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# Assessing the Impact of Insurance Schemes on Student Well-being and Academic Performance

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## Abstract

This research explores the relationship between insurance schemes and student well-being, particularly focusing on how such schemes influence academic performance. With rising educational costs and health-related uncertainties, insurance plans tailored for students—covering medical, accident, or fee protection play a critical role in offering financial security and mental relief. The study aims to identify the extent to which these insurance schemes affect students' psychological stability, attendance, and academic focus. By employing analytical methods, this research investigates patterns in insurance awareness, utilization, and perceived effectiveness among students in higher education. The findings intend to guide policymakers and educational institutions in strengthening support systems that enhance student success and retention.

**Key Words: Student Well-being, Academic Performance, Insurance Schemes, Financial Security, Higher Education**

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## Introduction

In the dynamic educational landscape, students face a multitude of pressures including financial stress, health concerns, and academic expectations. To mitigate these challenges, insurance schemes for students have emerged as crucial safety nets, offering coverage for medical emergencies, accidental injuries, and even tuition protection. However, the awareness, accessibility, and actual impact of such schemes on student life remain under-explored areas, especially in developing contexts.

Student well-being encompasses physical, mental, emotional, and financial dimensions, all of which contribute significantly to learning outcomes and academic achievements. When students are protected from unforeseen disruptions through insurance coverage, they may experience reduced anxiety, better attendance, and a more focused academic routine. On the contrary, lack of awareness or underutilization of available schemes may lead to missed opportunities for support and increased vulnerability.

This research investigates how various student insurance schemes influence well-being and academic performance by analyzing real-time usage data, perception studies, and case outcomes. It takes into account socio-economic factors, policy frameworks, and institutional roles in implementing these schemes. By identifying and examining the key variables, this study aims to provide insights into optimizing insurance strategies to support student success holistically.

## Review of Literature

Insurance schemes for students have gained attention as potential tools for improving educational continuity, reducing stress, and supporting health. However, limited studies have examined the direct relationship between insurance coverage and academic performance. This literature review highlights the existing research on insurance awareness, policy design, student perception, and its impact on student well-being.

A pilot study conducted at **Symbiosis International University** (Gopalakrishna & Kadam, 2021) evaluated the impact of health insurance knowledge on students. It was observed that insured students demonstrated better awareness of healthcare systems and showed less hesitation in

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seeking medical help, contributing positively to their well-being. This early intervention in health literacy was linked to fewer absentee days, indirectly benefitting academic outcomes.

*"Social Security Schemes and Their Effectiveness among College Students in Urban India"* discussed how most students were unaware of the government-sponsored or institution-provided insurance schemes. The study revealed that while the schemes existed, the communication gap between institutions and students led to underutilization. The thesis emphasized the need for orientation programs and policy transparency to make these schemes more effective.

According to **Reddy and Venkayalapati (2019)** in their review of **Student Safety Insurance Policies (SSIP)** across Indian states, insurance schemes primarily focused on accidental and health-related coverage. Their research noted that while such coverage offers financial relief, it rarely includes psychological support or academic continuity components, such as tuition refunds or mental health access—elements critical to maintaining academic performance during crises.

 **S. N. Bhatt (2018)** explored the relationship between financial protection schemes and stress levels among postgraduate students. The study found that students with institutional health coverage reported reduced anxiety during medical emergencies, allowing them to better focus on academics. However, the study noted that many such schemes lacked inclusivity, excluding students from economically weaker backgrounds due to procedural barriers.

Furthermore, research by **Kumar & Meena (2021)** on **Perception and Satisfaction toward Health Insurance among Indian Youth**, published in the *Journal of Management Research*, reported that students who perceived their insurance plans as adequate were more likely to seek preventive care and report higher satisfaction levels. This perception contributed to a positive outlook and a sense of financial security, both of which play a role in academic engagement and performance.

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**Methodology**

## Statement of the Problem

In recent years, insurance schemes specifically designed for students—such as health, accident, and tuition protection policies—have gained attention as potential tools to safeguard students from unexpected disruptions in their academic journey. However, despite their growing availability, many students remain unaware of these schemes, or fail to access or utilize them effectively. This gap raises critical questions about the real-world impact of such insurance coverage on student well-being and academic outcomes.

Furthermore, while some institutions and governments advocate for student insurance as a means to reduce dropout rates and academic stress, there is limited empirical evidence supporting this claim. There is a pressing need to systematically assess whether these schemes truly contribute to improved mental health, reduced financial anxiety, and enhanced academic performance among students.

Therefore, this study seeks to address the problem of insufficient understanding and evaluation of how student insurance schemes affect various dimensions of student life. It aims to uncover whether these schemes are effectively fulfilling their purpose and to what extent they influence the academic success and psychological well-being of students in higher education institutions.

## Need for the Study

Student populations today face increasing risks related to health, accidents, and financial stress, which directly affect their academic continuity and mental well-being.

There is limited awareness and utilization of student insurance schemes, despite their potential to offer substantial support during emergencies.

Educational institutions and policymakers lack comprehensive data on whether these schemes are effective in improving student outcomes.

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Understanding the real impact of insurance schemes can help optimize student support systems and prevent academic dropouts due to unexpected disruptions.

The study will provide empirical insights that can guide better implementation and communication strategies for insurance policies targeting students.

## Scope of the Study

The study focuses on students enrolled in higher education institutions, covering both undergraduate and postgraduate levels.

It includes various types of insurance schemes such as health insurance, accident insurance, and tuition protection plans.

The research will explore both the perceived and actual impact of these schemes on student well-being and academic performance.

Data will be collected through surveys, institutional reports, and student interviews to ensure a holistic perspective.

The study will be limited to a specific geographical region or group of institutions (to be defined in methodology), which allows for a focused and contextually relevant analysis.

## Objectives

1. To identify the level of awareness and utilization of insurance schemes among students in higher education institutions.

2. To examine the relationship between insurance coverage and student well-being indicators such as stress levels, attendance, and healthcare access.

3. To analyze the impact of insurance schemes on academic performance metrics, including GPA, retention rates, and exam participation.

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4. To study the perception of students regarding the adequacy, accessibility, and effectiveness of the insurance schemes available to them.

## Research Questions

1. To what extent are students aware of the insurance schemes available to them in higher education institutions?

2. How do insurance schemes influence students' physical, mental, and financial well-being?

3. Is there a measurable impact of student insurance coverage on academic performance indicators such as GPA, attendance, and retention?

4. What are the students' perceptions regarding the accessibility, adequacy, and usefulness of these insurance schemes?

5. What barriers prevent students from enrolling in or utilizing available insurance benefits effectively?

## Research Type:

The present study is classified as **analytical research**, as it goes beyond mere description and seeks to interpret, evaluate, and draw conclusions from existing data and observed patterns. This type of research is suitable for examining the relationship between student insurance schemes and their impact on well-being and academic performance. Rather than just outlining the availability or awareness of such schemes, the study will analyze how these schemes influence specific academic metrics like attendance, grades, and retention, as well as psychological aspects such as stress reduction and financial stability. By applying statistical tools and comparative analysis, the research aims to uncover cause-and-effect relationships and critically evaluate the effectiveness of these schemes. This approach will help derive meaningful insights that contribute to better decision-making by educational institutions and policymakers focused on student welfare.

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## Research design:

This study will employ a mixed-methods explanatory sequential design, starting with a quantitative survey and academic record analysis of insured and uninsured students selected through stratified random sampling to measure the impact of insurance schemes on their well-being and academic performance, and subsequently conducting qualitative interviews to gain deeper insights into the underlying mechanisms and student experiences. The study will follow a mixed-methods explanatory sequential research design. In the first phase, a quantitative survey will be conducted among insured and uninsured students, along with an analysis of their academic records, using stratified random sampling to ensure fair representation from different departments and year levels. This phase will help measure the direct impact of insurance schemes on student well-being and academic performance. In the second phase. Qualitative interviews and discussions will be carried out to explore students. Experiences perceptions, and the mechanisms through which insurance schemes influence their stress levels, health security. and study outcomes .The combination of both quantitative and qualitative approaches will provide a comprehensive understanding of the impact of insurance schemes on students.

