is relatively moderate compared to turnover and EBITDA, indicating some cost control or financial management efficiencies.

4.2 Liquidity & Leverage

Asian Star Company Limited

Current Ratio: 2023-24 = 1.81, 2022-23 = 2.4, 2021-22 = 2
Debt Equity Ratio: 2023-24 = 0.69, 2022-23 = 0.67, 2021-22 = 0.72
Debt service Coverage Ratio: 2023-24 = 2.72, 2022-23 = 4.06, 2021-22 = 18.12
ROE (%): 2023-24 = 6.80%, 2022-23 = 6.33%, 2021-22 = 6.86%
ROCE (%): 2023-24 = 7.08%, 2022-23 = 6.12%, 2021-22 = 5.62%
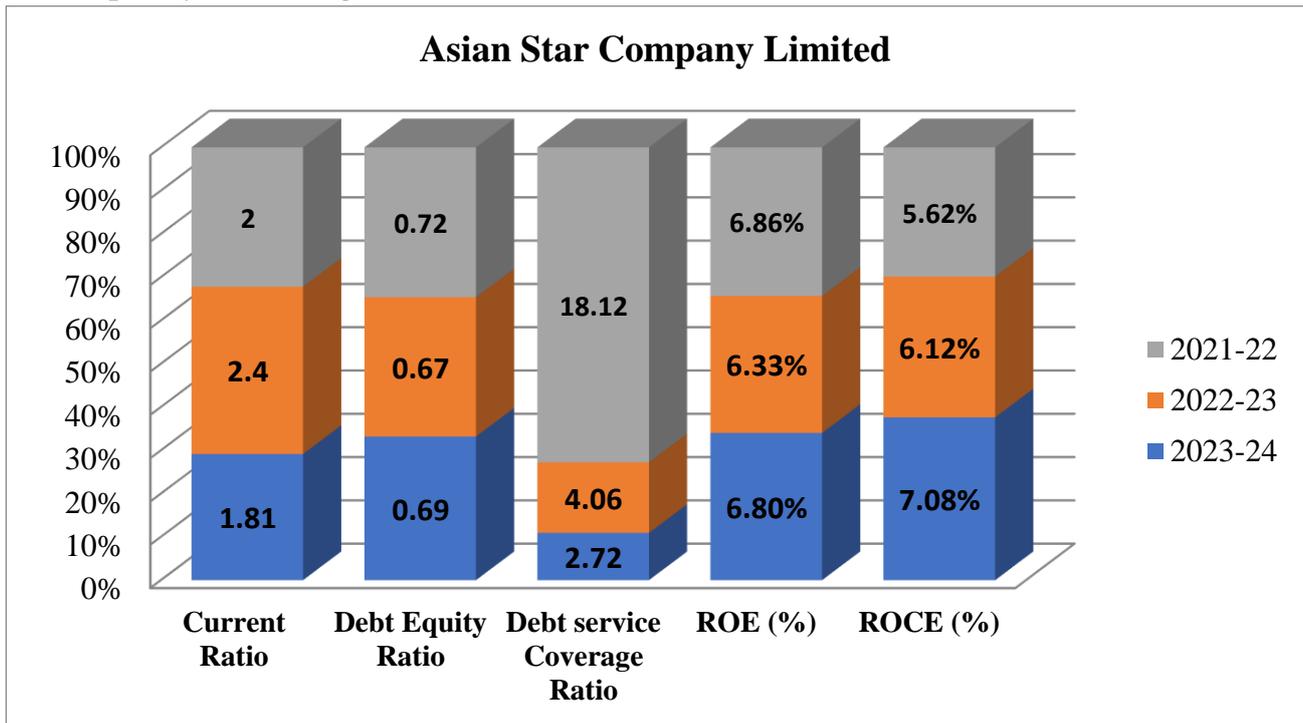
Interpretation:

Asian Star Company Ltd. maintained a stable **Current Ratio** over the three years, indicating consistent short-term liquidity. The **Debt Equity Ratio** stayed moderate, reflecting a balanced capital structure. However, a significant drop in **Debt Service Coverage Ratio (DSCR)** from 18.12 in FY 2021-22 to 2.72 in FY 2023-24 signals reduced debt repayment capacity. **Return on Equity (ROE)** remained steady around 6-7%, while **Return on Capital Employed (ROCE)** improved gradually, showcasing better utilization of capital despite pressure on operational margins.

4.3 Profitability

Asian Star Company Limited

EPS (Rs.): 2023-24 = 48, 2022-23 = 52, 2021-22 = 59
Book Value (Rs.): 2023-24 = 943, 2022-23 = 896, 2021-22 = 821
EBITDA Margin (%): 2023-24 = 3.34%, 2022-23 = 3.31%, 2021-22 = 2.94%
PAT Margin (%): 2023-24 = 2.19%, 2022-23 = 1.85%, 2021-22 = 2.12%
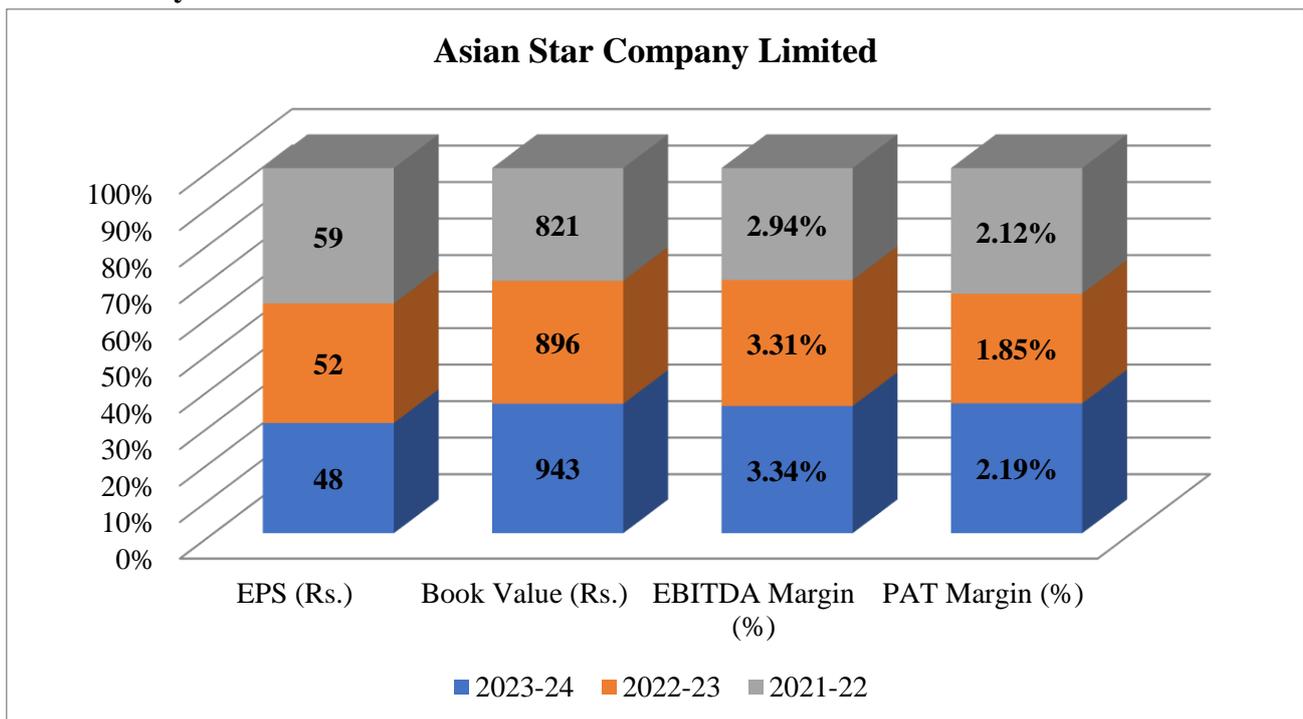
- **Interpretation:**
  EBITDA Margin improved slightly to 3.34% in FY 2023-24 despite falling sales, suggesting operational efficiency gains.

- **PAT Margin increased to 2.19%**, indicating stronger bottom-line management amid declining revenues.

- **EPS fell from ₹59 in FY 2021-22 to ₹48 in FY 2023-24**, in line with the profit trends.

- **Book Value steadily increased**, from ₹821 to ₹943 over three years, reflecting consistent value creation for shareholders despite recent profit pressure.

5. Findings

5.1 Turnover and EBITDA declined in FY 2023-24, indicating a slowdown in business performance compared to previous years.

5.2 Despite falling turnover, **EBITDA and PAT margins improved slightly**, reflecting better operational cost management.

5.3 The company's **Current Ratio remained stable** around 1.7–1.8, indicating consistent short-term liquidity.

5.4 Debt Service Coverage Ratio (DSCR) declined sharply, signaling reduced capacity to comfortably service debt obligations.

5.5 Debt Equity Ratio remained moderate, showing a balanced capital structure with controlled leverage.

5.6 Inventory and Receivables Turnover ratios weakened, suggesting slower inventory movement and delayed receivable collections.

5.7 Return on Equity (ROE) and Return on Capital Employed (ROCE) remained stable or improved, reflecting efficient use of shareholders' funds and capital employed, despite operational challenges.

5.8 The company maintained **financial stability and resilience**, supporting the proposal for **renewal of working capital limits under PSC/PSCFC**

6. Conclusion

6.1 Over the past three financial years, **Asian Star Company Limited** has displayed a mixed performance. While the company experienced a **notable decline in turnover and EBITDA in FY 2023-24**, it managed to protect its profitability margins through effective cost control, reflected in the steady **EBITDA and PAT margins**.

6.2 The company's **liquidity position remained stable**, with a consistent **Current Ratio** around 1.7–1.8. However, operational pressures were visible in the declining **inventory and receivables turnover ratios**, and a significant drop in **Debt Service Coverage Ratio (DSCR)**, indicating reduced debt repayment capacity.

6.3 On the leverage front, the **Debt Equity Ratio** remained moderate and under control. Despite business challenges, **profitability ratios like ROE and ROCE remained stable or improved**, reflecting sound financial management and better capital efficiency.

6.4 In summary, while Asian Star faced headwinds in sales growth and operational efficiency, its controlled leverage, maintained liquidity, and steady profitability ratios highlight a financially resilient structure, supporting its case for the **renewal of working capital limits under PSC/PSCFC at IDBI Bank**.

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EXPLORING THE NUTRITIONAL AND THERAPEUTIC POTENTIAL OF BEETROOT IN FUNCTIONAL BEVERAGES

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Abstract

Beetroot is mainly consumed as a food additive. Malnutrition and anemia are major concerns for adolescent girls. The reproductive years of life and beyond can be severely impacted by inadequate nutrition during adolescence. Beet juice is used to relieve anxiety and is thought to have a blood pressure stabilizing effect. It is thought to enhance athletic performance, reduce blood pressure, and improve blood flow in people with diabetes. Eating beets is advised in cases of gonorrhea due to the diuretic action of beetroot juice, which is occasionally used with Amla juice added. Beetroot juice reduces diabetes, obesity, and heart disease. In addition to relieving stomach pain during periods and preventing anemia by maintaining a normal amount of blood cells, jaggery's high iron and folate content helps adolescents with a variety of menstruation difficulties. Beetroot juice aids in the absorption of iron, which raises blood counts, improves circulation, and increases erythrocytes' ability to carry oxygen.

In summary: Beetroot juice offers numerous potential health benefits, including reduced blood pressure, improved athletic performance, and enhanced nutritional value. However, it's important to be aware of potential side effects and to consume it in moderation as part of a balanced diet

Introduction

When the body's supply of healthy red blood cells is insufcient, anemia can occur. Due to their increased need for dietary iron, adolescents are especially prone to iron deciency anemia. Reduced erythrocyte production, which happens as a result of reduced hemoglobin synthesis, can cause anemia. Two thirds of the body's iron comes from the heme found in hemoglobin. Chromic bleeding and frequent menstruation cause iron loss. Lack of replacement for the stored iron causes hemoglobin to produce less, which causes deciency anemia. Anemia, caused due to lack of iron in the blood, is a common problem these days. If you have been recently diagnosed with iron deciency anemia, here's the best natural remedy for your problem beetroot. Iron is important and can be found in beetroot. Anemia develops when there are not enough healthy red blood cells in the body. Adolescent are particularly susceptible to iron deficiency anemia in view of the increased need for dietary iron. Anemia can result from decreased erythrocyte production which occurs due to decreased Hemoglobin synthesis. Anemia, caused due to lack of iron in the blood, is a common problem these days. If you have been recently diagnosed with iron deficiency anemia, here's the best natural remedy for your problem – beetroot.

Iron is an essential nutrient required for the formation of hemoglobin, a protein present in red blood cells (RBCs) that is responsible for transporting oxygen to various parts of your body. Red beetroots contain critical measure of iron. Devouring beetroots and also drinking juice containing beet helps in recovery of red platelets. Beetroots help in forestalling and rewarding anemia health challenges. It is likewise known to be acceptable home solution for menstrual issues and menopause indications.

Beetroot, especially in juice form, is gaining recognition for its potential health benefits, including improved cardiovascular health, enhanced exercise performance, and potential detoxification effects. This introduction will explore the scientific basis for these claims, focusing on beetroot's unique compounds and their impact on the body.

Review of Literature
1. **Cliffordetal. (2015)**

   In their study, *"The Potential Health Benefits of Beetroot: A Review,"* Clifford et al. examined the nutritional and bioactive properties of beetroot, highlighting its rich content of dietary nitrates, betalains, flavonoids, and vitamins. The authors emphasized that the nitrate content in beetroot could contribute to lower blood pressure and improved cardiovascular health. The paper concluded that beetroot, whether consumed as juice or in whole form, serves as a potent natural supplement with a broad spectrum of health benefits.

2. **Siervoetal. (2013)**

   Siervo et al., in *"Inorganic Nitrate and Beetroot Juice Supplementation Reduces Blood Pressure in Adults: A Systematic Review and Meta-analysis,"* analyzed several clinical trials and found consistent evidence supporting beetroot juice's antihypertensive effects. Their meta-analysis confirmed that beetroot-based drinks could be used as a complementary treatment in blood pressure management, particularly in individuals with prehypertension or stage 1 hypertension.

3. **Jones (2014)**

   In *"Beetroot Juice and Exercise: Pharmacodynamic and Dose-Response Effects,"* Jones investigated how different dosages of beetroot juice affected endurance performance and recovery. The results indicated a dose-dependent relationship, with moderate intake yielding optimal results. The paper emphasized the need for standardized dosing in future research and highlighted the drink's popularity in both recreational and professional sports settings.

4. **Hobbsetal. (2012)**

   Hobbs and colleagues in their paper *"Acute Ingestion of Beetroot Juice Improves Cycling Time Trial Performance and Reduces Blood Pressure in Young Adults,"* conducted an experimental study with cyclists. Their findings showed that not only did beetroot juice improve time trial performance, but it also provided cardiovascular benefits during post-exercise recovery. The dual benefit underscored beetroot juice as a valuable supplement in fitness and health.

5. **Petrovicetal. (2019)**

   In their work titled *"Consumer Perceptions and Acceptance of Beetroot-Based Functional Beverages,"* Petrovic and team explored the market response to beetroot drinks. They found that while many consumers appreciated the health benefits, taste remained a barrier for widespread

adoption. The study suggested the development of beetroot-based blends with other fruit juices to improve palatability and consumer acceptance.

Objectives of the study: -
1. To study the nutritional value of beetroot in functional drinks.
2. To assess beetroot's therapeutic effects (e.g., antioxidant, heart health).
3. To identify challenges in consuming beetroot-based beverages.
4. To explore improvements in formulation and consumer appeal.

Research Methodology

This research adopts a **qualitative research approach** to explore the health benefits, consumer perceptions, and market trends associated with beetroot-based health drinks. The qualitative method is chosen to gain an in-depth understanding of how beetroot is being used in the functional beverage industry and how consumers interpret its health benefits, taste profile, and overall value as a health product.

Data Collection

The data for this study will be collected primarily through **secondary data sources and Primary data source**. Secondary data includes previously published research, reports, and other documented information that provide a comprehensive overview of beetroot's health properties and its place in the healthy drinks market. Primary data include data collection through google form that include the responses of people of different age and culture.

Sources of Secondary Data

- **Academic Journals and Research Papers**
  Peer-reviewed journals from databases such as Google Scholar, PubMed, and ScienceDirect will be reviewed to gather scientific evidence on the nutritional composition of beetroot and its health impacts, particularly in areas such as cardiovascular health, exercise performance, and antioxidant activity.
- **Health and Nutrition Reports**
  Reports and publications from health organizations such as the World Health Organization (WHO), American Heart Association (AHA), and National Institutes of Health (NIH) will be analyzed to contextualize beetroot's functional role in disease prevention and wellness.
- **Case Studies and Product Reviews**
  Real-world examples of beetroot juice brands and products will be studied to understand formulation practices, consumer acceptance, and product innovation in the market.

Data Analysis

The collected **secondary data** will be analyzed through **thematic analysis**, allowing the identification of key patterns and themes such as:
- Health benefits attributed to beetroot
- Scientific consensus vs. commercial claims
- Consumer behavior and preferences
- Challenges in product development (e.g., taste, stability)
- Emerging trends and innovations in the healthy drinks market

The insights derived from this analysis will be synthesized to draw conclusions about the role and impact of beetroot in health-focused beverage consumption.

1. Thematic Coding

The first stage of analysis involves open coding, where key concepts and phrases related to beetroot's health benefits, nutritional components, consumer behavior, and product development will be identified. This step will help form a preliminary codebook, organizing data into manageable themes. Codes will be categorized under broader thematic areas such as:

- Nutritional and bioactive components (e.g., nitrates, betalains, antioxidants)
- Documented health outcomes (e.g., blood pressure reduction, improved stamina)
- Product formulation and marketing (e.g., juice blends, packaging, labeling claims)
- Consumer perception and acceptance (e.g., taste, accessibility, cultural attitudes)

2. Comparative Analysis

Once thematic areas are established, the data will be analyzed comparatively to identify similarities and differences across different sources. For example:

- Comparing scientific literature with commercial product claims to assess alignment or exaggeration
- Evaluating consumer reviews across beetroot drink brands to find common preferences or complaints
- Reviewing market reports from different regions to detect geographic trends in popularity and usage

Primary Data collected through Google Form with 33 respondents that include people of age group more than 18 years that contain student and working people.

Have you ever been diagnosed with anemia (iron deficiency)?
32 responses

- yes
- no

68.8%

31.3%
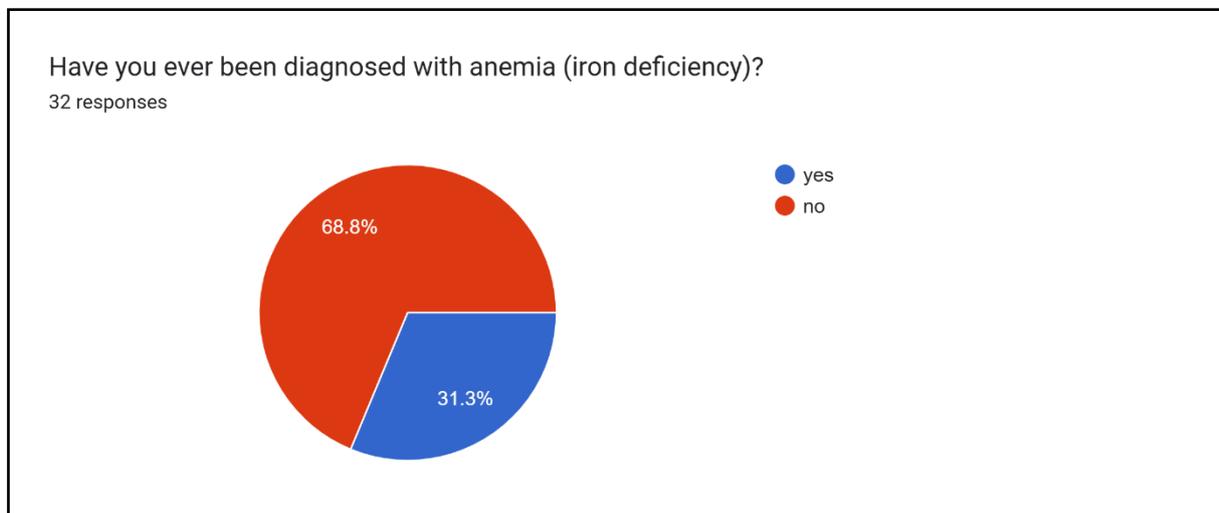
1) From the above data content, it is stated that most of the people are diagnosed with anemia (iron deficiency) that is 68.8%.