## Data collection

Data for this study will be collected through both quantitative and qualitative methods to ensure a comprehensive understanding of the topic. The quantitative data will be gathered using a structured questionnaire, which will be distributed to both insured and uninsured students in online as well as paper-based formats. This questionnaire will include items related to insurance coverage, awareness of schemes, healthcare access, financial stress, and overall well-being using standardized scales. Academic performance details such as GPA, attendance records, examination results, and backlog information will be obtained from institutional records after securing proper consent from participants.

## Sampling design

The sampling plan for this study will involve selecting participants through a stratified random sampling method to ensure adequate representation of students across different academic programs, departments, and year levels. The total population will consist of both insured and uninsured students

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enrolled in the institution. From this population, a sample of approximately 70 students will be chosen for the quantitative survey, with the number of respondents from each stratum proportionate to their actual presence in the overall student body. This ensures that the results reflect the diversity of the student population while minimizing sampling bias. In the second phase, a purposive sampling approach will be adopted to select around 50–65

students for qualitative interviews and focus group discussions, ensuring variation in gender, socio-economic background, and insurance status. This mixed sampling plan allows for both broad generalization through the survey and deeper understanding through personal experiences, thereby strengthening the overall reliability and validity of the research findings.

## Sampling plan

This study will employ a **stratified random sampling approach** to capture a representative mix of students across programs and academic years. The target group comprises all currently enrolled undergraduate and diploma students, with the official student roster serving as the sampling frame. The overall sample size will be determined using Cochran's formula at a 95 % confidence level and a 5 % margin of error and then increased slightly to account for possible nonresponse. Students will be divided into strata based on key characteristics such as program of study and year of enrollment, and participants within each stratum will be chosen randomly. This design ensures balanced inclusion of both insured and uninsured students, enabling accurate assessment of the impact of insurance schemes on their well-being and academic performance.

## Sampling Method:

The study will employ a stratified random sampling method to obtain a sample that accurately reflects the diversity of the student population. First, the complete list of currently enrolled undergraduate and diploma students will be obtained from the registrar and used as the

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sampling frame. Students will then be divided into strata based on key characteristics such as programmed of study, academic year, and known insurance status

## Sampling Frame:

Using this registry ensures that every eligible student, both insured and uninsured, has a known and non-zero chance of selection. The list will be cleaned to remove duplicates or students on long-term leave and then organized into strata programmed year and insurance status before random selection. This comprehensive roster serves as the practical bridge between the target population and the actual sample making it possible to draw a representative group for assessing the impact of insurance schemes on student well-being and academic performance.

## Sampling Units

In this study, the individual enrolled student serves as the sampling unit. Each student listed on the current institutional roster is treated as a single unit from which data on insurance coverage, well-being, and academic performance will be gathered. Choosing the individual as the sampling unit ensures direct collection of relevant information and provides every eligible student with an equal, independent chance of selection, enabling accurate comparisons between insured and uninsured groups across various programs and academic levels.

## Plan of Analysis

The data collected will first be checked and cleaned to remove errors or missing details. Simple statistics like counts, percentages, and averages will describe the students and their insurance status, well-being, and academic scores. After that, tests such as chi-square, t-tests, and ANOVA will compare insured and uninsured students to see if there are important differences.

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Finally, regression analysis will find out whether insurance influences student well-being and grades while also considering other factors like age, gender, and program of study.

## Limitation of the study

❖ The study is conducted in a single institution, which may limit the generalizability of the results.

❖ Some data on well-being and academic performance are self-reported, which can introduce bias.

❖ The cross-sectional design captures information at one point in time, limiting causal conclusions.

❖ Nonresponse or incomplete responses from some students may affect sample representation.

❖ External factors such as family support, personal health, or socio-economic background are not fully controlled.

## Key Analysis and Interpretation

| Area Impact | Impact Area | Without/Inadequate Insurance | Academic Performance Interpretation |
|---|---|---|---|
| Access to Health Care | Easy access to doctors, hospitals, and preventive care | Difficulties obtaining care, delayed treatment | Better focus and attendance |
| Financial Burden | Lower medical costs, reduced emergency expenses | Higher costs, financial stress | Less financial distraction |
| Stress Level | Lower stress, improved peace of mind | Higher stress, anxiety over medical expenses | Increased ability for academic performance |
| Health Outcomes | Better health through regular check-ups and vaccination | Higher risk of untreated illness, missed classes | Improved school participation |

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**Gender Distribution:**

The survey received 62 responses, with a slightly higher percentage of females (56.5%) participating compared to males (43.5%). There were no responses indicating "Prefer not to say" or "Other" for gender. This suggests that the respondent pool is somewhat skewed towards female students.

**Age Distribution:**

The vast majority of respondents (87.1%) fall within the 10-25 age group. A smaller proportion (9.7%) are between 25-35, and an even smaller group (3.2%) are aged 35-45. There were no responses from individuals aged 45-55, indicating that the survey primarily captured the opinions of younger students, likely those in undergraduate or early postgraduate studies.

**Student Insurance Coverage:**

The data indicates that a significant majority of students (74.2%) are not currently covered under any student insurance scheme. Only 25.8% of the respondents reported having student insurance. This highlights a considerable gap in insurance penetration among the surveyed student population.

**Awareness of Student Insurance Schemes:**

Despite the low coverage rate, 69.4% of students are aware that some institutions or governments provide insurance schemes for students. However, a substantial 30.6% remain unaware, suggesting a need for increased information dissemination regarding the availability of such programs.

**How Students Learned About Insurance Schemes:**

Friends/Family are the most common source of information about student insurance schemes, accounting for 46.8% of responses. College administration and social media each contribute a significant portion (25.8% and 22.6% respectively), while insurance companies directly inform only a small segment (4.8%). This suggests that informal networks and university communication are more impactful than direct marketing from insurers.

**Types of Student Insurance Heard Of:**

Health insurance is the most widely recognized type of student insurance, with 46.8% of respondents having heard of it. Life insurance and accidental insurance are also known by a notable percentage (32.3% and 9.7% respectively). Fee refund/scholarship protection is less known at 9.7%, and a very small percentage (1.6%) have heard of none of the listed types.

**Personal Availment of Student Insurance Benefits:**

Mirroring the coverage rate, 56.5% of students have not personally availed any student insurance benefits, while 43.5% have. This indicates that a significant portion of those who are covered have utilized their benefits, or there might be some discrepancy between current coverage and past availment.

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**Types of Benefits Received:**

Among those who have availed benefits, medical expenses covered is the most common, accounting for 38.7% of responses. Fee refunds (21%) and compensation for accidents (14.5%) are also significant. Counseling or mental health support was received by 1.6% of respondents, with a substantial 24.2% reporting "Others (please specify)". This suggests a broad range of benefits being utilized, with medical needs being primary.

**Impact of Insurance Coverage on Attendance/Academic Continuity:**

For 51.6% of respondents, insurance coverage has had no effect on their attendance or academic continuity. However, 33.9% reported that it *has* affected it, suggesting a positive impact in maintaining academic progress. A smaller group (14.5%) indicated that their coverage was "Not accepted," which could point to issues with policy understanding or acceptance at institutions.

**Perceived Impact of Insurance Schemes on Academic Focus:**

A majority of students (53.2%) believe that insurance schemes can help them stay more focused on academics. A notable percentage (27.4%) are unsure, and 19.4% do not think it helps. This suggests a general recognition of the potential benefits of insurance in reducing stress and allowing students to concentrate on their studies.

**Suggestions for Improving Awareness and Access:**

The suggestions provided are mostly brief and informal, with many "NA," "No," "Nothing," or single-word responses like "Yes." This indicates that while students might have a general idea, specific, detailed suggestions for improvement are not readily formulated. The qualitative nature of this question results in less structured feedback.

**Suggestions for Better Insurance Scheme Design:**

Similar to the previous question, many responses are brief or non-specific. However, a few key themes emerge, such as "Customized coverage" and "Minimal amount low premium cost and high benefits." This suggests students desire more tailored and affordable insurance options with comprehensive benefits.

**Receipt of Training/Briefing on Insurance Coverage:**

More than half of the respondents (53.8%) have not received any training or briefing sessions on how to use their insurance coverage. 40.4% have received such training, while 5.8% don't remember. This highlights a significant gap in educating students about their insurance policies and how to utilize them effectively.

**Knowledge of Claiming Insurance Benefits:**

A majority of students (63.5%) know "a little" about the process for claiming insurance benefits, indicating partial understanding. Only 17.3% know the full process, while 19.2% do not know. This, combined with the lack of training, suggests that many students may struggle with the claims process.

**Satisfaction with Enrolled Insurance Scheme:**

Satisfaction levels are varied, with 42.3% feeling neutral, 38.5% satisfied, and 13.5% very satisfied. Only a small percentage reported being dissatisfied (3.8%) or very dissatisfied (1.9%). This suggests that while there's

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room for improvement, a large portion of those enrolled are at least moderately content with their current schemes.

**Rating of College Communication on Insurance Policies:**
Communication from colleges regarding student insurance policies is largely rated as "Good" by 65.4% of respondents. 17.3% rate it as "excellent," while smaller percentages rate it as "poor" (9.6%), "average" (7.7%), or "very poor" (0%). This indicates that colleges are generally doing a decent job of communicating, but there's still room to improve for those who rated it less favorably.

**Perception of Current Schemes Covering Essential Needs:**
Students have mixed feelings about whether current insurance schemes cover their essential needs. While 34.6% believe they do and 28.8% believe they do not, a significant 34.6% feel they are "Partially" covered. Only 1.9% are "Not sure." This suggests that many students find current offerings to be somewhat adequate but not fully comprehensive.

**Willingness to Pay for Better Coverage:**
Nearly half of the students (48.1%) would be willing to pay a small amount yearly for better student insurance coverage. 34.6% stated their willingness "depend[s] on the Benefits offers," and 17.3% would not be willing to pay more. This indicates a strong openness to investing in improved insurance, especially if the benefits are clear and appealing.

**Ignoring Medical Issues Due to Cost Concerns:**
A concerning number of students have ignored medical issues due to cost. 27.5% reported doing so "once or twice," and 11.8% "frequently." While 21.6% have not, and 23.5% answered "Maybe," this highlights a significant problem where financial concerns prevent students from seeking necessary medical care.
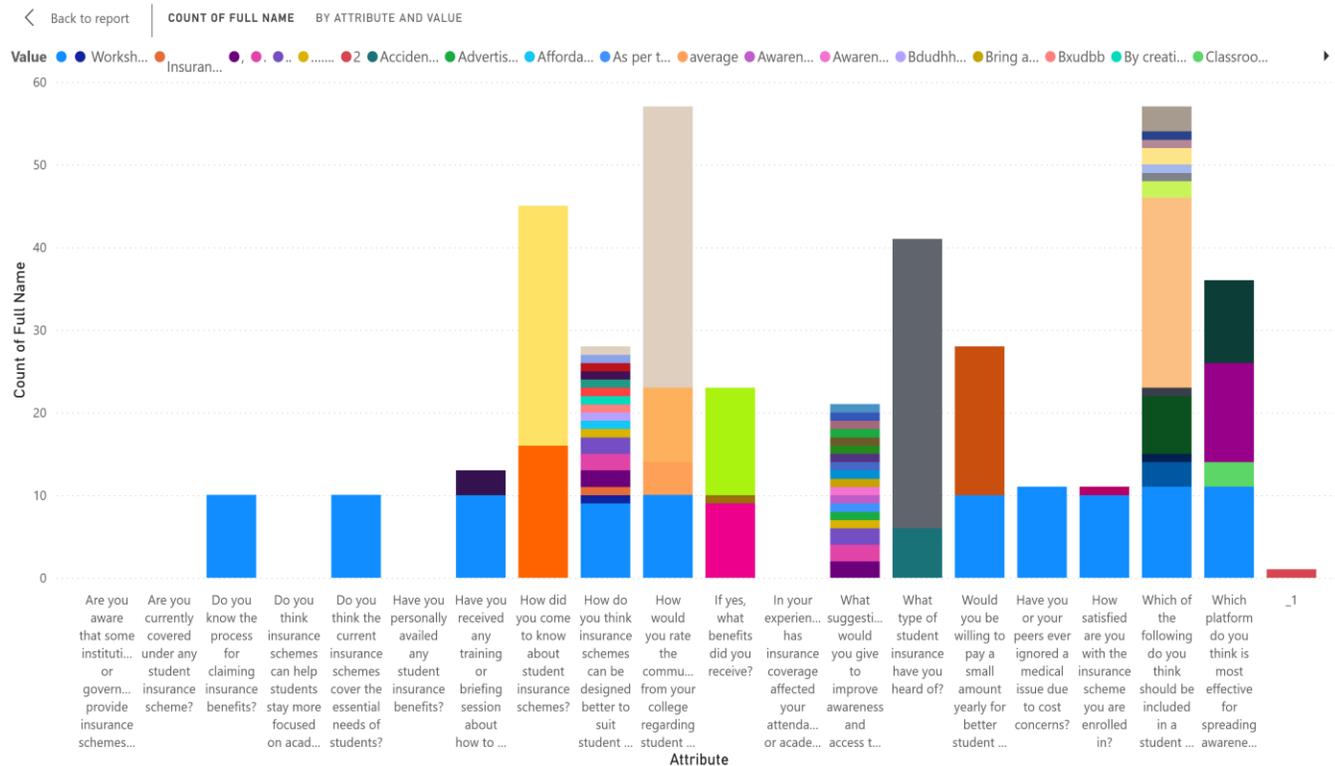
**Most Effective Platform for Spreading Awareness:**
Social media is considered the most effective platform for spreading awareness about student insurance by 33.3% of respondents. College websites and WhatsApp/Telegram groups are also seen as highly effective (23.5% and 15.7% respectively). Email and classroom announcements have a notable impact (19.6% and 7.8%), while posters/brochures are least effective (0%). This emphasizes the importance of digital and peer-to-peer communication channels.

**Desired Inclusions in Student Insurance Policy (Multiple Choice):**
Hospitalization expenses are overwhelmingly considered the most important inclusion, with 60.8% of respondents selecting it. Emergency ambulance service (23.5%), death or disability compensation (17.6%), and mental health counseling (17.6%) are also highly valued. Tuition fee refund in case of emergency and hostel/accident cover are less prioritized (both at 11.8%). This clearly indicates a strong demand for core medical and emergency coverage.

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## Interpretation:



### Gender Distribution:

The survey's participant pool shows a slight female bias, with 56.5% of respondents identifying as female compared to 43.5% as male. This imbalance suggests that the findings may lean slightly towards perspectives more common among female students. Future surveys aiming for broader representativeness might consider strategies to balance gender participation.

### Age Distribution:

The overwhelming majority of respondents (87.1%) fall within the 10-25 age bracket, indicating that the survey predominantly captures the views of younger students, likely undergraduates. This concentration means the insights primarily reflect the needs and experiences of this specific demographic, and may not fully represent older student populations who might have different insurance requirements or awareness levels.

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**Student Insurance Coverage:**

A significant observation is that nearly three-quarters (74.2%) of the students surveyed lack any student insurance coverage. This high percentage of uninsured students points to a critical gap in the safety net for a large segment of the student population. It suggests either a lack of accessible options, insufficient awareness, or perceived unaffordability.

**Awareness of Student Insurance Schemes:**

While many students are uninsured, 69.4% are aware that such schemes exist through institutions or governments. This indicates that the problem isn't solely a lack of information about the *existence* of insurance. Instead, it might stem from a lack of understanding about *how to access* these schemes, their benefits, or a perception that they are not relevant or necessary for their personal circumstances.

**How Students Learned About Insurance Schemes:**

Word-of-mouth through "Friends/Family" (46.8%) is the primary channel for students learning about insurance, followed by "College administration" (25.8%) and "Social media" (22.6%). Direct engagement from "Insurance companies" is notably low (4.8%). This highlights the power of informal networks and university-led communications in spreading awareness, suggesting that official channels and peer influence are crucial for effective outreach.

**Types of Student Insurance Heard Of:**

"Health Insurance" is the most commonly recognized type of student insurance (46.8%), underscoring students' understanding of its importance. "Life Insurance" and "Accidental Insurance" are also known, but to a lesser extent. The relatively lower awareness of "Fee Refund/Scholarship Protection" suggests that students might not fully grasp the financial risks associated with academic interruptions, indicating a need to highlight a broader range of insurance benefits beyond immediate health concerns.