Do you experience symptoms such as fatigue, dizziness, or pale skin?
32 responses

- Frequently
- Occasionally
- Rarely

62.5%
15.6%
21.9%
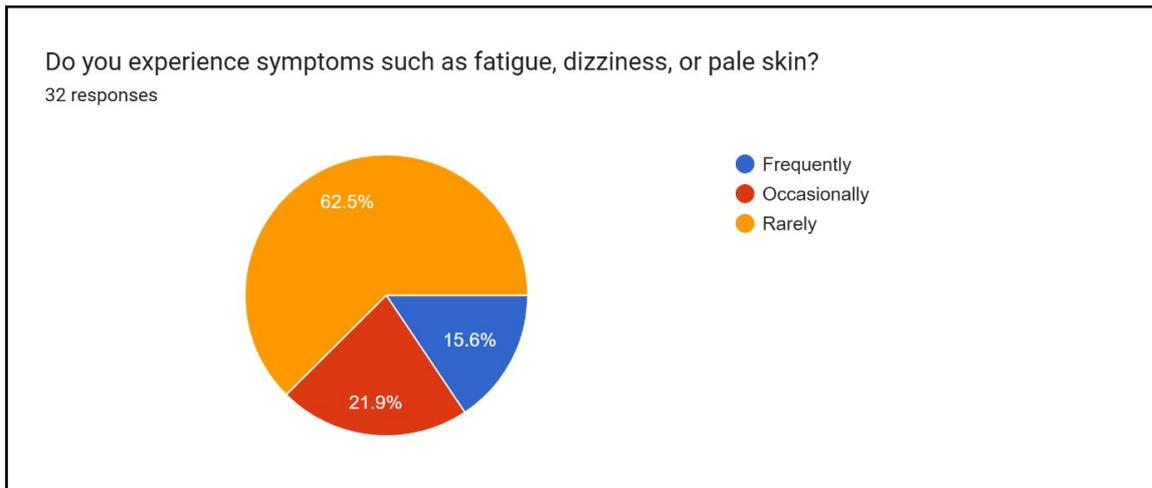
2) From the above data content it is stated that whether it is rarely or frequently all of the had experienced fatigue, dizziness, pale skin.

Have you ever used natural remedies like beetroot to manage these symptoms?
32 responses

- yes
- no

34.4%
65.6%
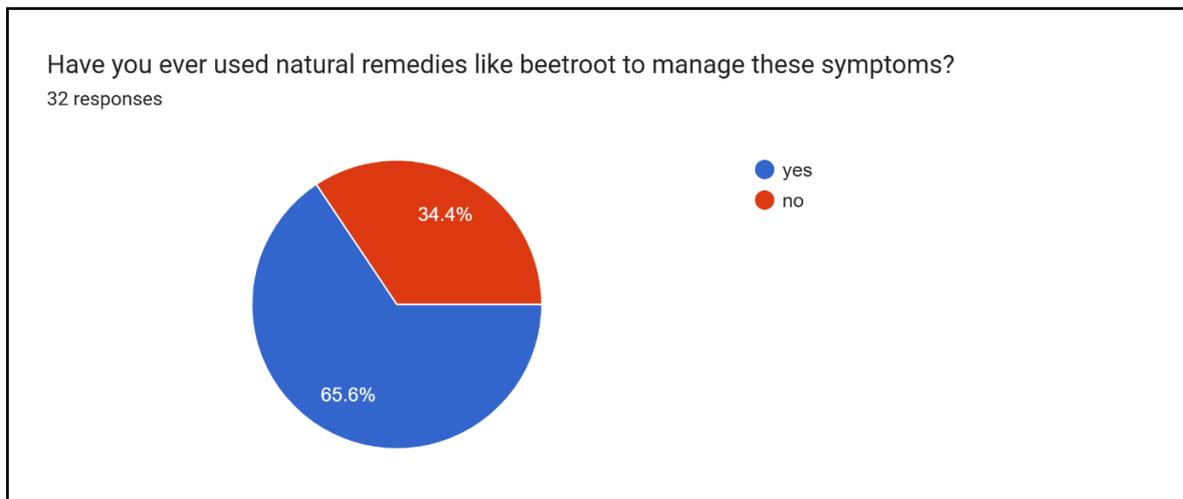
3) From the above data it can be stated that people prefer natural remedies that is homemade to cure the symptoms of fatigue, dizziness, pale skin.

How often do you consume beetroot?
32 responses

- Daily
- 3 - 5 times a week
- 1 - 2 times a week
- Rarely/never

34.4%
46.9%
15.6%
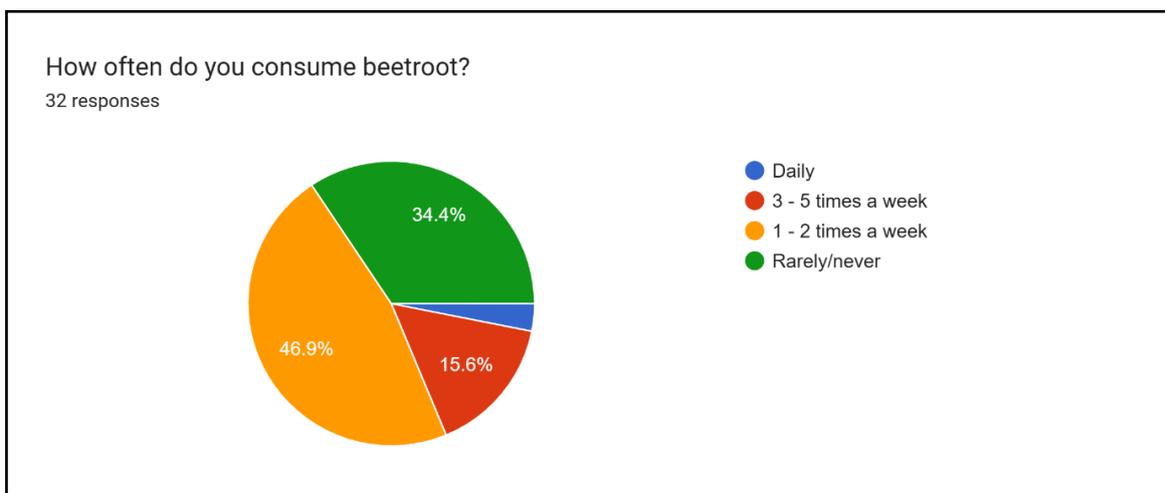
4) From the above data content it is stated that majority of people consume beetroot either 1 or 2 times or they rarely consume it.

What factors influence your decision to include beetroot in your diet?
32 responses

- taste
- health benefits
- other

81.3%
15.6%
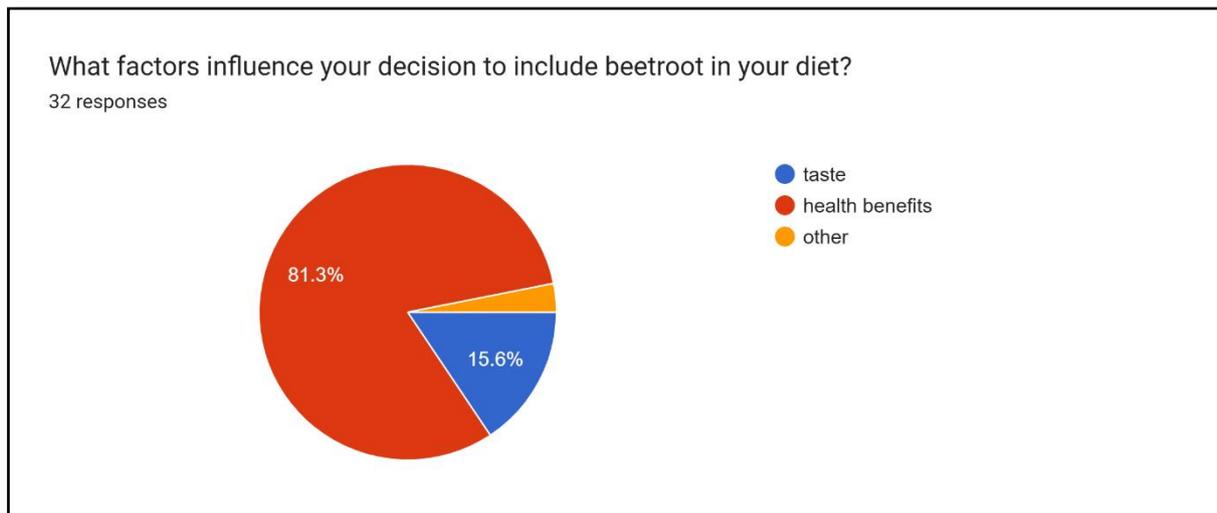
5) From the above data it is stated that people are more likely to consume beetroot for its health benefits and not for its taste as they accept that health is more important than taste.

Data Interpretation

The interpretation of the data collected for this research reveals significant insights into how beetroot-based health drinks are influencing the functional beverage market and public health discourse. Drawing from various secondary sources—including academic studies, health organization reports, market analyses, and case studies—the research identifies key themes around beetroot's nutritional value, health benefits, market acceptance, and challenges in commercialization.

The findings also indicate that beetroot-based drinks are not only promoted for their direct health effects but are increasingly being tied to lifestyle and identity marketing. Social media, health influencers, and wellness blogs often feature beetroot drinks as part of a clean-eating or fitness-oriented lifestyle. This trend supports the idea that consumers value not just the health benefits but also the symbolic value of consuming functional drinks aligned with wellness culture.

However, the data also points to several challenges in the commercialization and widespread adoption of beetroot drinks. High production costs, short shelf life of fresh juice, and the need for cold chain logistics can be limiting factors for market expansion. There are also gaps in consumer education regarding the actual health benefits versus marketing claims. While research supports many health claims, there remains a lack of standardized dosage guidelines for therapeutic benefits, which raises questions about efficacy in commercial products.

Additionally, some studies and market analyses raise concerns about accessibility and affordability, especially in low-income communities where functional drinks may be perceived as luxury wellness products rather than essential health supplements.

The interpretation of the data collected for this research reveals significant insights into how beetroot-based health drinks are influencing the functional beverage market and public health discourse. Drawing from various secondary sources—including academic studies, health organization reports, market analyses, and case studies—the research identifies key themes around beetroot's nutritional value, health benefits, market acceptance, and challenges in commercialization.

Conclusion

Beetroot stands out as a highly nutritious vegetable with a wide range of health benefits. Research has shown that its rich concentration of dietary nitrates and antioxidants can significantly support cardiovascular health, lower blood pressure, improve blood flow, and enhance physical performance. These effects are particularly beneficial for individuals with hypertension or those looking to boost athletic endurance.

Beyond general health benefits, beetroot has been found to exhibit specific therapeutic effects, including anti-inflammatory and cognitive-enhancing properties, which suggest promising roles in managing chronic conditions and age-related decline. However, despite the clear advantages of consuming beetroot and maintaining a healthy diet overall, there are notable challenges. These include socioeconomic barriers, lack of nutritional education, limited access to fresh produce, and the prevalence of processed foods, all of which make it difficult for many people to eat healthily on a consistent basis.

To address these issues, more public health initiatives, community-based nutrition programs, and policy efforts are needed to promote healthier food choices and ensure that nutritious options like beetroot are both accessible and affordable. Looking ahead, future research should continue to explore innovative ways to incorporate beetroot into the diet, investigate its long-term effects, and develop functional foods or supplements that can deliver its health benefits more efficiently. By overcoming current barriers and deepening scientific understanding, beetroot could play an even more significant role in advancing public health and preventive medicine.

Suggestions

For Health Product Developers:

It is recommended that manufacturers and product formulators continue to innovate beetroot-based beverages by improving taste profiles and enhancing nutritional content through natural blending (e.g., with apple, ginger, or citrus). Developers should explore diversified product forms such as beetroot smoothies, shots, and powdered drink mixes to meet varied consumer preferences. Emphasizing cold-pressed, organic, or low-sugar options may also enhance appeal among health-conscious consumers.

For Nutrition Professionals and Healthcare Providers:

Dietitians, fitness trainers, and wellness practitioners are encouraged to educate consumers about the scientifically proven benefits of beetroot—especially for cardiovascular health, exercise performance, and antioxidant support. They should also help establish safe and effective consumption guidelines, particularly for individuals with conditions like hypertension or diabetes. Integrating beetroot into personalized nutrition plans can enhance its functional role in preventive healthcare.

For Researchers and Academia:

Further studies are recommended to examine long-term health outcomes of regular beetroot consumption, especially in populations with chronic diseases. More research is also needed on bioavailability, ideal dosage levels, and interactions with other dietary compounds. Clinical trials comparing different forms of beetroot (juice, powder, capsules) would provide valuable guidance for product development and consumer safety.

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DESIGN AND ASSESSMENT OF A PHYTO-BASED EMULGEL USING GREEN TEA EXTRACT AND LAVENDER ESSENTIAL OIL

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Abstract

Acne vulgaris is a common chronic skin condition characterized by inflammation of the pilosebaceous units. While conventional treatments like antibiotics and retinoids are effective, they often come with undesirable side effects, including skin irritation, bacterial resistance, and teratogenic risks. This research focuses on formulating and evaluating a novel herbal emulgel using Green Tea extract and Lavender oil, targeting acne management with reduced side effects. The formulation utilizes the benefits of both gels and emulsions, making it suitable for the topical delivery of hydrophobic compounds. Evaluations include physical characterization, FTIR analysis, antibacterial testing, and spreadability. The results support the efficacy of this formulation as a safer and effective alternative for acne treatment. In response to these challenges, the present study focuses on the formulation and evaluation of a novel herbal emulgel incorporating green tea extract and lavender oil for the management of acne vulgaris. Green tea extract is rich in catechins, notably epigallocatechin gallate (EGCG), which possess potent antibacterial, anti-inflammatory, and antioxidant properties, capable of inhibiting *C. acnes* and reducing sebum production. Lavender oil, containing active components such as linalool and linalyl acetate, further contributes antimicrobial and soothing anti-inflammatory effects, enhancing the therapeutic profile of the formulation. The product was well-tolerated in preliminary skin irritation assessments, with no adverse reactions observed. These findings suggest that the green tea and lavender oil-based emulgel offers a promising, natural, and effective alternative for the topical treatment of acne vulgaris, potentially reducing reliance on synthetic agents and minimizing the risk of side effects and resistance.

Keywords: Acne vulgaris, green tea extract, lavender oil, herbal emulgel, antibacterial activity, anti-inflammatory, topical therapy.

Introduction

Acne is a chronic inflammatory disease of the pilosebaceous unit that often occurs with anaerobic Propionibacterium acnes (P. acnes). Acne lesions can be subdivided into two major categories: inflammatory lesions, including papules, pustules, cysts, nodules; and non- inflammatory lesions (comedones). Almost 90% of teenagers have an experience of acne lesions during their lifetime and half of them continue to have symptoms as adults, with a 50.9% prevalence rate of acne in women ages 20 to 29 years versus 26.3% in women ages 40 to 49 years. Acne pathogenesis is multifactorial and includes increased sebum and inflammation. Propionibacterium acnes colonizes pilosebaceous follicles and is a major factor in the inflammatory reaction that occurs with acne vulgaris. P. acnes produces lipases, proteases, hyaluronidases, and neutrophil chemotactic factors, which injure tissues and disrupt the follicular wall.

Treatment strategies are based on minimizing keratinocyte hyperproliferation, seborrhoea, colonization by Propionibacterium acnes, and inflammation. Both topical and oral antibiotics or isotretinoin are

traditionally used to treat acne, which many patients tend to be reluctant to use due to their adverse effects. For this reason, researchers are trying to develop new treatment options for acne with fewer side effect Consequently, herbal remedies might become alternative spot treatments for acne. Many studies have been conducted to investigate various ingredients of herbal extracts. Because many herbal extracts have demonstrated clinical efficacy against acne, the compound of multiple herbal extracts may have synergistic effect by targeting various molecular pathway.

In clinical management of acne vulgaris, a considerable number of antibiotics and chemotherapeutic agents are available in the global market as topical or systemic treatment modalities. Topical therapy is preferred as first-line treatment in mild acne whereas for moderate and severe type of acne, systemic therapy is required in addition to topical therapy. The medications have several adverse effects like birth defects, erythema, photosensitivity, allergic dermatitis, excessive skin irritation, urinary problem, joint and muscle pain, headache, depression etc.

Isotretinoin, an oral retinoid medication that is used to treat acne and other cutaneous disorders, is often used in adolescents. It is reported as the most effective acne therapy available. The most concerning side effects are teratogenicity, mucocutaneous events are by far the most common isotretinoin side effect. A study of 2 safety trials revealed that the most common adverse mucocutaneous side effects that patients complained about were cheilitis, chapped lips, dry skin, redness or rash, peeling, dermatitis, itching, epistaxis, mucosal dryness, and dry or irritated eyes. It raises the possibility that subjects who are sensitive to isotretinoin induced effects on the central nervous system, such as headache, may also be susceptible to other neural side-effects

Oral antibiotics used in the treatment of severe acne, grades III and IV, include tetracyclines (tetracycline, doxycycline, minocycline), erythromycin and co-trimoxazole. However, there are several adverse effects associated with tetracycline therapy. It commonly produces gastrointestinal upsets (e.g., vomiting, diarrhoea) and vaginal candidiasis through changes in the mucocutaneous bacterial flora.

Minocycline can cause reversible vestibular disturbance (e.g., dizziness, vertigo and ataxia). Minocycline causes a blue grey discolouration of the skin, particularly in areas that are inflamed.

Herbal medicines are gaining increased popularity due to their advantages, such as better patient tolerance, long history of use, fewer side-effects and being relatively less expensive. These plants are used alone or in combination with synthetic drugs to treat diseases. More importantly, other than consumption as preventive or treatment remedy, they might be accompanied with synthetic drugs to reduce their side effects. Many medicinal plants with anti-inflammation and antibacterial activities are used in different ways in the treatment of acne and other infective diseases.Walnut's leaf (Juglans regia), Agrimonia eupatoria, Syzygium cuminum, Syzygium cuminum,

Green tea extract is obtained from Camellia sinensis. It contains large number of polyphenols in the form of catechins which includes Epicatechin(EC), Epicathechin-3-gallate(ECG), Epigallocatechin(EGC) & Epigallocathechin-3gallate(EGCG). Out of the catechins, most abundant is EGCG. These polyphenols have anti-bacterial, anti-oxidant & ant-inflammatory activities. It has been shown to have effect on mild to moderate acne (non-inflammatory and inflammatory) but does not have any effect on closed comedones. It has also shown to have sebosuppressive effects.

Lavender is an herb native to northern Africa and the mountainous regions of the Mediterranean. Lavender is also grown for the production of its essential oil, which comes from the distillation of the flower spikes of certain lavender species. The oil has cosmetic uses, and it is believed to have some medicinal uses. The herb is highly regarded for skin and beauty and is commonly used in fragrances and shampoos to help purify the skin. It can be purchased over the counter (OTC) from drugstores. There are also many medicinal properties associated with lavender. Lavender oil works to kill bacteria, and this can prevent and heal acne breakouts. It unclogs pores and reduces inflammation when you put it on your skin

Within the major group of semisolid preparations, the use of transparent gels has expanded both in cosmetics and in pharmaceutical preparations. Polymer can function as emulsifiers and thickeners because the gelling capacity of these compounds allows the formulation of stable emulsions and creams by decreasing surface and interfacial tension and at the same time increasing the viscosity of the aqueous phase. In fact, the presence of a gelling agent in the water phase converts a classical emulsion into an emulgel. These emulgel are having major advantages on novel vesicular systems as well as on conventional systems in various aspects. Hydrophobic drugs can be easily incorporated into gels using o/w emulsions. Most of the hydrophobic drugs cannot be incorporated directly into gel base because solubility act as a barrier and problem arises during the release of the drug. Emulgel helps in the incorporation of hydrophobic drugs into the oil phase and then oily globules are dispersed in aqueous phase resulting in o/w emulsion.

Research Objectives

1. To formulate a plant-based emulgel drug delivery system incorporating hydrophobic herbal constituents with proven anti-acne properties.

2. To enhance the therapeutic efficacy against acne vulgaris through a combination of antibacterial, anti-inflammatory, and antioxidant actions, while promoting scar healing and minimizing side effects.

3. To ensure ease of application and improved patient compliance by developing a non-greasy, stable, and cosmetically acceptable topical formulation.

4. To evaluate the formulated emulgel using standard pharmaceutical parameters including: physical appearance, homogeneity, pH, spreadability, extrudability, and drug content uniformity.

5. To assess the antimicrobial efficacy of the emulgel against common acne-causing pathogens such as Propionibacterium acnes and Staphylococcus aureus.

Literature Review

1 **Treatment Modalities for Acne. Fox L, Csongradi C, Aucamp M, du Plessis J 2016 Aug .**Acne vulgaris is a multifactorial skin disorder affecting a significant proportion of adolescents and adults, with pathogenesis involving increased sebum production, follicular hyperkeratinization, microbial colonization (notably by *Cutibacterium acnes*), and inflammation 12. Conventional treatment modalities for acne include topical and systemic antibiotics, retinoids, hormonal agents, and physical therapies. While these approaches can be effective, they are often accompanied by side effects such as skin irritation, dryness, photosensitivity, and, notably, the risk of antibiotic resistance 1. Recent advances in understanding acne pathogenesis have highlighted the roles of hormonal influences, the skin microbiome, and inflammatory pathways, prompting the exploration of targeted and combination therapy

2. Emulgel: an effective drug delivery system. **Talat M, Zaman M, Khan R, Jamshaid M**, **2021 Aug**

the limitations of conventional therapies, there is growing interest in alternative and complementary treatments, particularly those utilizing plant-based actives with established anti-inflammatory and antimicrobial properties. Green tea extract and lavender oil are two such agents that have demonstrated efficacy in acne management due to their antioxidant, antibacterial, and soothing effects.

3. The effects of green tea on acne vulgaris: **Kim S, Park TH, Kim WI, Park S, 2021 Jan** Topical drug delivery remains the preferred route for acne therapy, but the incorporation of hydrophobic herbal actives into traditional gel bases is challenging due to solubility constraints. Emulgel formulations, which combine the advantages of emulsions and gels, have emerged as a promising solution for the topical delivery of both hydrophilic and lipophilic drugs 3. Emulgels offer improved drug loading, stability, controlled release, and enhanced patient acceptability, making them particularly suitable for delivering herbal extracts in acne treatment.

Research Methodology

Formulation Development
Selection of Ingredients: Choose appropriate concentrations of green tea extract (rich in polyphenols like EGCG) and lavender oil, considering their efficacy and safety profiles1.

Emulgel Preparation:
1.Prepare an oil-in-water (o/w) emulsion containing the hydrophobic herbal actives.
2.Incorporate the emulsion into a suitable gel base using gelling agents and emulsifiers
3.Optimize the formulation for stability, viscosity, and ease of application

Evaluation of Emulgel:
Physicochemical Evaluation-
1.Check appearance, color, homogeneity, and phase separation.
2.Measure pH, viscosity, and spreadability
3.Assess drug content uniformity and stability under different storage conditions

In Vitro Release Studies
1.Conduct drug release studies using Franz diffusion cells or similar apparatus to evaluate the release profile of the active ingredients from the emulgel

Table 1: Materials Used in the Experiment

Sr. no	Name of chemicals	Company
1	Green Tea Extract	SHB herbals
2	Lavender oil	Green leaf industries
3	Hyaluronic Acid (Mw – 1.00 MDa)	Meteoric Biopharmaceuticals Pvt Ltd
4	Transcutol	Dr. Bhanuben Nanavati College of Pharmacy
5	Tween 80	Dr. Bhanuben Nanavati College of Pharmacy
6	Sodium Benzoate	Dr. Bhanuben Nanavati College of Pharmacy

7	Ethanol	Dr. Bhanuben Nanavati College of Pharmacy
8	Methanol	Dr. Bhanuben Nanavati College of Pharmacy
9	Dichloromethane	Dr. Bhanuben Nanavati College of Pharmacy
10	Nutrient Agar	Dr. Bhanuben Nanavati College of Pharmacy

Antimicrobial Activity: Test the formulation against acne-causing bacteria such as Propionibacterium acnes and Staphylococcus aureus using agar diffusion or broth dilution methods.

EQUIPMENTS USED

Table 2: Equipment Used in the Experiment

Sr. no	Equipment	Manufacturer
1	Analytical weighing balance	Contech instruments ltd
2	Digital pH meter	Labman
3	Fourier Transform Infrared Spectrophotometer	Perkin Elmer RXI
4	UV-Visible Spectrophotometer	Shimadzu 1800
5	Brookfield Viscometer	Bishops Scientific Pvt. Ltd.
6	Incubation chamber	Meta Lab Scientific Ind.
7	Oven	Meta Lab Scientific Ind.
8	Refrigerator	LG
9	Autoclave	Meta Lab Scientific Ind.
10	Sonicator	Oscar Ultrasonic Pvt. Ltd.
11	Vortex	Labline

Data Analysis
➢ **PREFORMULATION STUDIES**
   CHARACTERIZATION OF DRUG SUBSTANCE/API
- API was characterized for physical parameters like appearance, colour, odour and solubility in various solvents.
- The solubility of drug was determined in various solvents such as water, methanol, ethanol, dichloromethane.

➢ **QUANTIFICATION OF GREEN TEA EXTRACT TOTAL PHENOLIC CONTENT**
   The Folin–Ciocalteu (F–C) assay is one of the most popular assays for phenolic analysis. The principle of the F–C assay is the reduction of the Folin–Ciocalteu Reagent (FCR) in the presence of phenolics resulting in the production of molybdenum–tungsten blue that is measured spectrophotometrically at 765 nm and the intensity increases linearly with the concentration of phenolics in the reaction medium

➢ **FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR)**
   It is a powerful tool for determining types of functional group. The wavelength of light absorbed is the characteristic of the chemical bond. The unique FTIR spectra of pure compound works as a molecular

fingerprint and that's why any changes in the spectra will indicate the change in the chemical structure of the substance. Green Tea Extract sample were scanned over a frequency range 4000-400 cm^{-1}.

FORMULATION DEVELOPMENT- SELECTION OF POLYMER FOR GEL BASE
Emulgels are polymer based. Polymer was selected based on their properties and literature search.

➢ **FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR)**
FT-IR spectra analyses were performed to confirm the chemical nature of polymer used.

➢ **DRUG SURFACTANT COMPATIBILITY STUDIES**
Drug-Surfactant compatibility studies were performed by blending drug and excipients in the ratio of 1:1, making up the volume with water and recording its %Transmittance.

➢ **STABILITY OF EMULSION**
After selecting compatible surfactants, the stability of emulsion was checked by mixing different percent and ratios of Smix in 5% oil and making up the volume by Millipore water.

The Smix ratio was used up to 40% (which is permissible for topical formulation) and was added in 5% of lavender oil and making up the volume by Millipore water.

The prepared emulsion was then subjected to Freeze thaw method where it was kept in a freezer for 24 hrs after which it was kept in oven at 40^{0}C for another 24 hrs.

➢ **PREPARATION OF GREEN TEA EXTRACT AND LAVENDER OIL LOADED EMULGEL**
Hyaluronic acid was selected as polymer and gel base for the formulation. After stability studies of the emulsion and selecting optimized formula, emulgel was prepared by mixing 5% lavender oil (500mg), 20% of 1:1 ratio of Smix (1g Transcutol : 1g Tween80), and 75% water (7.5g) of which 4g was used to swell different concentration of Hyaluronic acid i.e. 2%(0.2g), 2.5%(0.25g), 3% (0.3g), 3.5% (0.35g) and 4%(0.4g) and 3.5g of water was added to the emulsion which contained 2g of Green Tea Extract and 0.3g of Sodium benzoate as preservative.

➢ **CHARACTERIZATION OF GREEN TEA AND LAVENDER OIL EMULGEL PHYSICAL PARAMETERS**
Physical parameters such as color, odour and appearance were recorded.

VISCOSITY
Viscosity of the emulgel was measured using a digital Brookfield viscometer using spindle no. 64 at a speed of 50rpm.

➢ **SPREADABILITY**
Spreadability was determined by the apparatus which consists of a wooden block, which was provided by a pulley at one end. By this method, spreadability was measured on the basis of slip and drag characteristics of gels. An excess of gel (about 2 g) under study was placed on the ground slide. The gel was then sandwiched between this slide and another glass slide having the dimension of fixed ground slide and provided with a hook. A 1 kg weight was placed at the top of the two slides for 5 min to expel

air and to provide a uniform film of the gel between the slides. Excess of the gel was scrapped off from the edges. The top plate was then subjected to pull of 100 g with the help of string attached to the hook, and the time (in seconds) required by the top slide to cover a distance of 7.5cm was noted. A shorter interval indicated better spreadability.

➢ **PH:** The pH of the formulation should be close to the skin pH to avoid any irritation. The pH of the Emulgel was determined using a pH meter. The electrode was dipped in the gel and pH was recorded.

➢ **HOMOGENICITY:** The formulations were tested for their homogenicity by visual appearance after the emulgel applied as a thin layer on the slide.

➢ **WASHABILITY:** Formulations were applied on the skin and then ease and extent of washing with water were checked manually.

➢ **EXTRUDABILITY STUDY** The gel formulations were filled into collapsible metal tubes or aluminium collapsible tubes.The tubes were pressed to extrude the material and the extrudability of the formulation was checked.

➢ **FOURIER TRANSFORM INFRARED SPECTROSCOPY ANALYSIS:**FT-IR spectra analyses were performed to confirm the chemical nature of green tea extract loaded emulgel. The FTIR spectral analysis can also be used to assess the chemical composition of the drug and polymers in raw form, and to evaluate the probable interactions between the compounds in prepared film

➢ **ANTIBACTERIAL EVALUATION:**Agar well diffusion method was used for this purpose.Bacillus subtilis strains were used for the study. Bacterial cultures were poured to the freshly prepared nutrient media and stirred properly so that there would a uniform distribution of the culture all over the media. The media was poured in sterilized petri dishes and the media was stand still and allowed to solidify. Then, with the help of sterile cork borer wells were made in the petri dishes of 6mm diameter each, to which the prepared formulations were added and allow the drug to spread in the media. Then it was incubated for 24 hours at 37^0C. The diameter of zone of inhibitions were observed and with the help of ruler was measured (in mm).Here, in the study standard streptomycin was used for the comparison.

➢ **IN-VITRO ANTIOXIDANT ACTIVITY :** Free radical scavenging activities of green tea extract were incited using 2,2-diphenyl-l- picrylhydrazyl (DPPH) assay method. DPPH assay was performed for green tea extract and were compared against ascorbic acid as the control. 2ml of 0. 1mM DPPH radical solution was mixed with 1ml of various test concentrations. The absorbance of these test solutions was measured at 517nm after 30min. The % scavenging activity was calculated using the following equation

➢ **IN-VITRO DIFFUSION STUDY-** The optimised gel and marketed formulation were subjected to diffusion study to quantify the amount of drug release through membrane using dialysis membrane. Study was conducted on a Franz diffusion cell using 22 ml of receptor compartment and dialysis membrane. The receptor compartment was filled with Phosphate Buffer pH 5.5+ Ethanol (1:1). The temperature of the cell was maintained at 37°C + 0.5°C with constant stirring at 100 rpm. 2 gram of gel

equivalent to 10 mg green tea extract was placed in the donor compartment and covered. Sampling was performed at regular intervals (1, 2, 3, 4, 5 and, 6 hours), filtered and analysed for drug content by UV spectrophotometry.

➢ **STABILITY STUDIES OF EMULGEL FORMULATION-** Stress studies were conducted by storing the optimized formulation at different temperature conditions. Each formulation was stored in sealed glass containers in different temperature zones 3months .Refrigerator: 5oC +/- 3°C (3 months) Long term stability studies: 25°C +/- 2°C/ 60% RH +/- 5% RH (3 months) Accelerated temperature: 40°C +/- 2°C/ 75% RH +/- 5% RH (3 months) After the stability studies the sample will be evaluated for any physical change, drug content, viscosity

Data interpretation
CHARACTERIZATION OF DRUG SUBSTANCE/API LAVENDER OIL

Table 9: Physical Parameters of Lavender Oil

PARAMETERS	RESULTS
Appearance	Slightly Viscous Oil
color	Pale Yellow
Odour	Characteristic odour

SOLUBILITY
Table 10: Solubility of Lavender Oil in Solvents

SOLVENT	SOLUBILITY
Water	Insoluble
Ethanol	Sparingly Soluble
Methanol	Sparingly Soluble
Dichloromethane	Soluble
Methanol:Dichloromethane	Soluble

GREEN TEA EXTRACT
Table 11: Physical Parameters of Green Tea Extract

PARAMETERS	RESULTS
Appearance	Fine powder
color	Greenish brown
Odour	Characteristic odour

SOLUBILITY

Table 12: Solubility of Green Tea Extract in Solvents

Solvents	Solubility
Water	Soluble
Methanol	Soluble
Ethanol	Soluble
Dichloromethane	Insoluble

> ## TOTAL PHENOLIC CONTENT
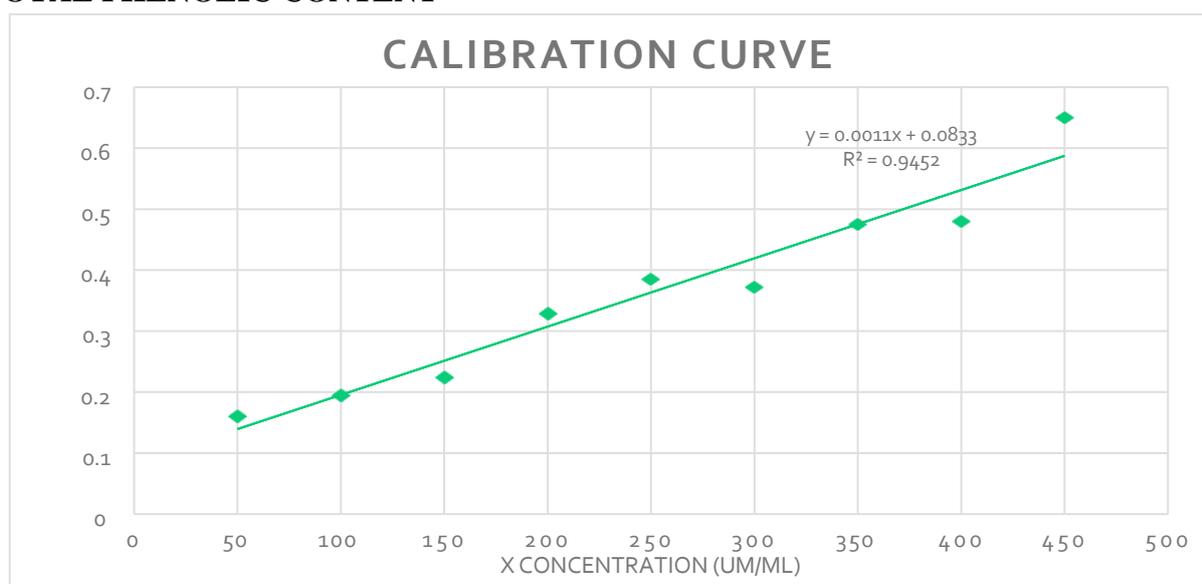
Fig 4: Calibration curve of Total Phenolic Content of Green Tea
The Total Phenolic Content of the green tea extract was found to be 978 mg GAE/g

FOURIER TRANSFORM INFRARED SPECTROSCOPY ANALYSIS
GREEN TEA EXTRACT
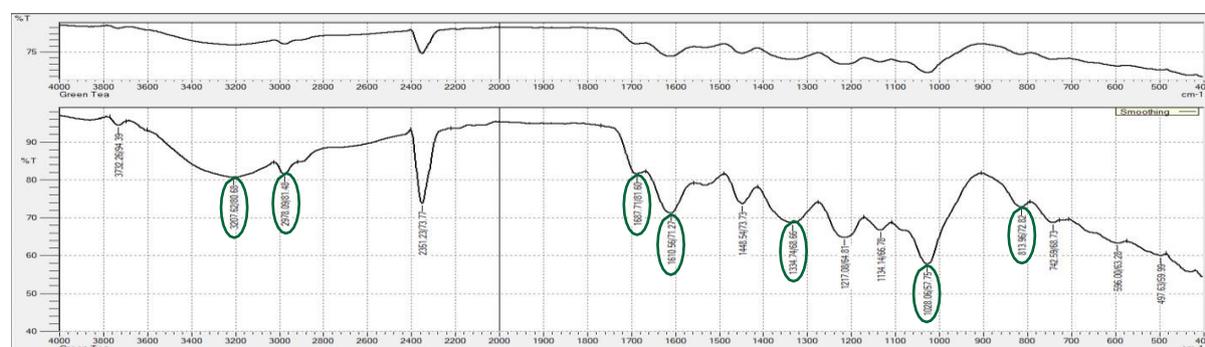
Fig 5: FTIR Spectrum of Green Tea Extract

In the IR spectrum of green tea, the band at 3207 cm–1 is due to stretching vibrations of O–H groups in water, alcohol and phenols and N–H stretching in amines. The C–H stretch in alkanes appear at 2978 cm-1. The strong band at 1610 cm–1 is attributed to the C=C stretch in aromatic ring and C=O

stretch in polyphenols. The C–N stretch of amide in protein gives the band at 1334 cm–1. The C–O–C stretching in polysaccharides gives a band at 1687 cm–1 and C–O stretching in amino acid causes a band at 1028 cm–1. Finally, the weak band at 813 cm–1 is the result of C–H out of plane bending.

Thus, from the IR spectrum it can be observed that green tea sample is rich in polyphenols, carboxylic acid, polysaccharide, amino acid, and proteins.

SELECTION OF POLYMER FOR GEL BASE
Hyaluronic acid was selected as the gel base as it not only helps to reduce the acne but also helps the skin to heal and recover from acne scars.

FOURIER TRANSFORM INFRARED SPECTROSCOPY ANALYSIS
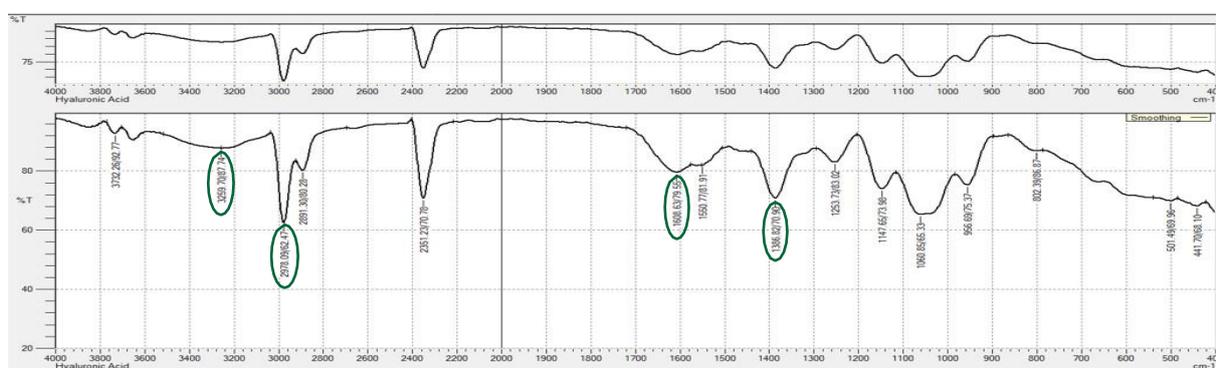
Fig 6: FTIR Spectrum of Hyaluronic Acid

The FTIR spectra of the Hyaluronic acid is shown in fig above. The strong band at approximately 3259 cm^{-1} can be attributed to hydrogen-bonded O-H and N-H stretching vibrations of the N-acetyl side chain. A group of overlapping bands of moderate intensity is observed at approximately 2978 cm^{-1} due to the C-H stretching vibrations. The bands at 1608 and 1386 cm^{-1} can be attributed to the asymmetric (C = O) and symmetric (C-O) stretching modes of the planar carboxyl groups in the hyaluronic acid

STABILITY OF EMULSION Out of all the mixtures prepared, the one with 20% 1:1 Smix (1g transcutol and 1g Tween 80), 5% lavender oil and 75% Millipore water with green tea extract found to be most stable after freeze thaw method

PREPARATION OF GREEN TEA EXTRACT AND LAVENDER OIL LOADED EMULGEL
Out of all the batches, Batch G2 gave a clear and good viscous gel which was considered as the final batch for evaluation.

➢ **PHYSICAL PARAMETERS**

Sr. No.	Parameters	Results
1	Color	Brownish green color
2	Appearance	Non staining, non-greasy gel
3	odour	Characteristic odour

4	Viscosity	Viscous
5	Spreadability	150g.cm/sec
6	pH	5.8

Table 14: Evaluation of Physical Parameter of Formulated Emulgel

WASHABILITY -The formulation washes of easily with water without leaving a greasy layer.

EXTRUDABILITY STUDY
The extrusion of the gel from the tube is an important during its application and in patient acceptance. Gels with high consistency may not extrude from tube, whereas low viscous gels may flow quickly, and hence, suitable consistency is required to extrude the gel from the tube. Extrudability of emulgel formulations was found to be good.

ANTIBACTERIAL EVALUATION:
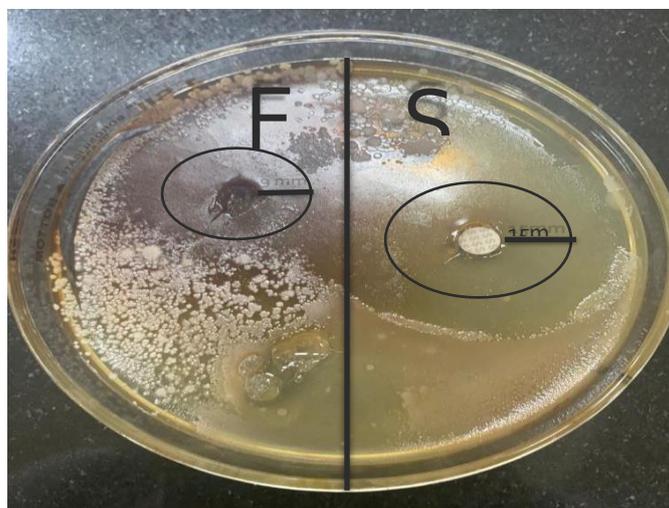
Anti-bacterial assay was taken of the formulation and is shown in fig below,The zone of inhibition of the prepared emulgel was found to be 9mm of the patch and that of standard streptomycin was found to be 15mm.

The patch shows good antibacterial activity

Conclusion
Topical application of gels at pathological sites offers great advantages in faster release of drug directly to site of action as compared to cream and ointment. Nowadays, Emulgels have been widely used as a vehicle for topical delivery of hydrophobic drugs. Extracts of plants and herbs with specific medicinal properties can be incorporated in this dosage form as active ingredients in order to additional benefits.

The formulated batch was brownish green, non-greasy, non-staining, viscous emulgel whose pH was found to be 5.8 and spreadability was 150 g.cm/sec. It was homogeneous, non-gritty, showed good washability, extrudability and anti-bacterial property. Therefore, it can be concluded that the prepared formulation could be a promising anti-acne treatment, showing less side effects as compared to as traditional drugs.

It can be further explored by using various herbal extracts and oils or synthetic drugs in combination with herbal extracts.