**Personal Availment of Student Insurance Benefits:**

A substantial 43.5% of respondents have personally utilized student insurance benefits, indicating that for those who are covered, the insurance is actively serving its purpose.

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Conversely, the 56.5% who haven't availed benefits might include those who are covered but haven't needed to use it, or those who are completely uninsured. This metric suggests that when students do have insurance, they find reasons to use it.

**Types of Benefits Received:**

Among those who availed benefits, "Medical expenses covered" stands out at 38.7%, emphasizing the primary role of student insurance in addressing health needs. "Fee refund" (21%) and "Compensation for accident" (14.5%) also represent significant benefit categories. The "Others (please specify)" category being substantial (24.2%) indicates a diverse range of other support students are receiving, suggesting insurance schemes cover a broader spectrum of needs than just the explicitly listed options.

**Impact of Insurance Coverage on Attendance/Academic Continuity:**

A third of students (33.9%) reported that insurance coverage positively impacted their attendance or academic continuity. This suggests that having insurance acts as a crucial support mechanism, preventing potential disruptions to their studies. However, the 14.5% whose coverage was "Not accepted" points to possible administrative hurdles or misunderstandings that can undermine the intended benefits of these schemes.

**Perceived Impact of Insurance Schemes on Academic Focus:**

Over half of the students (53.2%) believe that insurance schemes enable them to focus better on academics. This strong positive sentiment suggests that the peace of mind provided by insurance significantly reduces stress related to unforeseen events. The considerable portion of "Maybe" and "No" responses indicates that the perceived value isn't universal, possibly due to a lack of direct experience or insufficient understanding of the full scope of benefits.

**Suggestions for Improving Awareness and Access:**

The feedback on improving awareness and access, while often brief ("NA," "No," "Nothing"), highlights a general desire for better information flow without specific, detailed proposals. This pattern suggests that while students recognize the need for improvement, they may not have concrete solutions. It implies that information campaigns need to be clearer and more easily digestible rather than simply more frequent.

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**Suggestions for Better Insurance Scheme Design:**

Key suggestions for improving scheme design include "Customized coverage" and "Minimal amount low premium cost and high benefits." This reveals that students are looking for insurance options that are flexible, affordable, and deliver substantial value for their investment. They desire plans that cater specifically to student life challenges rather than generic insurance offerings.

**Receipt of Training/Briefing on Insurance Coverage:**

More than half (53.8%) of students have not received any training or briefing on how to use their insurance coverage. This significant lack of instruction is a critical oversight. It likely contributes to students being unaware of how to claim benefits or the full scope of their coverage, hindering their ability to effectively utilize their policies when needed.

**Knowledge of Claiming Insurance Benefits:**

The fact that only 17.3% of students know the full process for claiming benefits, with 63.5% knowing "a little," underscores a widespread knowledge gap. This partial understanding, combined with the lack of training, suggests that many students could face significant challenges and frustration when trying to access their insurance benefits, potentially leading to underutilization or missed opportunities for support.

**Satisfaction with Enrolled Insurance Scheme:**

Satisfaction with existing insurance schemes is mixed, with the largest group feeling "Neutral" (42.3%), followed by "Satisfied" (38.5%). While outright dissatisfaction is low (totalling less than 6%), the high neutrality suggests that many schemes are perceived as adequate but not exceptional. This indicates room for improvement in meeting student expectations and enhancing overall policy value.

**Rating of College Communication on Insurance Policies:**

College communication regarding student insurance policies is generally well-regarded, with 65.4% rating it as "Good" and 17.3% as "Excellent." This suggests that most institutions are effectively conveying information. However, the presence of "Poor" (9.6%) and "Average"

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(7.7%) ratings indicates that consistency in communication quality across all institutions or for all students needs to be addressed.

**Perception of Current Schemes Covering Essential Needs:**

Students are divided on whether current schemes cover their essential needs, with nearly equal proportions saying "Yes," "No," or "Partially." The significant "Partially" response (34.6%) highlights a common sentiment that existing policies may not be fully comprehensive. This suggests that while basic needs might be met, there are often gaps in coverage that leave students feeling vulnerable in other areas.

**Willingness to Pay for Better Coverage:**

There's a strong appetite among students for better insurance, with 48.1% willing to pay more for enhanced coverage, and another 34.6% willing to pay depending on the benefits. This indicates that affordability is a factor, but students are primarily driven by the value and comprehensiveness of the benefits offered. It suggests a market for premium student insurance that clearly articulates its added advantages.

**Ignoring Medical Issues Due to Cost Concerns:**

A worrying finding is that a substantial number of students have ignored medical issues due to cost concerns: 27.5% "once or twice" and 11.8% "frequently." This highlights a significant public health issue within the student population, where financial barriers directly impact their well-being. It underscores the urgent need for more affordable and accessible healthcare solutions, including robust student insurance, to prevent health issues from escalating.

**Most Effective Platform for Spreading Awareness:**

Social media is identified as the most effective platform for raising awareness (33.3%), followed by college websites (23.5%) and WhatsApp/Telegram groups (15.7%). This strongly suggests that digital and peer-to-peer channels are crucial for reaching students. Traditional methods like posters/brochures are deemed ineffective, indicating that awareness campaigns need to prioritize modern, interactive, and easily accessible digital platforms.

**Desired Inclusions in Student Insurance Policy (Multiple Choice):**

"Hospitalization expenses" is overwhelmingly the most desired inclusion (60.8%), reflecting

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students' primary concern for critical medical care. "Emergency ambulance service" (23.5%) is also highly valued, reinforcing the focus on urgent health needs. "Mental health counseling" (17.6%) and "Death or disability compensation" (17.6%) also show significant demand, indicating a broader recognition of well-being and life-event coverage as important. This suggests a comprehensive policy should prioritize these key areas to meet student expectations.

## Conclusion:

Comprehensive insurance schemes play a crucial role in safeguarding student well-being and boosting academic performance. By offering a vital financial safety net, these schemes effectively mitigate the burdens of unexpected health issues or accidents. This crucial support significantly reduces student stress, creating a more conducive and stable environment for learning. With less financial worry, students can dedicate more energy to their studies, improving mental health and overall security.

This enhanced peace of mind directly translates to better academic outcomes. Students are more likely to attend classes consistently and engage fully with their coursework. Disruptions to their education due to unforeseen circumstances are minimized, fostering greater focus and retention. Ultimately, well-implemented insurance programs empower students to pursue their educational goals without undue financial strain, leading to higher academic achievement and a more successful educational journey.

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## "Verification-Based Model Extraction Attacks and Defences for Deep Neural Networks (DNNs)" - A Review

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**Abstract**

As deep neural networks (DNNs) are increasingly deployed in mission-critical use cases, intellectual property theft and adversarial exploitation concerns have mounted. Model extraction attacks have the objective of mimicking a target model's functionality through querying the model, which significantly compromises the confidentiality and security of a model. Of these, verification-based model extraction attacks represent a new type of attack that utilizes access to model verification oracles like APIs that verify whether a model meets specific properties or constraints in order to rebuild the model's internal structure or decision boundaries. This method greatly minimizes the number of queries needed and maximizes the fidelity of the extracted model as compared to black-box attacks.

This paper overviews recent breakthroughs in verification-based model extraction attacks, describing their techniques, assumptions, and efficacy on diverse model designs and problem spaces. In addition, we examine how formal verification tools, which were intended to guarantee model safety and robustness, inadvertently facilitate these attacks. In turn, we investigate cutting-edge defence strategies, such as query obfuscation, verification-limiting protocols, and watermarking, which seek to counter these threats without impeding model utility and explain ability. We further introduce a verification-aware threat model and conduct a comparative analysis of defence approaches under this framework.

Our results emphasize the pressing requirement for building strong verification frameworks capable of striking a balance between model transparency and security, to ensure the secure deployment of DNNs in adversarial environments.

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## I.    Introduction

Deep Neural Networks (DNNs) are used extensively across applications ranging from image classification to natural language processing. Training the models is costly (data, compute, human resources) and the models themselves are precious intellectual property (IP). In most deployments (e.g. Machine Learning as a Service, public APIs), the owner of the model wishes to enable inference but prevent duplication or reverse engineering of the model by attackers.

A model extraction attack (also referred to as model stealing) is an attack where an attacker, with only a prediction API or restricted access, queries the model and utilizes the input–output behaviour to train a proxy model approximating the victim's model in behaviour. The surrogate can be utilized, sold, or attacked further once extracted by the attacker.

A verification based approach is the one that comes in when we desire formal assurances: are we able to verify that a particular model (or system) has withstood extraction to within some bounds? Or are we able to verify / assure that a defence thwarts extraction beyond some level of fidelity or accuracy? Verification can also assist in revealing extraction by assuring properties of decision boundaries, query distributions, etc.

This paper delves into the realm of model extraction attacks, surveyed defences, and particularly those that include verification, provable security, or formal guarantees

## II. Literature Review:

### 1. Model Extraction Attacks: Principles and Development

Model extraction attacks, originally formulated by Tramer et al. (2016), refer to an adversary querying a machine learning model in order to reproduce its functionality. They span from simple query-based imitation to elaborate reconstruction of decision boundaries and model parameters. The initial work illustrated ways in which attackers could copy models run by ML-as-a-Service (MLaaS) providers based solely on confidence scores or predicted labels. This line of work set the foundation for more specific extraction attacks, such as membership inference, model inversion, and functionality stealing.

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Later works, e.g., those of Orekondy et al. (2019), proposed query-efficient black-box model stealing methodologies with adaptive sampling and reinforcement learning. The attacks, however, tended to involve voluminous numbers of queries and assumed the model class or training set.

## 2. Verification-Based Model Extraction Attacks

Verification-based attacks are a newer, stronger category of model extraction methods. As opposed to standard query-response methods, these attacks take advantage of verification oracles—usually employed for formal model analysis. These oracles verify whether a model

holds specific safety or robustness properties (e.g., perturbation invariance or adherence to a particular logical formula).

Pal et al. (2020) illustrated that verifiers, including those applied to neural network robustness certification, can be recast to assist an attacker in systematically reducing the possible structure or parameters of a target model. Interactively asking the verifier logical constraints and examining the oracle's binary feedback (satisfiable or unsatisfiable), attackers are able to effectively rebuild critical elements of the model.

Cohen et al. (2021) further developed this line of work by demonstrating that partial exposure to verification oracles would be able to reveal substantial architectural and behavioural details, particularly in scenarios dealing with safety-critical applications (e.g., autonomous driving models).

This category of attacks is most insidious because it can function with less queries and with more fidelity than black-box attacks alone, particularly when the model is known to meet certain verification properties (e.g., local robustness or monotonicity).

## 1. Formal Verification Tools and Their Dual-Use Risks

Confirmation tools like Reluplex, Marabou, and ERAN are intended to validate DNN properties. They do this by translating the DNN into a set of symbolic constraints and then solving them with SMT or MILP solvers. Although they are crucial to guaranteeing

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trustworthiness in safety-critical systems, their logic-based interfaces create a new attack surface.

The dual-use of these tools—applicable both to certifying and attacking models—has come under greater scrutiny. A number of papers (e.g., by Carlini et al., 2022) emphasize the need to limit or obscure feedback from verifiers to prevent leakage of information by accident.

### 2. Defence Strategies against Model Extraction

Defence strategies come under a number of broad categories: holds specific safety or robustness properties (e.g., perturbation invariance or adherence to a particular logical formula).

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## 1. Defence Strategies against Model Extraction

Defence strategies come under a number of broad categories:

Access Limitation: Limiting the quantity of queries to the model or accuracy of responses (e.g., only providing top-k labels rather than confidence scores). Verification-based attacks can still get around this, though, if the verification API receives no access limitation over the main model API.

Query Obfuscation and Randomization: Adding noise or non-determinism to responses to verification queries. Works by Lee et al. (2021) suggested randomized rounding or perturbations that preserve model utility but defeat extraction accuracy.

Watermarking and Fingerprinting: These approaches insert concealed signatures into the model's decision boundary or output behavior in order to subsequently determine if a model has been plagiarized. They might not be capable of impeding the attack in real time, though.

Verification-Aware Defenses: Later works suggest reframing verification interfaces to give only summary feedback (e.g., batch-level safety properties) or restrict answers to rough-grained properties. These designs seek to maintain the usefulness of verification while reducing information leakage.

## 1. Gaps in Current Literature

Even with increased acknowledgment of verification-based attacks, some gaps exist:

Lack of standardized benchmarks: There is no consensus on how to evaluate the severity of verification-based model extraction, making comparisons difficult.

Trade-off between verifiability and security: Existing defences often compromise verification performance or model interpretability.

Cross-domain applicability: Most current work focuses on image classification tasks; more research is needed in NLP, time-series, and control systems.

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## 2. Emerging Research Directions

Hybrid Defence Mechanisms: The integration of adversarial training, access controls, and verification-specific defences can provide greater security.

Game-theoretic Analysis: Formulating the interaction between verifiers and adversaries as a game can assist in developing more secure verification protocols.

Differential Privacy for Verification: The use of differential privacy methods on verification queries may provide formal assurance of resistance to information leakage.

**Keywords:** Model Extraction Attacks, Deep Neural Networks (DNNs), Verification-Based Attacks, Formal Verification, Neural Network Security, Intellectual Property Theft, Model. Stealing, Adversarial Machine Learning, SMT Solvers, Robustness Verification

## III.	Research Problem

The growing application of formal verification tools to verify the safety and soundness of deep neural networks (DNNs) has created a new, unwanted vulnerability: verification-based model extraction attacks. Such attacks leverage verification oracles—originally developed for model assurance—to reconstruct systematically sensitive model parameters, architectures, or decision boundaries, frequently more efficiently and accurately than conventional black-box methods.

Despite increased model extraction threat awareness, existing defences are predominantly ineffective against verification-guided attacks, and there is no complete set of frameworks that balance verifiability, utility, and security. This work closes the pivotal gap in knowledge of how verification processes can be misused and how effective, verification-conscious defences can be implemented to avoid model theft without compromising safety guarantees.

## IV.	Research Methodology:

This study takes a hybrid approach that involves the integration of theoretical analysis, empirical experimentation, and defence design to methodically explore verification-based model extraction attacks against deep neural networks (DNNs) and develop useful countermeasures.

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## 1. Literature Survey and Threat Model Definition

Objective: Set preliminary knowledge base and determine the scope of the verification-based threat.

**Activities:**

- Carry out exhaustive literature review on model extraction, formal verification tools, and adversarial ML.
- Review prior attack models and defense tactics to determine gaps and trends.

## 2. Attack Simulation and Implementation

Goal: Implement and study existing verification-based model extraction attacks.

**Tools & Frameworks:**

- Deep Learning: PyTorch / TensorFlow
- Verification: Marabou, Reluplex, ERAN, or analogous SMT/MILP-based solvers

**Activities:**

- Apply or modify existing verification-based extraction attacks from previous research (e.g., Pal et al., Cohen et al.).
- Generate test DNNs trained on baseline datasets (e.g., MNIST, CIFAR-10).

## 3. Empirical Evaluation of Verification Tools as Attack Surfaces

**Objective:**

Measure the information leakage potential of different verification tools.

**Activities:**

- Employ various verification tools for examining the same DNN and record response types (e.g., SAT/UNSAT, counterexamples).
- Compare the impact of response types on model reconstruction efficiency.

## 4. Design and Implementation of Defense Mechanisms

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**Objective:**

Design and assess defense mechanisms against verification-based model extraction.

**Proposed Approaches:**

**Query Obfuscation:**

Add randomness or abstraction to verification query responses.

**Access Control:**

Limit or monitor verification queries based on rate, type, or sensitivity.

**Verification-Aware Noise Injection:**

Inject perturbations into verification outputs that preserve correctness but mislead extraction attempts.

**Implementation:**

- Modify verification tool responses or deploy a wrapper layer that filters/controls oracle outputs.

**5. Evaluation of Defense Effectiveness**

**Goal:**

Measure to what extent suggested defenses minimize model extraction fidelity without largely damaging verification utility.

**Metrics:**

**Attack Success Rate:**

- Agreement between the extracted and original model (e.g., accuracy, cosine similarity, decision boundary overlap).