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THE QUANTUM THREAT TO CYBERSECURITY: A REVIEW OF CRYPTOGRAPHIC BREAKDOWN AND POST-QUANTUM COUNTERMEASURES

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Abstract

This research paper investigates the profound implications of quantum computing on classical cryptographic systems and explores viable post-quantum alternatives. We examine how quantum computing fundamentally challenges the security assumptions of current cryptographic infrastruc- ture, particularly through quantum algorithms such as Shor's and Grover's, which threaten both asymmetric and symmetric encryption schemes. The paper provides a systematic anal- ysis of vulnerable cryptosystems, including RSA, ECC, and various public-key infrastructures that form the backbone of modern digital security. We present a detailed examina- tion of emerging post-quantum cryptographic approaches, with particular emphasis on lattice-based algorithms, hash- based signatures, code-based cryptography, and multivariate polynomial systems. The comparative analysis evaluates these methods based on security guarantees, computational effi- ciency, and implementation feasibility. Additionally, we discuss NIST's standardization efforts and the critical importance of cryptographic agility in facilitating the transition to quantum- resistant protocols. The paper also considers the practical challenges of migrating existing systems to post-quantum alternatives and the potential timeline for quantum threats to materialize. Our findings indicate that while quantum computing poses significant threats to current cryptographic paradigms, the development of robust post-quantum alter- natives offers promising paths forward, though requiring substantial infrastructure adaptation and international coop- eration. This research contributes to the ongoing dialogue about securing digital communications in the quantum era and provides actionable insights for organizations planning their cryptographic transition strategies.

Introduction

The advent of quantum computing represents one of the most transformative technological advancements of the 21st century. While it promises breakthroughs in optimization, material science, and artificial intelligence, it simultaneously poses existential threats to the foun- dational elements of modern cybersecurity. At the heart of this disruption lies the quantum computer's potential to break widely used classical cryptographic systems that secure everything from internet transactions and financial systems to government and military communications.

Classical public key cryptographic schemes—such as RSA and Elliptic Curve Cryptography (ECC)— derive their security from the computational difficulty of problems like integer factorization and discrete logarithms[1] . These problems are considered intractable by classical comput- ers, enabling secure

communication in the digital era. However, quantum algorithms such as Shor's algorithm can efficiently solve these problems, rendering these en- cryption methods obsolete in a post-quantum world. Additionally, Grover's algorithm can weaken symmetric cryptosystems by accelerating brute-force attacks.

Recognizing these vulnerabilities, researchers have ini- tiated the development of Post-Quantum Cryptography (PQC)—cryptographic systems that can withstand attacks from both classical and quantum adversaries. These in- clude lattice-based cryptography, hash-based signatures, code-based schemes, multivariate polynomial systems, and more. The field is rapidly evolving, bolstered by the ongoing efforts of the National Institute of Standards and Technology (NIST), which is leading a global initiative to standardize quantum-resistant algorithms.

This paper presents a comprehensive review of the chal- lenges and opportunities presented by quantum comput- ing to classical cryptographic infrastructure. It synthesizes current research on quantum threats, surveys leading PQC alternatives, and evaluates their comparative performance and implementation readiness. Furthermore, it addresses the concept of cryptographic agility—an organization's ability to adapt to evolving cryptographic standards—as a crucial factor in future-proofing cybersecurity systems. Through this exploration, the paper aims to contribute to the global discourse on transitioning to secure crypto- graphic protocols in the approaching quantum era.

Literature Survey

A. Introduction Quantum computing has emerged as a transformative force in computational science, capa- ble of solving certain classes of problems exponentially faster than classical machines. This capability presents a fundamental threat to widely used cryptographic al- gorithms such as RSA and Elliptic Curve Cryptography (ECC), which rely on the intractability of factorization and discrete logarithms. Quantum algorithms—most notably **Shor's algorithm** and **Grover's algorithm**—render these assumptions obsolete, endangering the confidentiality and integrity of global digital infrastructure [1], [2].

In response, researchers have accelerated the devel- opment of **Post-Quantum Cryptography (PQC)**—a new class of cryptographic algorithms designed to resist attacks from quantum adversaries. This section reviews sixteen seminal papers that examine the theoretical breakdown of classical cryptographic schemes and explore viable PQC alternatives [3]–[9].

B. Quantum Threats to Classical Cryptography

The foundational risk posed by quantum computing stems from **Shor's algorithm**, which can factor large integers and compute discrete logarithms in polynomial time—breaking RSA and ECC [1], [7]. **Grover's algorithm**, while less catastrophic, provides a quadratic speed-up for brute-force attacks, effectively halving the security of symmetric schemes like AES [2].

Mavroeidis et al. [1] and Li et al. [7] provide compre- hensive analyses of how quantum algorithms compromise current cryptographic assumptions. Sood [6] emphasizes the urgency of migration, drawing attention to the *"harvest now, decrypt later"* strategy, whereby encrypted data is stored now for future quantum decryption. Wright [3] and Sibi et al. [8] further underline the need for proactive cryptographic adaptation across industry and government sectors.

C. Emergence of Post-Quantum Cryptographic Techniques

In response to these emerging threats, the cryptographic community has developed several classes of quantum- resistant algorithms. Among them, the most prominent include:

- **Lattice-Based Cryptography:** Considered the leading PQC candidate, this approach is grounded in hard problems from high-dimensional lattices, such as the **Shortest Vector Problem (SVP)** and **Learning With Errors (LWE)**, which remain resistant to both classical and quantum attacks [4], [5]. Easttom [5] provides a comparative study, highlighting their practical imple- mentation and robust security features.

- **Code-Based Cryptography:** Originating from the McEliece scheme in the 1970s, these systems depend on the difficulty of decoding general linear error- correcting codes. While they boast strong resistance to quantum attacks, their large public keys present deployment challenges [6]. Sood [6] explores the fea- sibility of code-based systems in various operational contexts.

- **Hash-Based Signatures:** Well-suited for digital signa- ture applications, these rely on the collision resistance of cryptographic hash functions. Merkle tree-based signature schemes, such as XMSS and SPHINCS+, offer provable security under minimal assumptions and are considered ready for near-term adoption [4], [9].

These PQC techniques are currently under rigorous eval- uation by the **National Institute of Standards and Tech- nology (NIST)**, which is in the process of standardizing post-quantum cryptographic protocols [9].

OBJECTIVE

The objective of this paper is to investigate the evolving threat posed by quantum computing to contemporary cryptographic systems and to review the leading post- quantum cryptographic (PQC) approaches being devel- oped as countermeasures. Specifically, the paper aims to:

- Analyze how quantum algorithms, particularly Shor's and Grover's, compromise classical cryptographic schemes such as RSA, ECC, and AES.
- Examine the strategic implications of quantum threats, including the "harvest now, decrypt later" scenario.
- Survey the most promising classes of PQC algo- rithms—namely lattice-based, code-based, and hash- based schemes—and assess their practicality, security guarantees, and implementation challenges.
- Provide a comparative evaluation of current literature and standardization efforts, particularly those led by institutions like NIST, to support the migration to quantum-resistant cryptographic infrastructure.

By achieving these goals, the paper seeks to contribute to the cybersecurity community's understanding of the quantum threat landscape and inform decision-making around cryptographic readiness for the post-quantum era.

Research Methodology

A. Proposed Framework: Hybrid Cryptographic Transition Architecture (HCTA)

1) Introduction: As quantum computing continues to evolve, the threat it poses to existing cryptographic sys- tems becomes increasingly imminent. Although Post- Quantum Cryptography (PQC) offers promising

alterna- tives, the transition from classical to quantum-resistant protocols presents significant operational, compatibility, and security challenges. To address this transitional gap, we propose a Hybrid Cryptographic Transition Architec- ture (HCTA) — a theoretical framework designed to facili- tate secure, scalable, and phased migration from classical to post-quantum cryptographic systems.

2) Motivation: The majority of existing digital infras- tructure is built upon classical cryptographic schemes such as RSA, ECC, and DSA.[7] With quantum algorithms like Shor's rendering these schemes obsolete, it becomes essential to ensure that security mechanisms remain ro- bust during the migration period. However, immediate full-scale adoption of PQC is neither feasible nor prac- tical due to ongoing standardization efforts, performance trade-offs, and interoperability issues. HCTA is motivated by the need for a gradual, backward-compatible solution that maintains confidentiality and integrity even in hybrid environments.

3) Architecture Overview: HCTA advocates for a dual- layer encryption and authentication model during the transitional phase. Each cryptographic transaction—be it for key exchange, digital signatures, or secure communica- tion—operates under two parallel cryptographic schemes: one classical and one post-quantum.

a) Key Exchange Example::
- RSA/ECC used alongside Kyber or NTRU.[4]
- Session keys are derived from both, and either are combined or used redundantly.

b) Digital Signatures::
- A classical signature (e.g., RSA-2048) is paired with a PQC signature (e.g., Dilithium).
- Both signatures are transmitted and verified for re- dundancy.

c) Secure Channels::
- TLS configurations support dual suites (e.g., RSA + PQC KEM).
- Applications negotiate cipher preferences with a quantum-aware policy layer.

4) Theoretical Benefits[5]:
- Cryptographic Agility: Systems can dynamically adjust between classical and PQC algorithms as standards mature.

- Backward Compatibility: Ensures legacy systems can still operate while PQC capabilities are introduced incrementally.

- Quantum-Readiness Without Full Migration: Organi- zations gain quantum resilience without committing to untested PQC solutions.

- Layered Defense: Even if one cryptosystem is com- promised (classical or PQC), the second provides an additional barrier.

5) Application Scenarios:
- National Security Communication: Ensures continued secrecy of classified communications even after a potential RSA collapse.

- Financial Institutions: Transactions protected under both systems reduce risks of future replay or decryp- tion attacks.

- Cloud Services: Dual encryption for storage ensures confidentiality even if files are harvested today and decrypted by quantum attackers later.

Implementation of HCTA*:*

1) Overview:

1) We demonstrated real world application of HCTA using a client-server model having hybrid RSA-Kyber key exchange system along with AES encryption.

2) By doing this we simulated secure communication where both classical and post-quantum algorithms are used together to achieve protection against quantum attacks and at the same time without abandoning legacy systems.

3) Libraries we used:

- PyCryptodome for RSA and AES
- liboqs for Kyber implementation
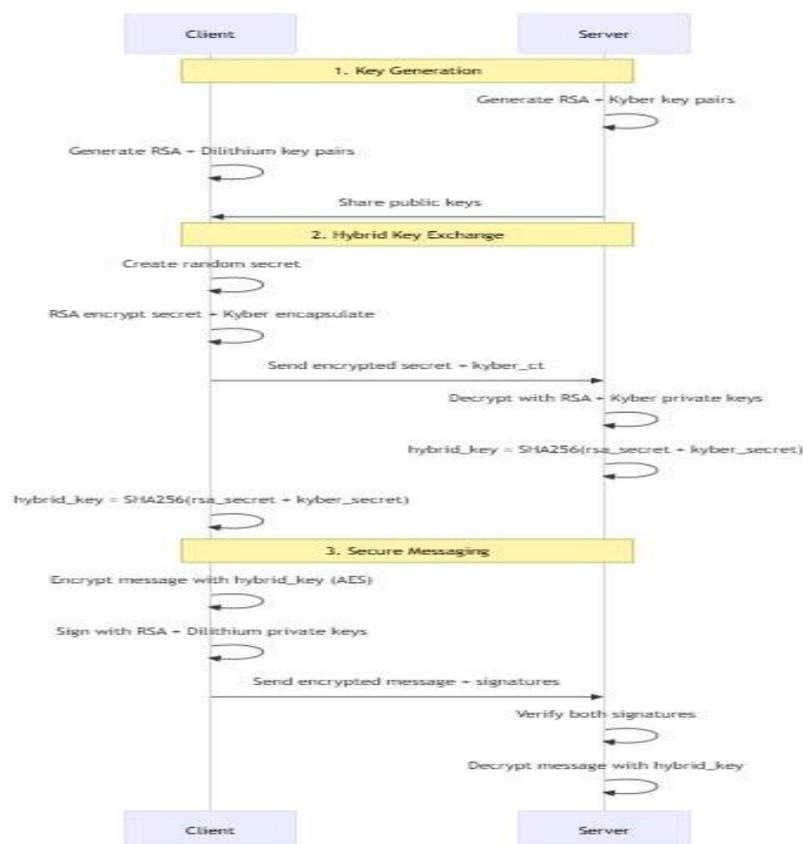
Fig. 1. The HCTA Process

2) System Architecture (Fig 1):

1) Key Generation
   a) Server generates public and private RSA and Kyber keys.
   b) Client generates public and private RSA and Dilithium keys (for digital signature).

2) Key Exchange
   a) The client generates a random secret and en- crypts it using the server's RSA public key.
   b) The client generates another random secret and encrypts it using the server's Kyber public

        key.

    c) Client then sends both to the server.

    d) The server uses its RSA private key to decrypt the session key.

    e) The server uses its Kyber private key to decap- sulate and retrieve the session key.

    f) The server combines the two secrets to form a hybrid session key (using SHA-256).

3) Message Encryption

    a) Using the derived hybrid session key, the client encrypts the message using AES encryption.

    b) The client signs the message using its RSA private key.

    c) The client signs the message using its Dilithium private key.

    d) Client then sends encrypted message along with the RSA signature, Dilithium signature, and the AES-encrypted message to the server.

    e) The server verifies the RSA signature using the client's RSA public key

    f) The server verifies the Dilithium signature us- ing the client's Dilithium public key.

    g) The server decrypts the message using the hybrid session key.

4) Simulating MITM Attacks

    a) In this implementation, we simulate a Man-in- the-Middle (MITM) attack to demonstrate the vulnerability of classical cryptosystems (RSA) and how the hybrid system mitigates these threats.

    b) The attacker intercepts the public keys (RSA + Kyber) sent by the server and replaces them with malicious keys.

    c) The client unknowingly encrypts secrets using the attacker's keys, which would normally allow the attacker to decrypt or modify the commu- nication.

    d) However, the hybrid approach (RSA + Kyber) prevents the attacker from successfully deriving the session key because one of the encryption layers (Kyber) will fail if tampered with.

Data Interpretation and Performance Evaluation

This section interprets the results of our experimental benchmarks and evaluates the feasibility of adopting a Hy- brid Cryptographic Transition Architecture (HCTA), which combines classical and post-quantum algorithms.

1)   *Benchmark Setup:* To measure the computational efficiency of HCTA, a Python-based benchmarking script was developed using **PyCryptodome** (for RSA and AES) and **liboqs** (for Kyber). Benchmarks were executed on a standard **Apple M1 MacBook** within a **Python 3.11 vir- tual environment**, targeting the following cryptographic operations:

- RSA (as a classical algorithm),
- Kyber (as a post-quantum candidate),
- AES (for symmetric encryption),
- Hybrid key derivation using SHA-256.

Interpretation and Analysis: The benchmark- ing results indicate that **Kyber's performance is su- perior to RSA** in key generation and compara- ble in encryption/decryption-like operations (encapsula-

tion/decapsulation). This supports the feasibility of tran- sitioning to post-quantum cryptographic schemes without significant computational trade-offs.

Additionally, **AES remains highly efficient**, making it suitable for payload encryption after a hybrid key has been derived.

The **HCTA model**, which combines the strengths of RSA, Kyber, and AES, proves to be **both secure and computationally efficient**. The minimal overhead intro- duced by Kyber, in particular, reinforces its candidacy for widespread adoption in post-quantum cryptographic infrastructures. This confirms that **hybrid cryptographic systems** can be practically deployed for secure communi- cations even before large-scale quantum threats material- ize.

Future Scope

While our implementation of HCTA successfully demonstrates secure hybrid communication using RSA, Kyber, and Dilithium, several areas remain open for future exploration:

- Our current system uses RSA and Dilithium for digital signatures. Future versions could explore other stan- dardized post-quantum signature schemes like FAL- CON and SPHINCS+,[9] each offering unique trade- offs in terms of speed, signature size, and implemen- tation complexity.

- The server currently does not authenticate itself back to the client. Introducing digital signatures for server public keys or integrating certificate-based authenti- cation would strengthen the trust model.

- Extending this hybrid approach into TLS (Transport Layer Security) could provide a pathway to real-world deployment in secure web applications.

- Additional benchmarks can be performed under net- work load, with larger message sizes and across different hardware architectures to validate scalability and efficiency in production-grade systems.

- Future work could simulate more sophisticated at- tacks, such as side-channel or chosen-ciphertext at- tacks, and explore how well the hybrid model resists them.

Cryptographic Operation	Time (seconds)
RSA Key Generation	0.132966
RSA Encryption	0.001350
RSA Decryption	0.000918
Kyber Key Generation	0.002497
Kyber Encapsulation	0.000037
Kyber Decapsulation	0.000011
Hybrid Key Derivation (SHA-256)	0.000017
AES Encryption	0.000022
AES Decryption	0.000012

TABLE I
Average runtime of cryptographic operations

2) **Performance Results:** The average time (in seconds) taken for each operation is summarized below:

Conclusions

The transition to the quantum era presents both a formidable challenge and a unique opportunity for the field of cybersecurity. This paper explored the vulner- abilities of classical cryptographic systems in the face of quantum computing advancements and emphasized the importance of Post-Quantum Cryptography (PQC) as a necessary countermeasure. Through our proposed Hybrid Cryptographic Transition Architecture (HCTA), we demonstrated a practical and phased approach to secur- ing communications during this transition period. Our client-server implementation, which combined RSA and Kyber for hybrid key exchange and AES for data confi- dentiality, showcased how classical and quantum-resistant algorithms can coexist to enhance security and maintain backward compatibility.

Additionally, our simulation of a man-in-the-middle (MITM) attack highlighted the limitations of classical cryptography and the resilience provided by hybrid cryp- tographic schemes. Benchmarking results einforced the feasibility of this approach with acceptable performance trade-offs. As the standardization of PQC progresses, frameworks like HCTA serve as a stepping stone toward fully quantum-resistant infrastructure. Future work may include integrating advanced post-quantum authentica- tion mechanisms and optimizing hybrid protocols for broader deployment.

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A STUDY OF ETHICS AND PRIVACY IN AI-DRIVEN TALENT MANAGEMENT IN INDIA

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Abstract: Artificial intelligence (AI) is increasingly affecting the future of talent management and is promising a number of tools that improve efficiency, accuracy, and decision-making. AI systems can analyses very large datasets to find the qualified candidate, avoid human bias, and promote diversity in hiring decisions. In talent management, AI's ability goes beyond performance evaluation, skill development, and retention strategies. This paper explores the ethical and privacy challenges associated with the integration of artificial intelligence (AI) into talent management practices. As AI becomes more prevalent in recruitment, performance evaluation, and employee development, concerns arise over data protection, algorithmic bias, fairness, transparency, and employee autonomy. The study aims to highlight these issues, review current regulatory frameworks, and offer practical recommendations for ethical AI implementation in human resource management.

Keywords: Artificial intelligence, talent management, recruitment, data, privacy, ethical issues, etc.

Introduction:

In recent years, the integration of Artificial Intelligence (AI) into Talent Management systems has transformed human resource (HR) practices across the globe. From automating resume screening to predicting employee attrition and personalizing learning and development, AI-driven tools promise unprecedented efficiency and objectivity in managing human capital. In India, this digital transformation is gaining momentum, with startups and established enterprises alike adopting AI-powered solutions to optimize workforce planning and performance management. However, this shift raises critical concerns about ethics, fairness, accountability, and privacy—areas that are not yet fully addressed in current organizational practices or regulatory frameworks.

AI systems, when deployed without sufficient safeguards, risk reinforcing existing social and economic inequalities. For example, AI models trained on biased historical data can perpetuate discrimination in hiring decisions, potentially affecting candidates based on gender, caste, or socioeconomic background. Similarly, employee surveillance technologies and algorithm-based performance evaluations raise questions about consent, autonomy, and the psychological well-being of workers. These concerns are especially pertinent in the Indian context, where workplace diversity, digital literacy, and legal protections for data privacy vary widely.

Despite the growing adoption of AI in talent management, there remains a significant gap in both academic literature and corporate policy addressing the ethical and privacy implications of these technologies in India. This research aims to critically examine the ethical challenges and privacy risks associated with AI-

driven HR practices in India. It explores how organizations are responding to these challenges, assesses the effectiveness of emerging legal frameworks—particularly the Digital Personal Data Protection Act, 2023—and offers recommendations for building a more transparent, equitable, and responsible AI ecosystem in human resource management.

By focusing on the Indian labor market and regulatory environment, this study contributes to the broader discourse on ethical AI implementation and provides valuable insights for HR professionals, technology developers, policymakers, and academics.

Literature Review:

The adoption of Artificial Intelligence (AI) in human resource management (HRM) has been a focal point of global research, with growing attention to the ethical and privacy implications of these technologies. This section synthesizes key literature on AI applications in talent management, ethical concerns surrounding algorithmic decision-making, and the evolving landscape of data privacy, with a particular emphasis on the Indian context.

AI is increasingly used in various HR functions, including recruitment, onboarding, performance appraisal, and workforce planning. According to Upadhyay and Khandelwal (2018), AI enables data-driven decision-making in talent acquisition and performance monitoring, enhancing efficiency and reducing operational costs. Tools such as applicant tracking systems (ATS), sentiment analysis engines, and predictive analytics are now commonly employed by Indian firms, especially in the IT and BFSI sectors.

However, as Tambe, Cappelli, and Yakubovich (2019) note, the effectiveness of these systems often hinges on the quality and diversity of training data. If the data reflect historical biases—such as preferences for certain colleges, gender, or language fluency—then the AI outputs are likely to perpetuate these inequities. This risk is particularly acute in India, where systemic social hierarchies often influence employment practices.