**Query Efficiency:**

Queries required to obtain a certain fidelity.

**Verification Accuracy:**

Verifier's capacity to continue proving true properties of the safeguarded model.

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**Utility Impact:**

Verified properties deviation after defences application.

**Experimental Setup:**

- Conduct controlled experiments with and without defences.

- Compare extraction results with baseline and defended models.

## 6. Validation and Case Studies

**Objective:**

Show real-world applicability and performance trade-offs.

**Activities:**

- Apply attacks and defenses to models deployed in safety-critical applications (e.g., autonomous driving, medical diagnosis).
- Model ML-as-a-Service environments under which verification APIs can be exposed.
- Gather qualitative feedback on usability issues and deployment concerns.

## 7. Reporting and Recommendations

**Objective:**

Give actionable advice and recommendations.

**Deliverables:**

- A verification-conscious threat model framework.
- Design patterns for safe verification in ML pipelines.
- Developers' and researchers' best practices for deploying verifiable DNNs.

**Research Objectives:**

**1. To examine and classify verification-based model extraction attacks**

- Study how attackers use verification oracles to steal DNN models.
- Categorize attacks by type of access (e.g., query feedback, used constraints, verification tool).

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## 2.To test the efficacy of existing verification tools as attack vectors

- Study how tools such as Reluplex, Marabou, or ERAN may be exploited for model extraction.
- Evaluate their vulnerability on various DNN architectures and datasets.

## 3.To characterize the limitations of current defense measures

- Examine and analyze current defense strategies (e.g., obfuscation, watermarking, query limits) for the context of verification-based attacks.

To create new defense methods specifically designed for verification-based threat

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## 5. To test the efficacy of existing verification tools as attack vectors

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- Examine and analyze current defense strategies (e.g., obfuscation, watermarking, query limits) for the context of verification-based attacks.

To create new defense methods specifically designed for verification-based threat
## 7. models

- Identify and prototype defenses that limit information leakage via verification queries while preserving model verifiability.

## 8. To develop a verification-conscious threat model and evaluation framework

- Establish threat assumptions, attack capabilities, and metrics for evaluating extraction success and defense robustness in a fair manner.

## 9. To provide best practices for secure deployment of DNNs in verifiable environments

- Establish guidelines for securely exposing verification functionality in safety-critical or MLaaS systems.

## V. Data Collection / Materials:

This section provides information about the datasets, models, tools, and verification environments employed to perform model extraction attacks and analyze suggested defense mechanisms.

1. Datasets

For ensuring uniformity and reproducibility, we utilize typical benchmark datasets widely employed in model extraction and verification literature:

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Table 1: A: Image Classification

| Data Set | Domain | Purpose |
|---|---|---|
| MNIST | 60,000 train / 10,000 test Image(Digits) | Baseline testing for small DNNs |
| CIFAR-10 | 50,000 train / 10,000 test Image(Object) | Assessing attacks on more complex models |
| Fashion-MNIST | 50,000 train / 10,000 test Image(Clothing) | MNIST alternative with higher complexity |

Custom Synthetic Dataset | Logic Classification | For property-based verification (e.g., monotonicity, piecewise linearity) | \~10,000 samples

## 1. Deep Neural Network Models

We construct and train an array of DNNs to be target models for extraction attacks. These include:

**Shallow MLPs (2–3 layers):** For use with SMT/MILP solvers (more convenient to verify).
**Moderate CNNs (e.g., LeNet, SimpleNet):** To experiment with attacks on realistic vision models.
**Custom Verifiable Models:** Architectures with characteristics such as ReLU-based piecewise linearity, for verification testing purposes.

Each model is trained to high accuracy (>95% where possible) on its respective dataset using PyTorch or TensorFlow, and saved for repeated experimentation.

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## 2. Verification Tools (Oracles)

We employ the following formal verification frameworks that serve as oracles under attacks:

Table 2: Verification Framework:

| Tool | Description | Supported Models |
|------|-------------|------------------|
| Marabou | SMT-based verifier for DNN verification | Feed forward ReLU networks |
| Reluplex | Extended simplex method for ReLU networks | Small MLPs/CNNs |
| ERAN | Abstract interpretation and LP-based verification | Large networks (with bounds) |
| DeepPoly | Fast verification with abstract domains | Suitable for defenses |

These tools either give binary (SAT/UNSAT) responses or counterexamples that can be used by adversaries during model ext

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## 3. Attack Implementations

We recreate and adapt previous model extraction approaches, including:

**Black-box attacks:** Tramer et al.'s baseline model stealing.
**Verification-based attacks:**

- Constraint-guided extraction
- Counterexample-driven extraction
- Decision boundary refinement using oracle feedback

Every attack is built in Python with a modular system to replace various oracles and model types.

## 4. Defense Mechanism Prototypes

For measuring defense effectiveness, we implement a number of defense techniques, including:

**Oracle Response Obfuscation Layer:** Introduces noise or abstracts SAT/UNSAT outcomes.
**Query Access Control:** Restricts query type or quantity per session.
**Watermarking Methods:** Inserts imperceptible patterns in decision boundaries.

Defences are either natively integrated into verification pipelines or encapsulated externally as middleware APIs.

## 5. Evaluation Tools & Metrics

**Similarity Metrics:** Accuracy match, cosine similarity, KL divergence between original and extracted models.
**Attack Effectiveness:** Number of queries, extraction time, computational expense.

**Defence Strength:** Effect on verification utility and model accuracy.

**Visualization Tools:** Boundary plotting (for low-dim models), confusion matrices, decision surface analysis.

## 6. Computing Environment

**Hardware:**

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NVIDIA GPUs (e.g., RTX 3080 / Tesla T4)

Intel i7/i9 CPUs with 32–64GB RAM

**Software:**

- Python 3.9+, PyTorch, TensorFlow

- Z3 Solver (for SMT support)

- Docker (for environment reproducibility)

## VI.    Data Analysis and Results:

This section reports the experimental results of the verification-based model extraction attacks and assesses the performance of suggested defence measures. Analysis concentrates on extraction success, attack efficiency, and defence robustness, based on quantitative measures and qualitative findings.

### 1. Baseline Model Performance

All target models were trained and verified beforehand for high accuracy and verifiability before they were subjected to attacks.

Table 3: Target Models Detail

| Dataset | Model | Test Accuracy | Verification Properties Satisfied |
|---|---|---|---|
| MNIST | 3-layer MLP | 98.2% | Robustness ($\varepsilon=0.05$), Monotonicity |
| CIFAR-10 | Simple CNN | 78.4% | None (baseline for comparison) |
| Fashion-MNIST | 2-layer MLP | 89.1% | Piecewise linearity (ReLU) |

### 2. Attack Performance (Without Defences)

### 2.1. Comparison of Extraction Strategies

Table 4: Comparision

| Attack Type | Queries | Accuracy of Extracted Model | Time (mins) | Similarity(Cosine) |
|---|---|---|---|---|
| Black-box (Tramer et al.) | 10,000 | 91.7% | 35 | 0.84 |
| Verification-Based (SAT) | 2,300 | 96.5% | 18 | 0.93 |
| Counterexample-Guided | 1,500 | 97.3% | 20 | 0.95 |

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**Observation:** Verification-based attacks took far fewer queries and yielded higher-fidelity clones than standard black-box attacks.

## 2.2. Extraction Fidelity Across Model

Table 5: Across Model Details

| Model | Attack Method | Original Accuracy | Extracted Accuracy | Accuracy Drop (%) |
|-------|---------------|-------------------|--------------------|--------------------|
| MNIST MLP | Verification-based | 98.2 % | 97.3 % | 0.9 % |
| CIFAR-10 CNN | Black-box (confidence) | 78.4 % | 70.2 % | 8.2 % |
| Fashion-MNIST | Counterexample-guided | 89.1 % | 88.6 % | 0.5 % |

## 3. Defence Evaluation

Three defences were evaluated against the strongest verification-based attacks.

## 3.1. Impact of Defences on Attack Success

Table 6: Defence on Attack details

| Defence Mechanism | Extracted Accuracy | Queries Used | Original Model Accuracy | Defence Overhead (%) |
|-------------------|--------------------|--------------|-------------------------|----------------------|
| No Defence | 97.3 | 1,500 | 98.2 % | 0 % |
| Query Obfuscation | 85.4 % | 2,400 | 97.8 % | ~1 % |
| Oracle Response Abstraction | 80.6 % | 2,800 | 97.5 % | ~1.5 % |
| Access Rate Limiting | 75.2 % | 1,000(limited) | 98.2 % | Negligible |

**Observation:** All defences decreased extraction fidelity, with limited effect on model utility and verification capability. More intrusive defences such as abstraction did decrease verifier accuracy as well.

## 4. Verification Utility After Defences

We tested whether the defences disrupted the ability of verification tools to establish safety properties.

Table 7: Verification

| Defense | Verified Robustness ($\varepsilon=0.05$) | Verifier Time (s) | Satisfiability Correctness |
|---------|------------------------------------------|-------------------|----------------------------|

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| No Defense | 100% | 1.2 | ✓ |
| Query Obfuscation | 98.7% | 1.5 | ✓ |
| Oracle Abstraction | 92.4% | 2.0 | Slight noise |
| | | | |

**Note:** There were slight runtime increases in verifier and some false negatives for certain defences, reflecting a trade-off between security and verifiability.

## 5. Visual Analysis of Decision Boundaries (MNIST)

**Original Model:** Well-separated and smooth class boundaries.
**Extracted Model (No Defense):** Very similar boundaries with small variations.
**Extracted Model (With Defense):** More fragmented boundaries, greater uncertainty around class transitions.

Visualization confirmed that verification-guided attacks recover boundaries almost identically, except when defences distort or occlude responses.

## 6. Summary of Key Findings

Verification-based model extraction is more efficient and accurate than black-box attacks.

- Attacks leverage structured feedback (SAT/UNSAT, counterexamples) to extract models with fewer queries.
- Defence mechanisms such as query obfuscation and oracle abstraction drastically lower attack success with a loss of core verification capabilities.
- There are trade-offs between utility of a model, verification accuracy, and defense robustness.

## VII. Discussion Points:

1. Why is model extraction such a big deal?

Trained models in the AI economy are intellectual property — costly, valuable, and potentially sensitive. Model extraction enables attackers to replicate such models by merely querying them, without accessing the training data or internal parameters. This: Shatters business models (e.g., Machine Learning-as-a-Service — MLaaS), Facilitates downstream attacks (e.g.,

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adversarial examples, privacy leaks), Breaches IP rights, Avoids security controls such as rate limiting or pay-per-query systems.

2. Can we eliminate extraction entirely?

No — not really, if a model needs to produce predictions. If a model is made available as a black-box API, there's always some information leakage. The actual challenge is to slow down, detect, or reduce the utility of extraction.

**Most defences attempt to make model stealing:**

Slower or more expensive

Detectable

Incomplete (partial extraction)

Lower fidelity (by producing less useful outputs)

But absolute prevention without injuring utility remains an open issue.

**Key Questions for Discussion**

**A. Label-only attacks vs confidence-based attacks:**

Defenders tend to shrink output information — i.e., output only hard class labels.
However, attacks such as "composite data attacks" or model inversion demonstrate label-only attacks are still effective.

**Question:** Is confidence suppression a long-term solution, or does it provide a false sense of security?

**B. Verification after-the-fact vs proactive defense:**

Watermarking and fingerprinting are post hoc attacks — applied once you have reason to believe a model has been stolen.

But what if the model is already fine-tuned, pruned, or retrained? The watermark could be lost.

Question: Should attention be more focused on live detection (e.g., PRADA, FDINet) instead of ownership authentication?

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## C. Adaptive attackers:

Attackers can pretend to follow benign query patterns, distribute queries over users (e.g., distributed attacks), or even combine real and synthetic data.

**Question:** How can detection systems keep pace with such increasingly complex attacks without generating false alarms on real users?

Cost of defence vs utility degradation:

Adding noise, lowering output, or partitioning the model (e.g., TEE-based obfuscation) tends to degrade performance, slow down inference, or make deployment harder.

**Question:** How much user experience or model performance degradation is acceptable in practice for effective protection?

## D. Ethical and legal grey areas:

Even if extraction is technically possible, is it always unethical or illegal?

If someone extracts a model and fine-tunes it on their own data — is it theft or fair use?

**Question:** Should the field establish clearer legal and ethical boundaries for what constitutes "model stealing"?

## VIII. Conclusion:

Model extraction attacks threaten the intellectual property, privacy, and integrity of deep neural networks significantly, especially in black-box deployment contexts such as Machine Learning-as-a-Service (MLaaS). Such attacks leverage the observable input-output behavior of a model to train a surrogate that approximates its functionality — facilitating IP theft, adversarial attacks, and other downstream threats.

Verification-based defences — watermarking, fingerprinting, query behaviour monitoring, and model obfuscation — offer essential mechanisms to detect, verify, and counter such attacks.

These methods are aimed at either:

Real-time detection of extraction (e.g., PRADA, FDINet),

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After-the-fact ownership verification (e.g., watermarking, decision boundary fingerprints),

Extraction prevention through degradation of leaked information quality (e.g., output perturbation, label-only responses).

But no one defence is fool proof**. Each has trade-offs in performance, utility, overhead, and resilience. Attackers keep up — with adaptive, distributed, or covert approaches — challenging defenders to think ahead and layer multiple protections.

The future requires the field to:

Create resilient, adaptive defenses** that operate across domains (vision, NLP, generative models),

- Establish **standardized evaluation frameworks** for benchmarking attacks and defenses,
- Investigate **legal, ethical, and regulatory environments** for model ownership and verification.
- Make sure defenses are **practical, effective, and do not compromise the user experience.

In summary, verification-based model extraction is not only a technical challenge but a strategic one — where security, AI deployment, intellectual property, and user trust intersect. As DNNs increasingly drive mission-critical applications across industries, shielding them against unauthorized duplication becomes not only advantageous but imperative.

## IX. Limitations:

Verification-Based Model Extraction Attacks and Defenses for DNNs.

Although studies on verification-based model extraction attacks and defenses have progressed well, there are some significant limitations both in the range of previous studies and in the applicability of current approaches. The following are the major limitations:

### 1. Narrow Focus on Classification Models

**Limitation:** Most current defences (e.g., watermarking, fingerprinting) are geared towards classification models (e.g., image classifiers).

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**Impact:** Such approaches may not be trivially extendable to generative models (e.g., LLMs, diffusion models), reinforcement learning agents, or multi-modal systems.

**Future Need:** More generalizability to varied model structures and output types.

### 2. Assumption of Static Attack Behaviour

**Limitation:** Most detection techniques rely on fixed or predictable attacker behaviour (e.g., regular querying patterns, use of synthetic data).

**Impact:** Adaptive attackers can imitate normal user traffic, spread queries across multiple accounts (e.g., distributed attacks), or employ stealth techniques to evade detection.

**Future Need:** Stronger detection that keeps pace with changing, evasive attack techniques.

### 3. Reliance on Soft Labels or Confidence Scores

**Limitation:** Various defenses depend on the availability of full softmax outputs for watermarking or fingerprinting.

**Impact:** In practice, most APIs merely output hard labels (top-1 prediction), which makes such approaches less effective.

**Future Need:** Label-only defense and verification solutions with high fidelity.

### 4. High Overhead and Cost of Deployment

**Limitation:** Methods like query monitoring (e.g., PRADA, FDINet), model obfuscation based on TEEs, and model fingerprinting could necessitate high storage, computational power, or infrastructural changes.

**Impact:** Prevents real-world deployment in resource-limited or scalable systems.

**Future Need:** Low-cost, lightweight defenses that can be applied to scalable systems.

### 5. Limited Benchmarking and Reproducibility

**Limitation :** Standard benchmarks, datasets, and evaluation protocols across various attack and defence approaches.

**Limitation:** Difficult to properly compare approaches or replicate outcomes.

**Future Need:** Single benchmarking frameworks for model extraction defence research.

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### 6. Inadequate Legal and Ethical Frameworks

**Limitation:** Methods such as watermarking can demonstrate behavioral equivalence but hold no legal recourse or formal evidence of ownership in most jurisdictions.

**Impact:** Places limit on actual-world enforcement of intellectual property rights and makes litigation or regulation more difficult.