One of the most pressing ethical concerns is algorithmic bias. Eubanks (2018) argues that AI systems, far from being neutral, often replicate existing social prejudices. In the Indian context, this is particularly dangerous given the prevalence of caste and gender discrimination in hiring. A study by Deekshith and Raj (2021) highlights how AI-based tools in India, trained on limited and homogeneous datasets, can produce discriminatory outcomes in recruitment and appraisal.

Transparency and explainability are also central concerns. Binns et al. (2018) argue that many AI systems function as "black boxes," offering little insight into how decisions are made. This lack of transparency can erode employee trust and accountability within organizations. In India, where awareness of digital rights remains low, employees are often unaware of how their data is being used or evaluated.

Accountability is another critical issue. Mittelstadt et al. (2016) discuss the "responsibility gap" created when human decision-makers rely heavily on AI outputs. In Indian organizations, where HR professionals may lack technical expertise, there is a growing dependence on third-party AI vendors, further complicating accountability and ethical oversight.

The collection and analysis of personal data in AI-driven HR systems raise serious privacy concerns. McKinsey's 2020 report on data ethics stresses the importance of obtaining informed consent, anonymizing data, and limiting data collection to what is necessary. In India, the situation is compounded by the delayed and fragmented regulatory approach to data privacy.

The enactment of the Digital Personal Data Protection (DPDP) Act, 2023 marks a significant step toward safeguarding individual privacy. However, scholars like Sinha and Sharma (2023) argue that the Act's implementation mechanisms are still unclear, and enforcement remains weak. Additionally, many Indian companies—especially SMEs and startups—lack the resources or awareness to comply with such regulations effectively.

Objectives of the Study:
- To examine the scope and applications of AI in talent management practices in India.
- To investigate the ethical challenges posed by AI-driven HR systems.
- To assess employee and employer perceptions of privacy in AI-enabled HR processes.
- To provide recommendations for developing ethical and privacy-conscious AI frameworks in HR management.
- To evaluate the existing legal and regulatory framework related to AI and data privacy in India.

Limitation of study:
1. The data was collected over a short period of time
2. The results depend on how honestly the respondents have answered.
3. There was a lack of data, recent surveys and statistics, related to the topic
4. The data collected from the survey focuses more on the people from Mumbai and less from other parts of the country.

Research Hypothesis:
H0: There is no significant relationship between the use of AI in talent management and employee perceptions of ethics and privacy.
H1: The use of AI in talent management significantly influences perceptions of ethical practices and privacy among employees in Indian organizations.

Research Methodology:
This study adopts a mixed-methods research design to holistically explore the ethical and privacy implications of AI in talent management within Indian organizations. The approach combines both qualitative and quantitative techniques to ensure a nuanced understanding of stakeholder perspectives, technological applications, and policy frameworks.

This research is primarily descriptive explanatory in nature. Data were collected in the second part of the research using the primary data collecting method via online questionnaires
- **Sample Design:** This research targets every person HR professionals, AI solution providers, and employees working in organizations that use AI in HR functions.
- **Sample Size:** Approximately 50–150 respondents across sectors (IT, BFSI, manufacturing, services).

- **Sampling Method:** Stratified purposive sampling to include representation from startups, MNCs, and public sector enterprises.
- **Tool:** Structured questionnaire with Likert-scale, multiple choice, and open-ended questions.

Findings & Discussions:

Responses were collected from 150 professionals working in HR or as employees under AI-based talent management systems.The primary quantitative data collection tool in this study was a structured questionnaire containing multiple **Likert scale items**. Respondents were asked to indicate their level of agreement with various statements related to ethics, fairness, transparency, and data privacy in AI-driven HR systems. A standard **5-point Likert scale** was used:

1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

Table 1.1

Statement	Mean	Std. Dev.
"I believe AI tools used in recruitment are fair and unbiased."	2.8	1.1
"My organization clearly communicates how AI-based decisions are made."	2.5	1.0
"I am concerned about how my personal data is used by HR AI tools."	4.2	0.9
"I trust AI tools more than human judgment in performance evaluation."	3.1	1.2
"I am aware of data privacy rights under the DPDP Act, 2023."	2.7	1.3

From the above table 1.1 it can be seen that Most respondents are **concerned about data privacy** (Mean = 4.2), indicating strong discomfort with current practices.There is **low trust in the transparency of AI systems** (Mean = 2.5) **Awareness of legal rights** under the DPDP Act is limited (Mean = 2.7), suggesting a gap in compliance education.

The Likert scale analysis reveals strong employee concerns about privacy, moderate skepticism toward AI fairness and transparency, and low legal awareness. These quantitative results support the qualitative findings and validate the research hypotheses regarding ethical and privacy risks in AI-driven talent management in India.

Reliability Analysis:

The researcher has undertaken Reliability Analysis using Cronbach's Alpha (α). The closer the value of Cronbach's Alpha (α) to 1, higher is the reliability of the items under consideration. Cronbach's Alpha (α) of 0.7 and above is considered to be 'Good', 0.80 and above is considered to be 'Better' and 0.90 and above is considered to be the 'Best'.

To ensure consistency of Likert items grouped under a common construct (e.g., **perceived fairness**, **privacy concerns**, **legal awareness**), **Cronbach's Alpha** was calculated:

- **Fairness and Bias** items: $\alpha = 0.78$
- **Privacy and Data Use** items: $\alpha = 0.82$
- **Legal Awareness** items: $\alpha = 0.71$

A Cronbach's Alpha above **0.70 indicates good internal consistency.**

Conclusion

This study highlights the complex ethical and privacy challenges associated with AI-driven talent management systems in India. While AI technologies offer significant potential to enhance HR efficiency and objectivity, their current implementation reveals substantial gaps in transparency, fairness, and employee privacy protections.

Employees often remain unaware of AI's role in HR decisions, facing increased risks of data misuse and algorithmic bias, particularly among marginalized groups. Simultaneously, limited understanding and enforcement of the Digital Personal Data Protection Act, 2023, hinder organizations from fully realizing ethical AI adoption.

To foster a trustworthy and equitable talent management ecosystem, Indian organizations must prioritize transparency, data privacy, and employee empowerment. Policymakers, employers, and AI developers need to collaborate closely to establish robust ethical frameworks and regulatory oversight that safeguard rights while leveraging AI's benefits.

The findings underscore the urgent need for a balanced approach that integrates technological innovation with responsible governance to ensure AI's positive impact on India's workforce.

COLLEGE STUDENT SATISFACTION WITH QUILLBOT USAGE IN THE MIRA-BHAYANDER AREA

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Abstract

QuillBot is an AI-driven writing tool that helps users improve their written communication through features such as paraphrasing, synonym replacement, grammar correction, and summarization. Widely used among students and academic professionals, QuillBot aims to improve writing efficiency, clarity, and overall quality. Its user-friendly interface and customizable writing modes make it an appealing tool for educational purposes. With increasing reliance on digital tools for academic tasks, understanding how specific features of QuillBot influence student satisfaction can offer valuable insights into its effectiveness and relevance in student learning environments.

The study investigates the behavior of college students using QuillBot in the Mira Bhayander area. Using purposive sampling, 50 students who used QuillBot were selected, and data was collected using a structured questionnaire. Primary data was obtained through surveys, while secondary data was drawn from academic literature. The Chi-square test was employed to test hypotheses regarding the association between various aspects of QuillBot and student satisfaction. The results revealed significant associations between satisfaction and features, including usage frequency, accuracy, ease of use, and paraphrasing. However, the summarizer feature showed no significant impact on satisfaction. These findings highlight the importance of core functionalities in shaping students' perceptions and overall satisfaction with QuillBot.

Keywords: Students, Satisfaction, Quill Bot

QuillBot is an AI-powered writing tool that enhances users' writing abilities by providing automated support for paraphrasing, sentence restructuring, grammar checking, and vocabulary enhancement in multiple languages. It offers various writing modes; such as Standard, Fluency, and Creative giving users control over tone and style. The grammar checker corrects spelling, punctuation, and syntax errors in real time. A synonym slider allows users to adjust the level of synonym replacement according to their needs. The Summarizer feature helps shorten long articles or essays into concise summaries. The Sentence Rephraser and Co-Writer tool enhances the writing process by suggesting coherent and engaging alternatives. QuillBot offers a user-friendly interface and integrates smoothly with Google Docs, Microsoft Word, and web browsers. Its premium version unlocks additional features such as increased word limits, faster processing, and more writing modes. Thus, QuillBot serves as a comprehensive writing companion designed to enhance productivity, creativity, and linguistic accuracy.

Objectives of the study

Objectives of the study are as follows:

1. To examine whether there is a significant association between students' frequency of using QuillBot, their perceptions of accuracy and ease of using QuillBot and their overall satisfaction with QuillBot.
2. To determine whether there is a significant association between students' perceptions of specific QuillBot features (Paraphrasing and Sentence Restructuring, and Summarizer) and their overall satisfaction with QuillBot.

Literature Review

A review of the literature provides a comprehensive overview of previous research relevant to the topic of study. It helps in identifying research gaps, theoretical frameworks, and key findings that guide the current investigation. The overviews of existing literature guiding the current study are as follows:

Frequency of Use

QuillBot is frequently utilized in both undergraduate and postgraduate settings, with students reporting regular use to improve their writing quality (Amanda et al., 2023). Students expressed a behavioral intention to continue using QuillBot, indicating frequent engagement with the tool (Rahmani, 2023).

Perceived Accuracy

Users generally perceive QuillBot as an accurate tool for grammar correction and paraphrasing. Studies have shown that students and professionals alike find the tool's output to be reliable and of high quality, particularly in terms of grammatical accuracy and sentence clarity (Gurbuz, 2024) (Fithriani, 2023). However, some users have noted that the tool's paraphrasing capabilities may occasionally produce less natural-sounding sentences, particularly when dealing with complex or nuanced content (Chanpradit et al., 2024).

Perceived Ease of Use

QuillBot is widely regarded as an easy-to-use tool, featuring a user-friendly interface that enables even novice students to navigate its features with minimal difficulty. The tool's simplicity and accessibility make it a valuable resource for students who are new to academic writing or who require assistance with grammar and paraphrasing (Thohir et al., 2024) (Rahmani, 2023). Furthermore, the tool's instant feedback and real-time suggestions provide users with a seamless and efficient writing experience (Gurbuz, 2024) (Fithriani, 2023).

Paraphrasing and Sentence Restructuring

QuillBot excels in paraphrasing and sentence restructuring, which are critical components of academic and professional writing. The tool primarily employs synonym substitution and word-level changes to rephrase sentences, although it also demonstrates some capability in sentence restructuring (Chanpradit et al., 2024). This feature is particularly useful for avoiding plagiarism and enhancing the originality of written content. However, studies suggest that while QuillBot is effective in basic paraphrasing, it may lack the sophistication required for complex sentence restructuring, which can sometimes result in less natural-sounding sentences (Chanpradit et al., 2024).

Summarizer

QuillBot's summarizer can summarize extensive documents, making it easier to extract key insights from large volumes of text (Asmitha et al., 2024).

Satisfaction Levels

Overall, students express high levels of satisfaction with QuillBot. The tool's ability to improve writing quality, combined with its ease of use, makes it a popular choice among students and professionals. Many students appreciate the time-saving features of QuillBot, as it allows them to quickly and efficiently enhance their writing without the need for extensive manual revisions (Thohir et al., 2024) (Rahmani, 2023). Additionally, the tool's user-friendly interface and intuitive design contribute to a positive user experience (Rahmani, 2023) (Bakri et al., 2024).

Research gap

QuillBot has been shown to enhance students' ability to articulate ideas clearly and systematically (Susanti et al., 2024). It encourages students to engage more with their writing tasks, fostering a more interactive learning environment. Despite the growing adoption of QuillBot among students, limited empirical research exists on how individual features influence student satisfaction. Existing studies often focus on general usability without isolating specific functionalities such as AI summarization. There is a lack of student-centric evaluation that links perceived accuracy and ease of use with satisfaction levels. This gap calls for a focused investigation into students' perceptions of specific features and their impact on overall satisfaction.

Hypotheses of the study

Based on insights drawn from the existing literature, specific hypotheses are formulated to test the proposed relationships.

1. Frequency of Using QuillBot and Overall Satisfaction

H_0: There is no significant association between the frequency of using QuillBot and students' overall satisfaction.

H_1: There is a significant association between the frequency of using QuillBot and students' overall satisfaction.

2. Perceived Accuracy and Overall Satisfaction

H_0: There is no significant association between the perceived accuracy of QuillBot and students' overall satisfaction.

H_1: There is a significant association between the perceived accuracy of QuillBot and students' overall satisfaction.

3. Perceived Ease of Use and Overall Satisfaction

H_0: There is no significant association between the perceived ease of use of QuillBot and students' overall satisfaction.

H_1: There is a significant association between the perceived ease of use of QuillBot and students' overall satisfaction.

4. Paraphrasing and Sentence Restructuring and Overall Satisfaction

H_0: There is no significant association between the perceived usefulness of the Paraphrasing and Sentence Restructuring feature of QuillBot and students' overall satisfaction.

H_1: There is a significant association between the perceived usefulness of the Paraphrasing and Sentence Restructuring feature of QuillBot and students' overall satisfaction.

5. *AI Summarizer and Overall Satisfaction*

H_0: There is no significant association between the perceived usefulness of the Summarizer feature of QuillBot and students' overall satisfaction.

H_1: There is a significant association between the perceived usefulness of the Summarizer feature of QuillBot and students' overall satisfaction.

Research Methodology

The study employs both descriptive and inferential research methods to examine the behavior and responses of college students using QuillBot in Mira Bhayander. Purposive sampling, a non-probability sampling technique, was used to select a sample where participants were selected based on a specific characteristic of QuillBot usage. A structured questionnaire, designed using a Likert scale, was distributed to a sample of 50 students using QuillBot. Primary data was collected through surveys, while secondary data was gathered from relevant academic sources. To analyze and validate the hypotheses, the Chi-square test was used as the primary statistical tool.

Results and Discussions

Table 1: Cross-tabulation of frequency of using QuillBot by students, their perception of the accuracy and ease of use of QuillBot and their overall satisfaction

Overall Satisfaction	Frequency of using QuillBot					Perceived Accuracy				Perceived Ease of Use			
	Always	Often	Sometimes	Occasionally	Total	Always	Sometimes	Never	Total	Very Easy	Somewhat easy	Less easy	Total
Highly Satisfied	8	12	1	1	22	17	5	0	22	20	2	0	22
Moderately Satisfied	9	8	0	3	20	11	9	0	20	17	3	0	20
Somewhat Satisfied	0	0	4	2	6	1	4	1	6	4	1	1	6
Not Satisfied	0	0	1	1	2	0	1	1	2	1	0	1	2
Total	17	20	6	7	50	29	19	2	50	42	6	2	50

(Source: Primary Data)

The table depicted that highly and moderately satisfied students predominantly used QuillBot frequently and perceived it to be 'always' accurate and 'very easy' to use. Students who perceived QuillBot as less accurate and less easy to use experienced lower satisfaction, leading to reduced usage of the tool.

Table 2: Cross-tabulation of students' perception of the features of QuillBot and their overall satisfaction

Overall Satisfaction	Paraphrasing and Sentence Restructuring					Summarizer				
	Extremely Useful	Moderately Useful	Slightly Useful	Not at all useful	Total	Extremely Useful	Moderately Useful	Slightly Useful	Not at all useful	Total
Highly Satisfied	14	7	1	0	22	5	2	9	6	22
Moderately Satisfied	10	8	1	1	20	2	5	8	5	20
Somewhat Satisfied	1	2	3	0	6	1	1	3	1	6
Not Satisfied	1	0	0	1	2	0	0	1	1	2
Total	26	17	5	2	50	8	8	21	13	50

(Source: Primary Data)

The table evaluates how students of varying satisfaction levels perceive the usefulness of the paraphrasing and sentence restructuring, and summarizer tools of QuillBot. Effective restructuring of text strongly contributes to students' satisfaction, possibly due to its direct impact on improving writing clarity and originality. The very low count of 'Not at all useful' supports the tool's overall reliability and acceptance for paraphrasing and sentence restructuring.

Table 2: Result of Chi-Square Test

Null Hypothesis	Chi-Square test Statistic	df	p-value	Result
H_0: There is no significant association between the frequency of using QuillBot and students' overall satisfaction.	33.4715	9	0.0001	Rejected
H_0: There is no significant association between the perceived accuracy of QuillBot and students' overall satisfaction.	22.0156	6	0.0012	Rejected
H_0: There is no significant association between the perceived ease of use of QuillBot and students' overall satisfaction.	15.938	6	0.01409	Rejected
H_0: There is no significant association between the perceived usefulness of the Paraphrasing and Sentence Restructuring feature of QuillBot and students' overall satisfaction.	25.6582	9	0.002	Rejected
H_0: There is no significant association between the perceived usefulness of the Summarizer feature of QuillBot and students' overall satisfaction.	4.1972	9	0.898	Accepted

The table highlights that various aspects of QuillBot such as frequency of use, perceived accuracy, ease of

use, and usefulness of key features are significantly associated with students' overall satisfaction. However, the usefulness of the summarizer feature showed no significant association with satisfaction suggesting its less influence on students' satisfaction compared to other features.

Conclusion

Paraphrasing and Sentence Restructuring emerged as key contributors to satisfaction, while the summarizer was less useful to the students. Overall, students' satisfaction appears to be significantly influenced by the perceived utility of tools that directly enhanced their writing skills and corrected their writing.

Limitations and Recommendation

The study is limited by its small sample size of 50 students, which may not represent the broader student population. Additionally, the use of purposive sampling may introduce selection bias, affecting the generalizability of the findings.

While QuillBot offers substantial benefits, concerns about over-reliance on AI tools in academic writing persist. Critics argue that such dependence may hinder the development of essential writing skills, signifying a balanced approach to integrating AI in educational settings (Sethuraman, 2023). Therefore, it is recommended that students critically evaluate and refine AI-generated content to ensure high-quality writing. Additionally, educators should guide students in using such tools responsibly to maintain academic integrity and develop their writing abilities independently.

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THE IMPACT OF MINDFULNESS PRACTICES AND ITS RELATION WITH WORKPLACE OUTCOMES

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Abstract

Mindfulness has grown from an obscure subject to an immensely popular topic.This research aims to determine the impact of mindfulness practices and its relationship with workplace outcomes. Due to transition and transformation in the society .Various aspects of society including workplace such as long working hours, poor communication, overwhelming loads, resistance to change, personality clashes and lack of recognition etc has affected workplace culture it results in hindering the productivity level and create a negative work environment. The purpose of this Study is to provide an overview of the impact of mindfulness practices at workplace and to identify its outcomes at individual level, as an employee, job, work, productivity level and organizational levels. This research uses Literature review method as a methodology for conducting research and offers an overview of the previous research done in this field and try to fill the gap and give researchers a scope for future study. Currently, there is growing enthusiasm for mindfulness research, and mindful-based training programs are conducted and gaining popularity in the workplace to reduce stress, improve employee well-being and boost output.

Mindfulness can be described as a 'present-focused consciousness' (Hyland, Lee & Mills, 2015). In other words, a mindful individual is not ruminating about the past or worrying about future.

Simply, workplace mindfulness is the degree to which individuals are mindful in their work setting (Dane & Brummel, 2013). What, then, does it mean to be mindful? Well, like so many constructs in positive psychology, mindfulness is not easily defined future; they are simply "being" in the here and now.

Secondly, mindfulness includes paying close attention to both internal and external stimuli (Hyland et al., 2015). Finally, as well as simply paying attention to stimuli, mindfulness involves doing this in an open and accepting way (Hyland et al., 2015). To summarise, a definition from Brown, Ryan and Creswell (2007): mindfulness is *"a receptive attention to and awareness of present moment events and experiences" (Brown et al., 2007: 212).*

Mindfulness involves noticing what is happening without evaluating, analyzing or reflecting upon it – it is therefore said that mindful information processing is 'pre-conceptual' (Hülsheger, Alberts, Feinholdt & Lang, 2013).

Thus, a mindful employee will take in what is happening in the workplace and not react to it, rather, simply taking in information from their surrounds. They will non-judgmentally approach their work and their relations with other colleagues and management.

Although the majority of research into individual differences in mindfulness see it as a trait, many

researchers now consider mindfulness to be a psychological state that varies from moment-to-moment within individuals (Hülsheger et al., 2013).

Furthermore, mindfulness has been described as a natural human capacity, which varies in regard to strength across both situations and persons (Hülsheger et al., 2013).

Well, it means that throughout the working day, at any one time, employees' mindfulness is variable; they may be closely paying attention, non-judgmentally, in a meeting – focused on whatever the presenter is talking about.

Keywords: Mindfulness Practices, Stress Reduction, Employee, Well-Being.

Introduction:

Mindfulness (Baer, 2011), Mindfulness is commonly defined as a way of paying attention that is focused in the present moment in a non-judgmental, non-reactive, and compassionate manner (Baer, 2011; Kabat-Zinn, 1994, 2003). Through mindfulness, all experiences that enter awareness (e.g., distressing emotions and thoughts) are viewed as fleeting experiences that naturally rise and fall rather than experiences that should be avoided or acted upon (Kabat-Zinn, 2003; Marlatt et al., 2004). Mindfulness has been thought to be a naturally occurring individual difference or a dispositional trait (Brown and Ryan, 2003) that can be developed through meditative practices and mindfulness based interventions (Baer et al., 2006; Baer, 2011). Examination of instructions and definitions used in mindfulness practices and interventions, along with confirmatory and exploratory analyses of existing mindfulness questionnaires, indicates that trait mindfulness is multidimensional (Baer, 2011; Baer et al., 2006). In particular, one formulation suggests that mindfulness is comprised of five facets: (1) observing, which refers to noticing or attending to internal and external experiences; (2) describing, which refers to labeling internal experiences with words; (3) acting with awareness, which refers to attending to one's activities of the moment; (4) non-judgment, which refers to taking a non-evaluative stance toward thoughts and feelings; and (5) non-reactivity, which refers to the tendency to allow thoughts and feelings to come and go without being attached to them (Baer et al., 2006). These facets seem to represent dispositional qualities that are malleable through mindfulness training (Baer, 2011).

Mindfulness is best thought of as a way of being rather than an activity in and of itself. Almost any activity can be carried out with mindful awareness. Originally associated with Buddhist psychology, the term "mindfulness" comes from the Sanskrit word "Smṛti," which literally translates to "that which is remembered" (Williams, Leumann, & Cappeller, 2004). From this, we can understand mindful-ness as remembering to pay attention to our present moment experience (Shapiro & Carlson, 2009; Black, 2011)

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- **Mindfulness:** Being fully present in the moment, observing thoughts and emotions without judgment, which helps to stay centered during heated discussions.
- **Emotional regulation:** Recognizing and managing one's own emotions, allowing for a calmer response to potentially triggering situations.
- **Active listening:** Deeply focusing on the other person's perspective, truly understanding their feelings and concerns by actively listening without interruption.
- **Empathy:** Cultivating the ability to see a situation from another person's point of view, fostering compassion and understanding.
- **Non-judgmental attitude:** Approaching the conflict without preconceived biases or assumptions, allowing for a more open dialogue.
- **Focus on the present:** Avoiding dwelling on past grievances or future anxieties, staying focused on the current situation and finding solutions.

How meditation can be applied in conflict resolution:
- **Before a difficult conversation:** Taking a few minutes of meditation to center oneself and prepare for a calm and focused interaction.
- **During a conflict:** Utilizing breathing techniques or mindfulness practices to manage emotions and remain present in the conversation.
- **After a conflict:** Engaging in meditation to process emotions, de-escalate tension, and reflect on the situation with a clearer perspective.

Meditation skills, when applied to conflict resolution, primarily enhance the ability to remain calm, focused, and empathetic, allowing individuals to actively listen, understand different perspectives, and manage their own emotions effectively during a disagreement, leading to more constructive dialogue and potential solutions.

Key meditation skills beneficial in conflict resolution:
- **Mindfulness:**
  The practice of being fully present in the moment, which helps individuals stay grounded and

avoid getting caught up in emotional reactions during a conflict.

- **Emotional regulation:**
  Meditation helps individuals identify and manage their emotions, allowing them to respond calmly and thoughtfully instead of reacting impulsively.
- **Active listening:**
  By cultivating focus and awareness through meditation, individuals can better listen to others' perspectives without interrupting or judging, fostering understanding and empathy.
- **Perspective taking:**
  Meditation can help individuals step back from their own viewpoint and consider the situation from another person's perspective, promoting compassion and open-mindedness.
- **Non-judgmental attitude:**
  A core aspect of meditation is observing thoughts and feelings without judgment, which translates to conflict resolution by allowing individuals to listen to opposing viewpoints without bias.

How to apply meditation skills in conflict resolution:

- **Take a moment to breathe:**
  Before engaging in a difficult conversation, take a few deep breaths to center yourself and calm your emotions.
- **Focus on the present:**
  Actively listen to the other person's words and body language without letting your mind wander to past grievances or future worries.
- **Acknowledge emotions:**
  Recognize and validate your own emotions as well as the other person's feelings during the conflict.
- **Paraphrase and summarize:**
  To ensure understanding, rephrase what the other person has said to demonstrate active listening and clarify any misunderstandings.
- **Use "I" statements:**
  Express your own needs and perspectives using "I" statements to avoid accusatory language and promote clear communication.

Literature Review

However, most definitions, such as the one described by Hyland, Lee and Mills (2015) share three elements. Mindfulness can be described as a 'present-focused consciousness' (Hyland, Lee & Mills, 2015). In other words, a mindful individual is not ruminating about the past or worrying about the Put very simply, workplace mindfulness is the degree to which individuals are mindful in their work setting (Dane & Brummel, 2013). What, then, does it mean to be mindful? Well, like so many constructs in positive psychology, mindfulness is not easily definedfuture; they are simply "being" in the here and now.

Secondly, mindfulness includes paying close attention to both internal and external stimuli (Hyland et al., 2015). Finally, as well as simply paying attention to stimuli, mindfulness involves doing this in an open and accepting way (Hyland et al., 2015). To summarise, a definition from Brown, Ryan and Creswell (2007): mindfulness is *"a receptive attention to and awareness of present moment events and experiences" (Brown et al., 2007: 212).*

Mindfulness involves noticing what is happening without evaluating, analyzing or reflecting upon it – it is therefore said that <u>mindful information processing</u> is 'pre-conceptual' (Hülsheger, Alberts, Feinholdt & Lang, 2013).

Thus, a mindful employee will take in what is happening in the workplace and not react to it, rather, simply taking in information from their surrounds. They will non-judgmentally approach their work and their relations with other colleagues and management.

Although the majority of research into individual differences in mindfulness see it as a <u>trait</u>, many researchers now consider mindfulness to be a psychological state that varies from moment-to-moment within individuals (Hülsheger et al., 2013).

Furthermore, mindfulness has been described as a natural human capacity, which varies in regard to strength across both situations and persons (Hülsheger et al., 2013). What does this look like in the workplace?

Well, it means that throughout the working day, at any one time, employees' mindfulness is variable; they may be closely paying attention, non-judgmentally, in a meeting – focused on whatever the presenter is talking about. Or, perhaps, later in the day they are less mindful and are sitting staring at the computer wondering what to cook for dinner.

So, the person has the capacity to be mindful, however their mindfulness at any one time is variable.

Mindfulness has a multitude of benefits for workplaces and businesses.

Speaking very generally, there are some mindfulness-based processes that are thought to affect employee performance and wellbeing.

These include response flexibility, decreased rumination, empathy, <u>affect regulations</u>, increased <u>self-determination</u> and persistence, improved working memory and more accurate affective forecasting (Glomb, Duffy, Bono, & Yang, 2012).

<u>Benefits of mindfulness</u> in the workplace also include improvements in task commitment, and enjoyment of work (Hyland et al., 2015). Let's have a look at some of the work-related benefits of mindfulness in some more detail…

Mindfulness results in improved social relationships (Glomb et al., 2012). Positive workplace relationships can have a significant impact. They buffer the effects of workplace stressors, promote thriving in employees, and foster communication, creativity and citizenship behaviors (Glomb et al., 2012).

Glomb et al. (2012) suggest that mindfulness promotes positive social connections in the workplace through a number of integral mindfulness processes, but most especially empathy and response flexibility.

Employees who practice being mindful are therefore more likely to show greater acceptance of colleagues without reactivity (Glomb et al., 2012). Optimal functioning of organizations is, in many ways, dependent

upon positive interpersonal relationships.

Given that some studies have suggested that training in mindfulness may be linked to social connectedness, this highlights the important role that mindfulness may play in workplace relationships and the success of the organization (Glomb et al., 2012).

A benefit of mindfulness in the workplace is that it promotes resiliency. Glomb and colleagues (2012) nominate two processes associated with mindfulness as being likely to foster <u>resilience</u>: affective regulation and persistence.

Mindfulness helps individuals to approach others positively and, in addition, it protects them from the negative emotions and agitation of another person by regulating affect appropriately and decreasing reactivity (Glomb et al., 2012).

In the workplace, resiliency is at the face of interpersonal or task-related stressors, and is also a vital part of optimal work functioning.

Mindfulness also improves task performance.

The way that mindfulness is implicated in <u>workplace performance</u> is dependent on the nature of the task, and the contextual factors of the work… some mindfulness processes will beneficially affect a variety of types of job, whereas others are more specific (for example, for jobs with a lot of emotional content, decreased rumination and improved affective regulation may hold the key to performance) (Glomb et al., 2012).

It has also been found that mindfulness is associated with fewer cognitive failures (such as forgetting, distraction and blunders) – which suggests that mindfulness may therefore lead to improved workplace performance and fewer accidents (Glomb et al., 2012).

Mindfulness also promotes an awareness of 'gut feelings' and it has been suggested that tapping into these intuitions may facilitate improved task performance when the level of expertise is high (Glomb et al., 2012).

Furthermore, mindfulness is also thought to promote better decision making, with <u>decision biases</u> being less likely due to attention to internal and external stimuli, and reduced heuristic processing.
As you can see, the benefits of mindfulness in the workplace are many and varied.

Mindfulness in the workplace is important for a wide range of reasons. The first relates to how satisfied an employee is in their job – which clearly has implications for their wellbeing, psychologically, and emotionally.

Affective events theory has been applied to mindfulness in the workplace by suggesting that mindfulness may be positively related to job satisfaction, because mindfulness facilitates more adaptive appraisals of work stressors (Hülsheger et al., 2013).
In other words, when something challenging happens at work, a mindful employee will not simply react and judge what is happening emotionally, rather they will consider it with a more adaptive stance.

Therefore, by construing the stressor at work with a more proactive approach, the employee will also be more satisfied in their work.

Furthermore, mindfulness may also relate to job satisfaction because it increases self-determined behavior (Hülsheger et al., 2013). Self-determined behavior is behavior that is consistent with an individual's needs and values (Hülsheger et al., 2013).

Mindfulness also promotes awareness of an individual's basic values and needs because it decreases habitual and automatic functioning and brings attention and awareness to experiences in the present moment (Hülsheger et al., 2013). The relationship between mindfulness and job satisfaction will be explored in the next section, where research is considered.

Another reason why mindfulness is important is because it can help combat and manage employee stress (Hyland et al., 2015). Chronic stress is a widespread problem in society, perhaps most especially at work.

According to the National Institute for Occupational Safety and Health (1999), 26% of workers say that they are "often or very often stressed at work" (Hyland et al., 2015). Workplace stress has a significant impact not only on individuals, but also the effectiveness of organizations.

Going back all the way to 1990, workplace stress cost American business as much as $150 billion every year… Mindfulness training has proven benefits for employee health and wellness, including to help decrease workforce stress and build resilience (Hyland et al., 2015).

Mindfulness can even help improve high potential development in business. In 2013, 35% of the total spending on training in US organizations went on leadership development (Hyland et al., 2015). However, despite this expenditure, three quarters of all CEOs still nominate leadership development as a top business concern (Hyland et al., 2015).

A lack of self-awareness is found to be the single biggest factor in derailment of high potential leaders. Thus, given that awareness of self and others is a component of mindfulness, increasing mindfulness will also be associated with increased self-awareness.

This also suggests that mindfulness plays a role in the success of high potential employees, and the effectiveness of processes that organizations have in developing high potential (Hyland et al., 2015).

Mindfulness is also important in the workplace because it can enhance engagement and decrease burnout (Hyland et al., 2015).

It is shown that employees' investment in their jobs is associated with greater employee satisfaction, lower intention of turnover and increased organizational citizenship behaviors (Hyland et al., 2015).

This employee engagement has been linked to mindfulness. Mindfulness has been shown to relate both to increased performance and decreased intention of turnover (Hyland et al., 2015). Mindfulness programs may enable organizations to foster employee engagement and commitment – especially in the case of high-stress and high-burnout jobs (Hyland et al., 2015).

Mindfulness can also help employees cope with organizational change (Hyland et al., 2015). These days, change is a predominant feature of the workplace.

Research shows that a large reason why efforts for workplace change often fail is employee resistance. Mindfulness can help employees cope with change – it may reduce the stress that is associated with loss of job control that often occurs with organizational change (Hyland et al., 2015).

Increased mindfulness is also associated with lower levels of ego-defensive reactivity under threat, and it promotes objectivity, both of which help an individual cope with change in the workplace (Hyland et al., 2015)

Delve into the Research

Compared to the interest in mindfulness showed by academia, business and government, research in the industrial-organizational community has been somewhat sparse (Hyland et al., 2015).

Nevertheless, we take a few moments to examine the research that has looked at mindfulness in the workplace.

Research into mindfulness, as a general construct, has been studied by employing a wide range of methodological approaches: survey designs, experimental studies, cross-sectional and longitudinal studies (Hyland et al., 2015).

Examples of instruments designed to measure mindfulness are the FMI and the MAAS.

The FMI is the Freiburg Mindfulness Inventory, which has both a long form (30 items) and a short form (14 items) (Hyland et al., 2015). Both forms have been shown to be psychometrically sound (Hyland et al., 2015).

The MAAS is the Mindfulness Attention and Awareness Scale, consisting of 15 items (Hyland et al., 2015). This scale can distinguish between people who have various levels of experience with mindfulness. So, now that you have an understanding of what mindfulness research looks like, let's take a closer look at mindfulness in the workplace context.

Coping and Calm

In 2008, Hunter and McCormick conducted a small exploratory qualitative study, examining a range of workplace outcomes derived from mindfulness practice for eight managers and professionals.

These outcomes included heightened awareness of external stimuli, greater acceptance of an individual's work situation, increased coping ability and the ability to remain calm in stressful/challenging work situations, better adaptability and more positive workplace relationships.

Hunter and McCormick analyzed the interviews they conducted, and found out a number of things about employees who practice mindfulness. They found that individuals who practice mindfulness have more modest, realistic work goals, are more selfless and are less concerned with material acquisition and wealth (Hunter & McCormick, 2008).

They also found that mindful individuals are more likely to find meaning in life from sources other than work (Hunter & McCormick, 2008).

Affect and mindfulness-based interventions

Tamara Giluk (2010) conducted research that looked at outcomes from employees' participation in either the Mindfulness-Based Stress Reduction (MBSR) program or the Mindfulness-Based Cognitive Therapy (MBCT) which were conducted at the University of Iowa. The findings of this particular study were limited by a very low sample size, the study thus lacked statistical power.

The study did show, however, that mindfulness was significantly related to positive affect and negative affect, but that no correlation was found with the quality of relationships or job performance.

Stress and mindfulness

Allen and Kiburz (2012) looked at mindfulness as a trait. Their study showed that greater trait mindfulness was associated with greater work-family balance (Allen & Kiburz, 2012). It also found that trait mindfulness predicted improved sleep quality, and increased vitality (Allen & Kiburz, 2012).

Galantino and colleagues (2005) were interested in stress and mindfulness. They looked at subject-reported stress symptoms, as well as salivary cortisol (a known indicator of stress levels) in health-care professionals (Galantino, Baime, Maguire, Szapary & Farrar, 2005).

An 8-week long mindfulness meditation program was implemented. Mindfulness meditation was found to be related to significant decreases in employees' emotional exhaustion (Galantino et al., 2005). It was discovered, however, that changes in salivary cortisol and subject-reported stress symptoms from baseline to 8 weeks post-program completion were weak and not statistically significant (Galantino et al., 2005).

Mindfulness, emotional exhaustion, and job satisfaction

Following on from Galantino's work, Hülsheger and colleagues (2013) looked at the relationship between mindfulness, emotional exhaustion and job satisfaction in a sample of interactive service workers. Their research looked at jobs that require employees to interact directly with customers/clients which means that they are often faced with emotionally charged encounters.

These employees therefore need to manage their emotions as an inherent part of their job. This form of 'emotional labor' means that these employees are generally more likely to experience emotional exhaustion and decreased job satisfaction, because these factors relate to other important organizational outcomes, including task and contextual performance, staff turnover and absenteeism (Hülsheger et al., 2013).

Study 1:

The first study conducted by Hülsheger et al. (2013) was a 5-day diary study involving 219 employees. Mindfulness was found to be negatively related to emotional exhaustion and positively related to job satisfaction, at both the within and between person levels. Surface acting mediated the relationship between mindfulness and job satisfaction and emotional exhaustion at both levels of analysis (Hülsheger et al., 2013).

Perhaps you are wondering what surface acting is? Put simply, surface acting refers to an emotion regulation strategy involving the suppression of negative emotions and 'faking' positive emotional

expressions in jobs in which positive emotional displays are expected.

Study 2:
Hülsheger et al.'s (2013) second study looked at 64 participants who took part in the experimental field study. The individuals either took part in a mindfulness intervention or were assigned to a wait-list control group. It was found that participants in the mindfulness intervention group reported significantly less emotional exhaustion and greater job satisfaction than those in the control group.

Findings of Hülsheger et al's (2013) research suggests that mindfulness promotes job satisfaction in emotionally draining work roles, and that it can also help to prevent burnout caused by emotional exhaustion.

1. Introduction to Mindfulness
Mindfulness, as defined by Kabat-Zinn (1994), refers to "paying attention in a particular way: on purpose, in the present moment, and non-judgmentally." Rooted in Buddhist traditions, it has become a widely adopted psychological practice in modern therapeutic, educational, and organizational settings. Mindfulness is increasingly recognized as a tool for enhancing psychological functioning, resilience, and interpersonal relationships in the workplace.

2. Theoretical Foundation
The theoretical framework of mindfulness in organizational behavior is supported by **Self-Determination Theory (Ryan & Deci, 2000)** and **Cognitive Behavioral Theory (Beck, 1976)**. Mindfulness improves **meta-cognitive awareness**, **emotional regulation**, and **attentional control**, all of which are essential for workplace functioning (Brown & Ryan, 2003).

3. Mindfulness and Workplace Stress
Numerous studies confirm that mindfulness reduces workplace stress. Hülsheger et al. (2013) found that employees who practiced daily mindfulness reported significantly lower levels of emotional exhaustion. Mindfulness practices help employees become aware of stress triggers without immediately reacting, thereby fostering adaptive coping mechanisms (Glomb et al., 2011).

4. Mindfulness and Job Satisfaction
Mindfulness is associated with higher levels of job satisfaction. Aikens et al. (2014) observed a significant improvement in job satisfaction after an 8-week mindfulness program. It promotes psychological flexibility and a sense of intrinsic motivation, both of which are correlated with increased satisfaction at work (Shapiro et al., 2006).

5. Mindfulness and Employee Engagement
Employee engagement — characterized by vigor, dedication, and absorption — has shown positive correlations with mindfulness. Leroy et al. (2013) indicated that mindful leaders foster more engaged teams. Mindful employees demonstrate greater presence and focus, which translates to enhanced task involvement (Malinowski & Lim, 2015).

6. Mindfulness and Productivity
Several studies have linked mindfulness with increased task performance and productivity. Dane &

Brummel (2014) found that mindfulness improves task accuracy and decision-making under pressure. It enhances attention to detail, reduces mind-wandering, and promotes better time management.

7. Mindfulness and Organizational Citizenship Behavior (OCB)

Organizational Citizenship Behavior (OCB), which includes altruism, conscientiousness, and civic virtue, is positively influenced by mindfulness. Reb et al. (2015) found that mindful employees are more likely to help colleagues and go beyond formal job requirements, largely due to increased empathy and self-awareness.

8. Mindfulness and Emotional Intelligence

Mindfulness supports emotional intelligence by enhancing self-regulation and empathy. According to Schutte and Malouff (2011), mindfulness practice strengthens emotional clarity and interpersonal effectiveness, thereby improving team dynamics and leadership skills.

9. Workplace Mindfulness Interventions (WMIs)

Organizations are increasingly implementing Workplace Mindfulness Interventions. Programs such as **Mindfulness-Based Stress Reduction (MBSR)** and **Mindfulness-Based Cognitive Therapy (MBCT)** have shown promising outcomes in reducing turnover intentions, improving well-being, and enhancing job performance (Good et al., 2016).

10. Research Gaps

Despite a growing body of research, gaps still exist:
- Most studies are based in Western contexts; there is limited research from South Asia, especially India.
- Longitudinal data is scarce, making it difficult to assess the long-term impact of mindfulness.
- More empirical evidence is needed on sector-specific outcomes, such as education, healthcare, and IT.

Conclusion

The literature clearly supports the positive impact of mindfulness on various workplace outcomes such as stress reduction, job satisfaction, productivity, and engagement. However, further empirical studies are required, particularly in diverse cultural and organizational contexts, to validate and expand these findings.

Findings of Literature Review

1. Mindfulness Reduces Workplace Stress
- Mindfulness practice helps employees regulate emotions and reduces anxiety and burnout.
- Daily mindfulness was associated with **lower emotional exhaustion and improved resilience** (Hülsheger et al., 2013; Glomb et al., 2011).

2. Positive Impact on Job Satisfaction
- Employees who practice mindfulness report **higher levels of job satisfaction**.
- Mindfulness promotes self-awareness and intrinsic motivation, which are key drivers of satisfaction (Aikens et al., 2014; Shapiro et al., 2006).

3. Enhances Employee Engagement

- Mindful individuals tend to be more **focused, dedicated, and absorbed in their work**.
- Mindfulness fosters present-moment awareness, which improves engagement (Leroy et al., 2013; Malinowski & Lim, 2015).

4. Improves Productivity and Performance
- Mindfulness enhances attention and cognitive flexibility, leading to **better task performance and efficiency**.
- It minimizes mind-wandering and improves decision-making under pressure (Dane & Brummel, 2014).

5. Strengthens Organizational Citizenship Behavior (OCB)
- Mindfulness is linked to **pro-social behaviors**, such as helping others and showing organizational loyalty.
- It cultivates empathy, emotional regulation, and ethical awareness (Reb et al., 2015).

6. Increases Emotional Intelligence
- Practicing mindfulness develops **self-regulation and emotional clarity**, key components of emotional intelligence.
- Enhanced emotional intelligence improves team dynamics and leadership abilities (Schutte & Malouff, 2011).

7. Workplace Mindfulness Programs are Effective
- Structured programs like **MBSR and MBCT** yield measurable benefits in stress reduction, well-being, and job performance (Good et al., 2016).
- These interventions also reduce absenteeism and turnover intentions.

8. Sector and Culture-Specific Research is Limited
- Most studies are Western-centric; there is **limited research in Indian or Asian organizational contexts**.
- Comparative data across industries like IT, healthcare, and education is sparse, indicating a need for localized studies.

Overall Conclusion

Mindfulness practices significantly contribute to **improved psychological well-being and positive organizational outcomes**, including reduced stress, greater engagement, better job performance, and enhanced employee relations. However, the field would benefit from **more culturally diverse, longitudinal, and industry-specific studies**.

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Key Journals to Refer
1. **Journal of Applied Psychology**
Publishes empirical studies on workplace behavior and interventions like mindfulness.

2. **Mindfulness (Springer Journal)**
A leading peer-reviewed journal dedicated to mindfulness theory, practice, and research.

3. **Journal of Management**
Features reviews and empirical studies linking mindfulness to management practices.

4. **Human Relations**
Examines psychological and social dimensions of workplace interactions, including mindfulness.

5. **Journal of Occupational Health Psychology**
Focuses on employee well-being, burnout, and stress-reduction interventions.

6. **Journal of Vocational Behavior**
Covers work engagement, career development, and mindfulness-related factors.

7. **International Journal of Stress Management**
Publishes research on occupational stress and mindfulness-based coping.

8. **Harvard Business Review (HBR)** *(for practitioner insights)*
While not academic, it provides industry-relevant insights on mindfulness practices at work.

FINANCIAL PREDICTIVE FORECASTING DESPITE ADOPTION CHALLENGES TO ENSURE EFFICACY IN THE MUCH EVOLVING FINANCIAL LANDSCAPE

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ABSTRACT

Artificial Intelligence (AI) enhances financial forecasting by analysing vast datasets (data warehousing) identifying patterns, and predicting future trends with high accuracy. Techniques like machine learning, neural networks, and natural language processing enable real-time analysis of market data, economic indicators and news improves decision-making, risk management, and strategic financial planning across industries. AI substantiates its value in financial forecasting AI algorithms analyse historical and real-time data faster and more accurately than traditional models. For example, Banks use AI to forecast loan defaults using customer data. AI models like Long Short-Term Memory (LSTM) networks are effective in predicting stock prices, currency movements, and interest rate changes based on time-dependent patterns. Natural Language Processing (NLP) tools analyse news articles, earnings calls, and social media to gauge market sentiment, which can significantly impact stock prices and investor behaviour.AI detects anomalies and potential risks early by analysing transaction patterns, credit histories, and market signals, aiding in proactive financial decisions-advisors use AI to create personalized investment portfolios, constantly adjusting them based on market changes and client goals. AI simulates multiple economic scenarios, helping financial institutions assess how their portfolios perform under different conditions. In essence, AI enhances the precision, adaptability, and strategic depth of financial forecasting, making it an essential tool for modern finance. By evaluating predictive accuracy, integrating diverse data sources, enhancing risk management by using scenario analysis, addressing trust challenges, and leveraging high-frequency data, stakeholders can make more informed decisions in the evolving financial landscape.

Keywords: Data Warehousing, Machine Learning, Scenario Analysis, Financial Forecasting, Artificial Intelligence

Machine learning (ML) helps in **financial forecasting** by enabling systems to learn from historical data, identify patterns, and make data-driven predictions about future financial trends. In financial forecasting, supervised learning models such as regression, decision trees, support vector machines (SVM), and ensemble methods (like Random Forests and Gradient Boosting) are widely used. Deep learning models, particularly recurrent neural networks (RNNs) and long short-term memory networks (LSTMs), are powerful in capturing sequential dependencies and temporal patterns in time series financial data.

These models excel in modelling complex, nonlinear relationships in data, such as price fluctuations and market cycles, making them highly effective for forecasting stock prices, currency exchange rates, or economic indicators.

Natural Language Processing (NLP) allows AI to understand and analyse human language from text sources like financial news, earnings reports, social media posts, and analyst comments.

Sentiment analysis, event detection, and topic modelling derived from NLP help capture market sentiment and external events that influence financial markets. Incorporating these insights can improve the accuracy of financial forecasts. Feature engineering involves creating new input variables (features) from raw data to help AI models understand the underlying financial phenomena better. Examples include technical indicators (moving averages, RSI), macroeconomic indicators (interest rates, inflation), and derived sentiment scores. Properly engineered features provide richer context, enabling models to make more precise predictions.

Optimization techniques adjust model parameters to minimize forecasting errors. Algorithms like gradient descent, genetic algorithms, or Bayesian optimization fine-tune AI models, improving their predictive performance on financial data. Financial forecasting models need to be interpretable for stakeholders to trust and act on the predictions. Tools such as SHAP values, LIME, and attention mechanisms in neural networks explain how the AI model arrives at its predictions, highlighting important factors driving forecast outcomes. Techniques like probabilistic modelling and scenario analysis evaluate the confidence intervals of predictions and assess financial risks, helping investors and firms make informed decisions.

Few reliable and well-known examples of AI applications in Financial Forecasting:

- **Robo-Advisors (e.g., Betterment, Wealthfront)**
  Robo-advisors use AI algorithms to analyse market data and individual investor profiles to create personalized investment portfolios.
  AI Application: They apply machine learning to forecast asset performance and rebalance portfolios automatically based on predictive models and risk tolerance.
  Example: Betterment uses AI to forecast market trends and optimize investment strategies for retirement planning.

Algorithmic Trading Systems (e.g., Renaissance Technologies)
- Quant hedge funds like Renaissance Technologies use AI-driven algorithmic trading systems to execute trades at high speeds based on forecasts.
- **AI Application:** These systems employ deep learning models, natural language processing, and time series forecasting to predict price movements and market volatility, executing trades milliseconds ahead of competitors.
- **Example:** Renaissance's Medallion Fund is famous for its use of complex AI models to generate consistent financial returns.

Credit Scoring and Risk Prediction (e.g., Zest AI, Upstart)
- Companies use AI models to predict the creditworthiness of borrowers more accurately than traditional credit scoring systems.
- **AI Application:** Machine learning models analyse diverse financial behaviour's, repayment histories, and macroeconomic data to forecast default risk and adjust lending policies accordingly.
- **Example:** Upstart's AI models have been shown to reduce default rates while approving more loans compared to conventional credit scoring.

Sentiment Analysis for Market Prediction (e.g., Accern, Dataminr)
- These platforms use NLP to analyse news, social media, and financial reports in real-time to gauge market sentiment.
- **AI Application:** By forecasting how sentiment shifts might impact stock prices or market sectors, these tools provide early warning signals or investment opportunities.
- **Example:** Accern's AI engine scans millions of data points to deliver sentiment-driven alerts that hedge funds use for market forecasting.

Economic Indicator Forecasting (e.g., IBM Watson for Financial Services)
- IBM Watson uses AI to forecast macroeconomic indicators like GDP growth, inflation, and unemployment rates by analysing vast datasets, including unstructured data.
- **AI Application:** Deep learning models and NLP interpret economic reports, policy changes, and market data to help financial institutions anticipate economic trends.
- **Example:** Banks use Watson's forecasts to adjust their investment and lending strategies ahead of economic shifts.

Stock Price Prediction Platforms (e.g., Kavout)
- Kavout combines AI-driven quantitative models with fundamental and technical data to generate stock "K Scores" predicting future price movements.
- **AI Application:** The platform employs deep learning and feature engineering on historical stock data and news to forecast which stocks are likely to outperform.
- **Example:** Asset managers integrate Kavout's AI forecasts into their trading decisions to improve portfolio returns.

Fraud Detection and Financial Crime Prevention (e.g., PayPal, Mastercard)
- AI models detect unusual transaction patterns and forecast potentially fraudulent activities.
- **AI Application:** Machine learning analyses transaction data in real-time to identify anomalies and forecast risk probabilities.
- **Example:** PayPal's AI systems predict and prevent fraudulent transactions by continuously learning from evolving fraud patterns.

These examples highlight how AI components such as machine learning, deep learning, NLP, and optimization work together in practical financial forecasting and decision-making tools used by institutions and investors worldwide.

Bayesian Optimization (BO) is a **probabilistic, model-based optimization technique** designed to find the best hyperparameters efficiently with fewer model evaluations.

It works by building a **surrogate probabilistic model** (usually a Gaussian Process) of the objective function (e.g., validation error or loss as a function of hyperparameters).

Instead of randomly searching or grid searching the hyperparameter space, BO **intelligently explores** promising regions based on past observations, balancing exploration (testing new areas) and exploitation (refining known good areas).

Step-by-Step Process of Bayesian Optimization in Financial AI Models
Step 1: Initialize with Sample Points
- The optimizer begins by selecting a small number of hyperparameter combinations (e.g., learning rate, number of layers) to evaluate.
- The AI model is trained on financial data with those hyperparameters, and performance metrics (such as prediction accuracy, mean squared error, or Sharpe ratio) are recorded.

Step 2: Build a Surrogate Model
- Using these initial results, BO constructs a Gaussian Process (GP) or another probabilistic model that approximates the relationship between hyperparameters and model performance.
- The GP not only predicts the expected performance but also estimates the uncertainty (variance) of the prediction for unexplored hyperparameter values.

Step 3: Acquisition Function Guides the Search
- An acquisition function (e.g., Expected Improvement, Upper Confidence Bound) uses the surrogate model to decide which hyperparameters to try next.
- It quantifies the **trade-off between exploiting regions where the model expects good results and exploring regions with high uncertainty** to avoid missing better settings.

Step 4: Evaluate New Hyperparameters
- The chosen hyperparameters are tested by training the AI model on financial data.
- The observed performance updates the surrogate model, improving future predictions.

Step 5: Iterate Until Convergence
- This cycle repeats, gradually honing in on the hyperparameter combination that optimizes the financial forecasting model's predictive accuracy or minimizes error.
  Therefore, Bayesian Optimization is Well-Suited for Financial Forecasting
- **Efficiency:** Financial datasets can be huge, and training models is expensive. BO reduces the number of expensive trainings runs by focusing on promising hyperparameters.
- **Robustness to Noise:** Financial data is noisy and volatile. The probabilistic nature of BO accounts for uncertainty in model evaluations, preventing overfitting to random fluctuations.
- **Global Optimization:** Unlike simpler methods (grid search, random search) that may get stuck in local optima, BO probabilistically explores the hyperparameter space to find a global optimum.
- **Adaptability:** BO can handle continuous, discrete, and categorical hyperparameters—common in complex financial models (e.g., number of decision trees, activation functions, learning rates).

Mastercard's Approach to Fraud Detection and Prevention
  Mastercard uses a combination of advanced **Artificial Intelligence (AI), Machine Learning (ML), and big data analytics** to protect millions of transactions daily from fraud. Their system is designed to identify suspicious activities quickly and accurately, minimizing false positives while preventing fraud losses.

Real-Time Transaction Monitoring
- Mastercard monitors every transaction in **real time**, analyzing billions of data points including transaction amount, location, time, merchant type, and device information.

- They use AI models that have been trained on vast datasets of historical transaction records, including known fraud patterns.
- These models look for anomalies—transactions that deviate from a cardholder's typical behaviour or show patterns common in fraudulent transactions.

Decision Intelligence and AI

- Mastercard's **Decision Intelligence** platform employs sophisticated machine learning algorithms to assess the risk of each transaction.
- This platform uses predictive analytics to assign a fraud risk score, evaluating:
    o **Behavioural factors:** Unusual spending amounts or locations.
    o **Device fingerprints:** The device or browser used for the transaction.
    o **Velocity checks:** Frequency of transactions in a short time.
    o **Geolocation data:** Detects if a transaction is happening in an unlikely or high-risk location.
- If a transaction is flagged as suspicious, it may be declined or flagged for further verification.

Mastercard AI Research Lab

- Mastercard has an internal AI Research Lab that continually develops and improves fraud detection models.
- Their AI techniques include **deep learning**, which can identify complex, nonlinear fraud patterns that traditional rule-based systems might miss.
- The models also learn and adapt over time, improving detection as fraud tactics evolve.

Global Data Network

- Mastercard benefits from its massive **global network of transactions**, allowing it to spot emerging fraud trends early.
- By aggregating anonymized data across millions of merchants and cardholders worldwide, Mastercard's systems identify and respond to new fraud schemes rapidly.
- This network effect helps protect cardholders everywhere by sharing insights across geographies and industries.

Tokenization and Secure Authentication

- Mastercard uses **tokenization**, which replaces sensitive card information with a unique digital token during transactions.
- This means that actual card data is never transmitted during purchases, reducing the risk of interception and misuse.
- Additionally, Mastercard supports **strong customer authentication methods** (like biometrics, two-factor authentication) under regulations such as PSD2 (in Europe), adding another layer of security.

Collaboration with Issuers and Merchants

- Mastercard works closely with banks (issuers), merchants, and payment processors to share fraud intelligence and coordinate responses.
- When suspicious activity is detected, issuers may contact cardholders for verification, or merchants might require additional authentication.

Mastercard's AI-Driven Fraud Solutions
- **Mastercard's Decision Intelligence:** An AI-powered system that dynamically evaluates transaction risk.
- **Mastercard Safety Net:** A solution that detects fraudulent online and mobile transactions in real time, protecting digital commerce.
- **RiskRecon:** Provides cybersecurity risk assessment to merchants, helping prevent fraud before it occurs.

Mastercard safeguards against fraud by combining:
- **Real-time monitoring** of transactions worldwide.
- AI and machine learning models that predict and flag suspicious behaviour.
- Advanced technologies like tokenization and secure authentication.
- A vast global data network to spot new fraud trends.
- Collaboration with financial institutions and merchants for rapid response.

This multi-layered, AI-driven approach enables Mastercard to detect and prevent fraudulent activities swiftly and effectively, protecting both consumers and businesses.

IBM Watson is a powerful AI platform that leverages **machine learning, natural language processing (NLP), and advanced analytics** to generate forecasts and insights by analyzing massive amounts of structured and unstructured data—from market data and economic indicators to news articles, social media, and policy reports.

Banks use these forecasts to **anticipate economic trends** and adjust their financial strategies accordingly, particularly in portfolio management and lending.

Generating Economic Forecasts with Watson
- **Data Integration:** Watson ingests vast datasets, including historical market data, GDP growth rates, inflation figures, unemployment trends, corporate earnings reports, and geopolitical news.
- **Natural Language Processing (NLP):** Watson analyzes unstructured text from news sources, government releases, and analyst reports to detect emerging themes or risks (e.g., rising inflation, regulatory changes).
- **Predictive Modeling:** Using machine learning models, Watson identifies patterns and generates forecasts for key economic indicators like interest rates, inflation, currency fluctuations, and sectoral growth.
- **Sentiment & Event Impact Analysis:** Watson assesses market sentiment and evaluates how specific events (e.g., trade tariffs, elections) may affect economic conditions.

Portfolio Adjustment Based on Watson Forecasts
- **Risk Assessment:** Banks use Watson's forecasts to gauge economic risks affecting asset classes (stocks, bonds, commodities). For example, if Watson predicts rising interest rates, bond prices may fall, so banks adjust bond holdings to reduce exposure.
- **Asset Allocation:** Forecast insights guide the rebalancing of portfolios, shifting capital toward sectors or regions expected to outperform or away from those facing economic headwinds.

- **Stress Testing:** Banks simulate portfolio performance under different economic scenarios predicted by Watson, helping them prepare for potential downturns or volatility.
- **Opportunity Identification:** Watson's insights can uncover emerging investment opportunities, such as growth in renewable energy sectors due to policy shifts.

Lending Strategy Adjustment Based on Watson Forecasts

- **Credit Risk Modeling:** By anticipating macroeconomic shifts, Watson helps banks predict potential borrower defaults or changes in creditworthiness ahead of time.
- **Dynamic Loan Pricing:** Banks adjust interest rates and lending terms based on economic outlooks. For instance, if a recession is forecasted, banks may tighten lending criteria or increase loan pricing to compensate for higher risk.
- **Portfolio Diversification:** Insights from Watson enable banks to diversify loan portfolios across industries less likely to be affected by economic downturns.
- **Early Warning Systems:** Watson flags sectors or borrowers vulnerable to economic shifts, prompting proactive risk management like increased monitoring or loan restructuring offers.

Benefits of Using Watson Forecasts for Banks

- **Improved Decision-Making:** Banks make data-driven, forward-looking decisions rather than reactive ones based solely on past performance.
- **Faster Response to Market Changes:** Real-time insights enable quicker portfolio and lending adjustments.
- **Reduced Financial Risks:** Anticipating downturns helps banks mitigate losses through prudent risk management.
- **Enhanced Customer Relationships:** By adjusting lending strategies responsibly, banks can offer better terms and support to customers in changing economic climates.

Renaissance Technologies is known for employing **a team of mathematicians, physicists, computer scientists, and statisticians** rather than traditional finance experts.

According to **James Simons**, the founder, the firm uses **machine learning, pattern recognition, and statistical arbitrage**—all hallmarks of AI and advanced analytics.

The Medallion Fund processes **massive datasets**, including price data, economic indicators, and alternative data sources, to identify subtle market inefficiencies.

It uses **nonlinear models**, **time-series analysis**, and **ensemble methods** to detect complex, nonlinear relationships and predict price movements across equities, futures, currencies, and commodities.

Academic and Industry Validation

- A 2014 paper by *Alexander* in the **Journal of Portfolio Management** highlights that Renaissance's edge comes from exploiting **high-frequency data and intricate predictive signals** extracted using machine learning models.

- In **The Wall Street Journal** and **Bloomberg** reports, Renaissance is described as a pioneer in **applying AI and big data techniques in finance**, which were ahead of their time compared to conventional quant funds.

- The fund's consistent outperformance is often attributed to its **ability to adapt models continuously** through feedback loops and **Bayesian updating**, which are key AI concepts.

- **Reuters** and other major news outlets cite Renaissance's use of "cutting-edge algorithms" and "proprietary AI techniques" as central to the Medallion Fund's strategy.

- Renaissance guards its algorithms and data rigorously, which has helped maintain its competitive edge.

- The fund's proprietary AI models are believed to leverage **ensemble machine learning**, **natural language processing** (for news and sentiment analysis), and **genetic algorithms** to evolve strategies.

- By continuously learning from new data, the fund's AI models adapt to changing market dynamics, reducing risk and enhancing returns.

Impact and Legacy
- Renaissance's success with the Medallion Fund has set a benchmark for AI in quantitative finance.

- It has inspired a wave of hedge funds and asset managers to adopt machine learning and AI for financial forecasting and trading.

- The fund's performance during volatile periods (e.g., the 2008 financial crisis) showcases the robustness of its AI-driven approach.

Conclusion

Artificial Intelligence has undeniably transformed financial forecasting by enabling more accurate, timely, and data-driven insights, even within the complex and rapidly evolving Indian financial ecosystem. AI-powered models enhance decision-making for banks, investors, and financial institutions by processing vast datasets, capturing market sentiment, and predicting economic shifts with unprecedented precision. Despite significant challenges—such as data quality issues, lack of skilled professionals, regulatory uncertainties, and infrastructure constraints—India's growing digital infrastructure and expanding fintech ecosystem provide a strong foundation for AI adoption. As institutions continue to invest in AI capabilities and address these hurdles, the potential for AI to drive greater financial inclusion, risk management, and market efficiency in India remains immense. Ultimately, embracing AI in financial forecasting can empower Indian financial markets to become more resilient, innovative, and globally competitive.

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COVID-19 IMPACT ON E-BANKING SERVICES ON A COMMERCIAL BANK IN INDIA

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Abstract

Commercial banks came into existence in India in 1806. Commercial banks' main aim is to provide finance to the customer and business. As time passed the commercial bank updated with new changes and accepted the new technology to provide quality services to the customer. This acceptance of the trending technology changed normal banking into digitalized banking. Nowadays covid-19 has changed the banking activity a lot which has both advantages and disadvantages. This study is about the pandemic impact of e-banking services in commercial banks in India.

Introduction

In late 2019, India came to know about the coronavirus, which is passed through China. The 1st coronavirus affected women found in Kerala who travel to Kerala by flight. After the coronavirus, infected people started to increase in India. Based on that the prime minister of India Mr. Narendra Modi announces 22 March 2020 Public curfew for one day. After that, the prime minister announced a 21-day lockdown on 25th March 2020. The 1.3 million population of India have supported this movement against the covid - 19. After this 21 days lockdown, the corona virus-positive cases till increasing in India. Based on the prime minister of Indian government has increased the lockdown period time-wise to control the corona virus-positive cases in India.

Phase 1: 25th march 2020 – 14th April 2020
Phase 2: 15th April 2020 – 3rd May 2020
Phase 3: 4th May 2020 – 17th May 2020
Phase 4: 18th May 2020 – 31st May 2020
Phase 5: 1st June 2020 – 30th June 2020(Lockdown only for containment zones).

This lockdown phase helps the government of India to decrease corona-positive cases in India. The lockdown badly affects the general shops, merchandising, and covid-19. It also badly affects the jobs of the many youths who work in the private sector. During this pandemic period, the temples, shops (other than glossary and medical shops), schools- colleges, malls, and restaurants remain shut. But from 1st June 2020, the shops allow to open for morning 7 to 12 pm and the restaurants allow to do home delivery services

of food.

In these periods everyone at home and the mass population start to do online transactions 10 times more than they earlier did. This affects banking activity so much that this major increase in online banking affects customer behavior towards online banking. Pandemics have both positive and negative effects on online banking services. On the positive side, India moves to digitalization, the world fast because of pandemic and pandemic also affects banking, number of transactions, number of customers, number of amounts, use of the various e-payment options, etc. On the other hand, customers do worry about safety and privacy, senior citizens are afraid to do online transactions because of the lack of knowledge and trust issues on online fraud and online money stolen, etc.

Literature review

Korankye (2014) investigated the effect of electronic banking not only limited to profitability. Study results conclude almost 80 percent of customers are enjoying and happy with the introduction of electronic transaction facilities in banks.

A study by Floh and Treiblmair (2006) found customer satisfaction and customer trust to be the most important antecedents to customer loyalty. The study examines the quality of service, trust, and overall satisfaction provided by banking and financial institutions from Australia.

Ismail Yildirim (2016)In 1998, online banking services started in Turkey.Online.Online banking services are rapidly increasing. A researcher found the result of the correlation between security concerns and avoiding the use of Internet banking In the study researcher measures the security of online banking transactions. As well as how e-banking services are developing in Turkey.

Worku,Tifahun A,and tafa MA(2020).. Studies analyze the difference between traditional banking and electronic banking. The study explains the various electronic banking services such as ATM/ POS/ Internet banking, mobile banking, etc. Studies provide various information about various banking services and their usage according to age, gender, and occupation, which majority are using the electronic banking services, etc. A study shows the relationship between electronic banking satisfaction among bank customers and demographic characteristics. Studies, analysis type of bank accounts, frequency of branches account, satisfaction in electronic banking services and e-banking delivery channel and customer responses on electronic banking facility.

Study determined customer satisfaction on e-banking SERVQUAL) which related to reliability, empathy, ease of use was found to be positivity, which Influencing bank activities, efficiency, responsiveness, security which Influencing customer satisfaction of the bank. The study determines the distinguish between indicator ease of use and reliability to adopting mobile banking strategies to provide high-quality services to the customer of a bank. studies included a literature review on mobile banking initiatives taken by the bank, how banks improve the quality of mobile banking services quality scale, the reliability of using mobile banking, the efficiency of mobile banking, privacy and security of the customer.

W Sardjono[1], E Selviyanti[2], M Mukhlis[3] and M Tohir[4].(2021) Global issues: utilization of e-commerce and increased use of mobile commerce application as a result of the covid-19 pandemic – studies show an increase in the use of e- commerce during the pandemic. During the pandemic, traditional purchasing decreases because of lack of purchasing power in a covid-19 situation, people encourage E-commerce and

electronic transaction to take place and make purchasing effortless. Buying and selling online increases tremendously, which positively impacts a bank's electronic transactions on both volume and value**.** Studies show the effort taken by the bank to promote e-commerce and mobile commerce by making various offers for the customer. Studies include a literature review on the Impact of covid -19 on economic fields of e-commerce and mobile commerce. Studies analyze the positive impact on health-related products, products supporting work from homes, such as computers, mobile phones, and other accessories related to office work, and food products. The study analyzed changing the behavior of the customer towards e-commerce and mobile commerce. Studies also determine changing purchasing preferences of customers from traditional purchasing to electronic purchasing. Studies show the increasing demand for daily necessary products and health-related products which are necessary for customers during this pandemic.

Objectives
1. To understand covid -19 impact on bank.
2. To understand covid -19 impact on customer preference
3. To understand the changing behavior of the customer during the pandemic.

Research Methodology
This paper was created by using primary data and secondary data. Primary data was collected by the survey from customers and secondary data from various research thesis, research papers. Studies using theoretical data to show the impact of covid-19 on E-banking. the literature used in the paper is from the various research papers, articles, journals, and websites. This paper has used the data from the survey on customer preference and their behavior towards online banking. The study shows the positive and negative impact of covid – 19 on commercial banks in India.

Result and Discussion
In 2015 Digitalization was announced by the Indian government. From 2015to 2019, the growth of digitalization in all sectors wasn't as expected by the Indian government. But from 2019 bank customers started to use the e-banking facility in large numbers. In 2019, the coronavirus affected Indian citizens found in Kerala. on the basis of this Indian government announce the lockdown in 4 phases. In this period electronic transactions and electronic commerce increase quite rapidly, which is unexpected Covid -19 affected the Indian economy negatively in an early stage of pandemic. After the vaccination started in India, the Indian economy moved towards a positive ratio because most of the Indian citizens started e-banking services for daily expenses. E-banking plays a key role in this pandemic situation. There's a positive impact of the covid-19 on the e-banking sector such as the number of customer acceptance of e-banking is increasing because of the ease and fast transaction. The major reason for the increase in e-banking is the accessibility of the b banking services by the bank customer. There's a tremendous increase in the number of customers who use e-banking for electronic transactions during this pandemic situation. There's some negative effect of the covid -19 on e-banking services. During the covid, most of the citizens, likely or unlikely, use the e-banking services but the issue rises of security of the fraud of the bank customer and awareness about the fraud done by the third party. Citizens of India are also afraid to share their personal information and bank details on the internet while they do the transaction or doing e-commerce activity. covid -19 affected the banking sector both positively and negatively

Positive Impact
1)Acceptability of E-banking

Covid -19 positive impact on the acceptability of e-banking services. During this pandemic period, electronic banking and e-commerce increased rapidly, which is unexpected. People who have never done online banking or e-commerce are starting to learn and accept the e-commerce and e-banking facility which is easy to use and convenient for both senior citizens and youth both. Youth who do the e-commerce purchasing and e-banking on monthly basis now youth do e-banking on a daily and weekly basis. Because of the increase in e-commerce purchasing and e-banking, this affects positively on online banking services, online business.covid-19 was the turning point for the growth of electronic transactions and electronic banking. According to the survey, bank customers are ready to accept the online facility provided by banks because of the convenience and ease of using this electronic technology for buying and selling goods. In the pandemic online demand increase for online purchasing for necessary products, food products, and health-related products. Now in unlock phase in India, online purchasing and online transactions are still positively increasing and this helps to improve the Indian economy.

2) Accessibility of e-banking

In the pandemic accessibility of e-banking facilities increase tremendously. Now a day's anyone and everyone can use E-banking services from anywhere in this world where they have internet connectivity. Because of the ease and fast transaction, more and more bank customers are using the E-banking facilities of their bank. This increase in the electronic transaction increases the profit ratio of the bank and which positively affects the banking financial performance. In a pandemic, people are scared to go out in this situation According to the survey of bank customer uses, the online banking facility because of ease and convenience. Ecommerce and E-banking both are in demand during this pandemic. Accessibility of e-banking is very helpful for every individual because of the e-banking facility, day-to-day life purchase electricity bill, gas bill, bank EMI, and every expense done through an electronic transaction from home. An individual who leaves away from their family for employment purpose or any other purpose can send the money within one day to their relatives by using an e-banking facility from any place in the world.

Negative impact
1) Security

During the pandemic situation, most of the population wish to an electronic transaction by using e-banking services of their respective banks, or other online payment options rather than cash transactions for their expenses. But sometimes this e-banking facility comes into question when there's a question of customer security. In the starting period when banks introduced e-banking services, hardly 20 percent population accepted this change and coped up with e-banking facilities. Bank customers who are above 60 age group are so much concerned about their banking transactions and uploading personal and bank information on the internet. Some of the bank customers face online banking scams and online banking fraud. Most of the time people don't know the banking hidden charges while doing online transactions which directly affects their bank balance. Sometimes banks show the warning or show the hidden charges page on online site but in hurry or because of lack of knowledge people don't read the instruction or charges page and directly click on the ok or I agree on a button.

2) Privacy and Risk:

By using an e-banking facility customers do the online transaction because it is easy and fast but sometimes customers get afraid to do an online transaction because they have to fill in personal information such as name, address, date of birth, city, credit, and debit card details on the web. Customers are afraid that if they put their personal information on the internet then it can be misused or do some illegal activity. E-banking

do have privacy terms and conditions but due to lack of knowledge people didn't read the terms and condition and do their transaction which affects their privacy, like they get messages from unknown sources, there, get fraud calls, and sometimes they get threatened calls, etc. Most senior citizens don't trust e-banking because of a lack of confidence, and because of proper knowledge of how to use e-banking services while doing electronic transactions.

Conclusion

The study determined a tremendous increase in the number of customer acceptances for online banking. The study also shows the increase in transaction amounts and positive effects on online banking. The pandemic also changes customer preferences from normal banking to online banking. The study also shows a negative impact on customer safety and insecurity about online transactions, such as online fraud and online money stolen. We hope this paper will help you to understand customer preferences in online banking and online transactions. And change in performance of bank by using E-banking services. Pandemic impact on online banking and customer's behavior towards e-banking.

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FUTURE OF WORK IN ARTIFICIAL INTELLIGENCE

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ABSTRACT

This paper explores the transformative role of Artificial Intelligence (AI) in modern businesses, analyzing its journey from academic innovation to market integration. It investigates the profound socio-economic impacts of AI, examining both its opportunities and challenges. Using a neo-Schumpeterian economic framework, the study identifies innovation, knowledge, and entrepreneurship as key drivers of AI's commercial success. It reviews significant technological advancements such as deep learning and evaluates global trends through the analysis of top 200 AI start-ups, highlighting sectorial impacts (e.g., cybersecurity, healthcare) and funding patterns. The study also identifies geographical concentrations of AI innovation, with the U.S. leading the charge. The paper concludes by warning of an emerging "AI divide" and calls for attention to ethical, social, and technical challenges to ensure inclusive growth. Ultimately, it argues that AI is not a transient hype but a pivotal force reshaping global economic landscapes.

MANUSCRIPT

The research paper delves into the evolution of Artificial Intelligence (AI) and its integration into business practices, with a particular focus on its implications for the global economy. Framing AI as a core component of the Fourth Industrial Revolution, the study underscores how technologies like deep learning, big data, and high- performance computing have driven AI's resurgence and applicability across sectors. At the foundation of the analysis is the neo-Schumpeterian economic model, which emphasizes innovation, knowledge, and entrepreneurship. These elements are shown to be central to the successful deployment of AI in the commercial sphere. The study emphasizes the historical trajectory of AI, referencing predictions made in 1973 and highlighting how many of those envisioned applications—such as automatic translation, robotic diagnostics, and self-driving cars—are now realities. These companies were selected using CB Insights' Mosaic algorithm, which evaluates a range of factors including business model, investor quality, and funding history. The analysis revealed that sectors such as cybersecurity, healthcare, business intelligence, and core AI are the most dominant fields. Despite being only 2% of start-ups, the media and news sector attracted over 25% of total investment in AI18, reflecting strategic interest in AI-driven content delivery. Geographically, AI development is concentrated in just 13 out of 195 countries, with the United States—especially California—dominating. This geographical skew is flagged as a potential source of a future "AI divide," mirroring concerns seen in the digital divide. The paper also explores the role of datasets and algorithms in AI development. It details successful applications of deep learning in fields like computer vision, speech recognition, and game-playing, noting that many of these systems now exceed human-level performance. It identifies challenges in transparency, ethics, trust, and talent shortages that may hinder widespread adoption.

INTRODUCTION

Innovation has historically driven improvements in living standards, while also disrupting conventional technologies. Recent advances in fields such as cloud computing, IoT, big data, data science, AI, and

blockchain have shifted from being niche to widely adopted across industries. These technologies, many of which are decades old, have become mainstream due to improvements in computing power, open-source development, and global connectivity platforms like GitHub and GitLab. AI stands out as the core driver of the Fourth Industrial Revolution (Industry 4.0), enhancing the functionality of other technologies. It is credited with offering transformative potential for business operations and economic systems. The paper identifies several benefits of AI at the business level: uncovering patterns in large datasets, enabling real-time analytics, improving product design, and enhancing decision-making, which leads to increased efficiency, profit, and expansion. To analyze AI's impact, the study employs Neo-Schumpeterian Economics, a framework that emphasizes the roles of innovation, knowledge, and entrepreneurship. The methodology includes evaluating two top-100 AI startup lists to explore trends in commercialization, investor interest, and geographic distribution.

Therefore, identifying drivers of AI's growth, academic innovations advancing intelligent products, dominant AI sectors, leading investment trends, and regions spearheading AI development. The paper argues that AI is not merely hype, but a genuine catalyst of economic and social transformation. The research aims to help countries better prepare for widespread AI adoption, and offers insights into how AI is reshaping global business landscapes.

RESEARCH OBJECTIVES AND DATA COLLECTION

We are living in a remarkable era of rapid technological advancements, where innovations are becoming a part of everyday life faster than ever before. Artificial Intelligence (AI) has emerged as one of the most significant drivers of this transformation. From robots working in industries to self-driving cars, and from smartwatches monitoring our health to AI beating world champions in games like Chess and Go, AI is impacting nearly every aspect of life. The year 2016 marked a major shift in how the world viewed AI, with almost every leading tech company aiming to become an "AI company." This raises several important questions—why is there such a rush towards AI, and what is causing this sudden spike in interest? Although AI as a concept has existed for over six decades, it has only recently begun to show exponential growth and real-world impact. The reasons behind this transformation, and the extent to which AI is changing industries, are worth investigating. This study aims to explore these critical questions by analyzing various sources including research papers, company reports, AI magazines, and online discussions. Understanding these trends will help society adapt to AI-driven changes and prepare for the challenges and opportunities that lie ahead in the future.

STATE OF THE ART OF AI

Artificial Intelligence as a formal field was established in 1956 by John McCarthy, who believed that machines would eventually achieve human-level intelligence. Since its inception, AI has experienced phases of great enthusiasm and progress, followed by periods of stagnation known as "AI winters," largely due to limitations in data availability and hardware capabilities. Despite these setbacks, AI has witnessed a remarkable resurgence in recent years, primarily due to the development of deep learning and the availability of massive datasets and high-performance hardware like GPUs and TPUs. The core of AI applications" is the intelligent agent (IA), which operates in a continuous loop of sensing, thinking, and acting. It processes large volumes of data— commonly referred to as big data—to learn patterns, extract features, and make informed decisions. The recent rise in low-cost sensors and devices has contributed significantly to the explosion of data available for AI training. A key element in the success of modern AI systems is the availability of diverse and accessible datasets online, which are systematically documented

in the appendix of this study. These datasets serve as the foundation upon which AI algorithms operate. Machine learning techniques like SVMs, decision trees, Bayesian methods, and particularly deep learning networks (DLNs) are widely used to process this data.

Although DLNs have existed since the 1940s, only in recent years have they become viable, thanks to advanced processing capabilities provided by GPUs. Today, DLNs have even outperformed human accuracy in certain domains like vision, speech, text analysis, and gaming, indicating the immense potential of AI technology.
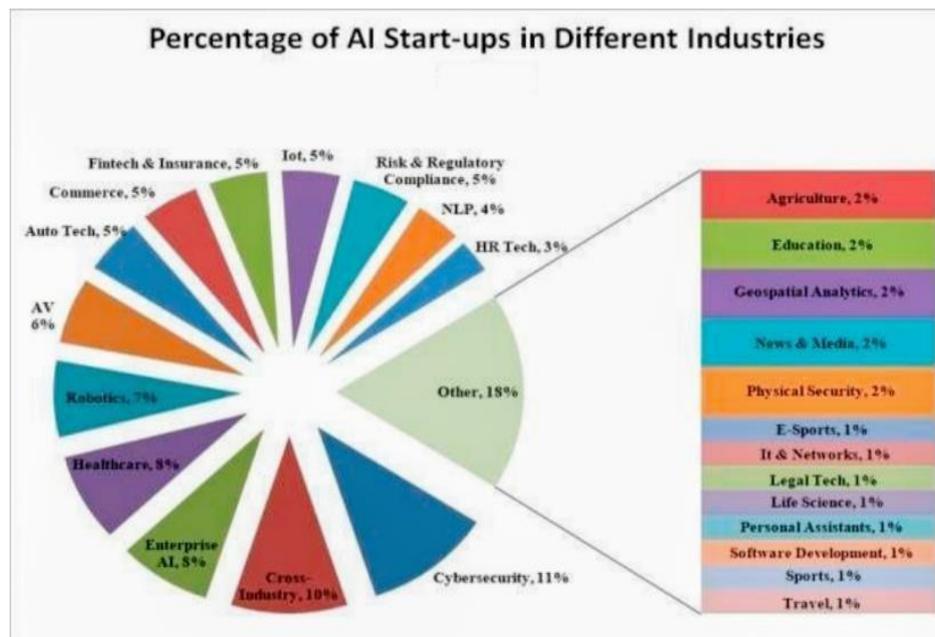
GLOBAL MARKET ANALYSIS

In today's knowledge-driven economy, start-ups are crucial for innovation and economic growth, especially when it comes to the adoption of Artificial Intelligence (AI). To understand the real-world impact of AI on businesses, two curated lists of the top 100 AI start-ups were analyzed. These lists were created using the Mosaic algorithm by CB Insights, which evaluates various factors such as funding history, business model, investor quality, and profile strength. The research findings, part of which were presented at DIGITS 2018 and later submitted to the *Journal of Business Research*, provide valuable insights into how AI start-ups are shaping the business landscape globally. These start-ups are spread across 22 different industries—from healthcare and education to autonomous vehicles and business intelligence—highlighting how AI is transforming almost every sector. The funding trends are equally impressive. From a modest \$25.88 million invested in 2011, global AI start-up investments surged to \$1.87 billion by 2016 and then jumped further to\$12.74 billion in 2018. Interestingly, while only 2% of AI start-ups operate in the news and media sector, they received over 25% of the total funding, largely due to giants like SoundHound Inc. and Bytedance. Both are focused on making human-machine interaction seamless. Geographically, the AI revolution remains concentrated, with start-ups from AI17 and AI18 based in just 13 out of 195 countries. The U.S., especially California's Silicon Valley, dominates the scene, housing nearly 75% of these top AI ventures—clearly making it the global hub for AI innovation.

Total Funding Raised by AI17 (in $million)
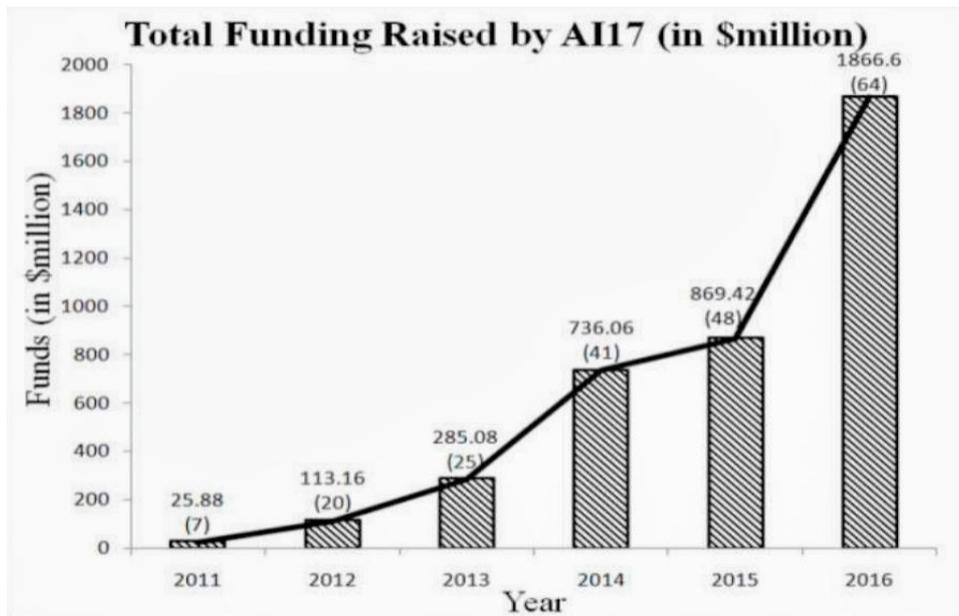
CONCLUSION

This study delves into the major breakthroughs and technological advancements in Artificial Intelligence, showing how far the field has come. What was once considered futuristic—AI-powered products envisioned nearly five decades ago—has now become reality, proving that AI is not a passing trend but a transformative force in global business. The rapid development and deployment of AI systems are largely due to two primary enablers: the explosion of big data and the rise of powerful processing units like GPUs and TPUs. The research Identifies four key areas where deep learning has made the biggest impact— computer vision, speech recognition, text analysis, and gaming. Each area has seen applications that not only function efficiently but, in some cases, outperform human capabilities. A curated list of datasets and sources has been included to support researchers and practitioners further. Analyzing 200 leading AI start-ups also reveals the rising global demand and commercial interest in AI. Investments have been consistently increasing, pointing toward an exponential appetite for AI-powered solutions. Sectors like healthcare, business intelligence, cybersecurity, and marketing are expected to drive this growth even further. AI is helping companies become more productive, efficient, and customer-focused, while also reducing costs and errors. However, the study highlights a critical concern—AI innovation is largely concentrated in a few global regions, creating an "AI divide" similar to the digital divide, which may worsen global inequalities. Additionally, issues like software vulnerabilities, lack of transparency, trust, ethics, and a shortage of skilled talent still pose significant barriers to the safe and widespread adoption of AI in real-world applications.

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