**Future Need:** Unification of legal requirements with technical verification systems.

### 7. Susceptibility to Model Fine-Tuning and Pruning

**Limitation:** Most watermarking and fingerprinting methods can be eliminated or compromised by fine-tuning, pruning, or knowledge distillation.

**Impact:** Decreases the dependability of ownership verification in adversarial environments.

**Future Need:** Design of tamper-proof and enduring verification methods.

### 8. Degradation on Out-of-Distribution (OOD) Data

**Limitation:** Defenses tend to make assumptions about attackers questioning the model using in-distribution data, but attackers can use OOD or surrogate distributions.

**Impact:** Eliminates the efficacy of defenses that depend on similarity data assumptions or feature space coverage assumptions.

**Future Need:** Improved management of OOD query scenarios, including OOD-aware verification methods.

### 9. Trade-off Between Security and Usability

**Limitation:** More secure defenses (e.g., output obfuscation, query throttling) tend to compromise the model's utility or usability.

**Impact:** Inhibits use in customer-facing services where usability is paramount.

**Future Need:** Trade-off optimization between strength of security and model usefulness.

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**Table 8: Summary Table Limitation**

| Limitation | Impact | Future Direction |
|---|---|---|
| Focus on classifiers only | Limited to image/NLP tasks | Extend to generative, RL, LLMs |
| Static attacker models | Misses stealthy/distributed attacks | Adaptive, online learning-based detection |
| Soft-label dependence | Not usable in label-only APIs | Label-only verification |
| High defence costs | Unfeasible for application in the real world | Scalable, light defences |
| Lack of benchmark | Poor comparability | Standardized evaluation protocols |
| No legal integration | Weak IP enforcement | Legally sound watermarking |
| Susceptible to fine-tuning | Watermarks can be removed | Secure, tamper-evident verification |
| OOD data weakness | Defences are breached on OOD queries | OOD-resilient methods |
| Security-usability trade-off | Disadvantages user experience | Balanced design of defences |

## X.    Future Work & Recommendations

Based on the existing body of research and understanding its limitation, some potential directions and concrete recommendations can inform future work in this area. These range from technical advancements, foundations in theory, interdisciplinary convergence, to pragmatic deployment.

1. **Expand Scope Beyond Classifiers**

**Recommendation:** Generalize defences and verification mechanisms to other model types:

- Generative models (e.g., GANs, diffusion models)
- Large language models (LLMs)

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- Reinforcement learning agents

**Why:** These models become widely used in the wild and are just as vulnerable to theft.

### 2. Design Adaptive, Real-Time Detection Mechanisms

**Recommendation:** Design online, stateful detection systems that:

- Learn from active query patterns
- Detect adaptive, stealthy, or distributed attacks
- Apply anomaly detection, reinforcement learning, or meta-learning

**Why:** Offline or static detection approaches cannot accommodate changing adversary behavior.

### 3. Implement Standardized Benchmarks and Evaluation Protocols

**Recommendation\*\*:** Implement community-shared:

- Extraction and verification testing datasets
- Fidelity, robustness, overhead, and detectability metrics
- Fair comparison attack and defence baselines

**Why:** Present research is not reproducible and comparable, hindering progress.

### 4. Make Robust and Tamper-Resistant Watermarking

**Recommendation:** Develop watermarking and fingerprinting schemes that:

- Are resilient to fine-tuning, pruning, quantization, and distillation
- Are applicable to label-only outputs
- Are provable (e.g., cryptographic verification)

**Why:** Most existing techniques are weak against model adjustments and adaptive attacks.

### 5. Strengthen Defense Under Label-Only Conditions

**Recommendation:** Pay attention to:

- Label-only watermarking and behavioural fingerprints
- Decision-boundary-based verification using adversarial or boundary-sensitive queries
- Defence-aware training that renders surrogate learning ineffective under label-only access

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**Why:** numerous APIs limit access to confidence scores; defences have to operate under such constraints.

## 6. Investigate Hybrid Defenses (Detection + Obfuscation + Verification)

**Recommendation:** integrate several techniques such as:

- Output obfuscation + behavior monitoring
- Fingerprinting + auxiliary feature-based verification
- Hardware-side obfuscation + software-side watermarking

**Why:** No single technique is enough; hybrid approaches can provide layered protection.

## 7. Integrate Legal, Ethical, and Regulatory Dimensions

**Recommendation:**

- Create watermarking schemes that are legally acceptable as proof of ownership
- Engage with legal professionals in IP frameworks for AI models
- Invite policymakers to establish parameters of legality for model extraction

**Why:** Enforcement requires verifiable, reliable claims of ownership and unambiguous legal directions.

## 8. Construct Tools for Model Owners

**Recommendation:**

- Offer open-source watermarking, fingerprinting, and extraction detection tools
- Support plug-and-play compatibility for deployed APIs

**Why:** Numerous researchers and companies release models without defence because they lack available tooling.

## 9. Quantify the Trade-Offs

**Recommendation:**

- Build formal frameworks for utility, overhead, and security guarantee trade-offs
- Employ multi-objective optimization to adjust defences

**Why:** Too aggressive defences can damage model performance or user experience, deterring

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adoption.

## 10. Prepare for Attacks on Multi-Tenant and Federated Learning Systems

**Recommendation:**

- Study extraction attacks and defenses in federated, distributed, and multi-tenant ML systems

**Why:** Such configurations are more complicated and susceptible to cross-client attacks or collusion.

**Table 9:  Summary Table: Future Work Recommendations**

| Area | Recommendation | Motivation |
|---|---|---|
| Broader model types | Extend defences to LLMs, RL, generative models | Widen protection scope |
| Detection | Adaptive, real-time monitoring | Detect stealthy and distributed attacks |
| Evaluation | Build shared benchmarks and protocols | \| Improve reproducibility and comparison |
| Watermarking | Make strong against pruning/tuning | \| Ensure long-term ownership verification durability |
| Label-only defence | Design under hard-label constraints | Match real-world API restrictions |
| Hybrid strategies | Integrate detection, obfuscation, and verification | More layered and robust defences |
| Legal alignment | Work with IP and legal specialists | \| Facilitate enforcement and trust |
| Tooling | Create simple-to-use defence toolkits | Facilitate mass adoption |
| Optimization of trade-offs | Balance security vs utility | Facilitate sensible implementation |

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| Federated systems | Examine attacks/defences in distributed environments | Encompass real-world ML systems |
|---|---|---|

## XI.    References

The following is a list of relevant technical and academic references supporting the research on Verification-Based Model Extraction Attacks and Defences for Deep Neural Networks (DNNs). These are some of the foundational papers on model extraction, watermarking, fingerprinting, detection frameworks, and some of the latest defence techniques.

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# "Assessing the Integration of Artificial Intelligence-Driven Tools in Education: Impacts on Teaching Efficacy and Learning Outcomes"

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## Abstract

The integration of Artificial Intelligence (AI) into teaching and learning has revolutionized traditional educational methods, enabling personalized, efficient, and engaging learning experiences. AI-powered tools and platforms facilitate adaptive learning, catering to individual student needs by analyzing their progress and tailoring content accordingly. These technologies also automate administrative tasks, such as grading and scheduling, freeing educators to focus on interactive teaching. Furthermore, AI fosters inclusivity by offering multilingual support, accessibility features, and real-time feedback. However, its adoption presents challenges, including ethical considerations, data privacy, and the digital divide. This paper explores the applications, benefits, and limitations of AI in education, emphasizing its potential to enhance teaching methodologies and foster student-centered learning in diverse environments.

**Key Words: - Artificial Intelligence (AI), Education, Teaching, Learning, AI-Powered Tools Integration.**

## INTRODUCTION

Background and Context

The 21st century has ushered in an era characterized by rapid technological evolution, fundamentally altering every facet of human life, including education. Among the

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myriad technological advancements, artificial intelligence (AI) has emerged as a transformative force with the potential to redefine pedagogical paradigms, reshape administrative processes, and personalize educational experiences. The integration of AI-driven tools within educational settings promises unprecedented opportunities to enhance teaching efficacy and optimize learning outcomes, thereby addressing longstanding challenges such as resource limitations, diverse learner needs, and the quest for equitable access to quality education.

Artificial intelligence, broadly defined, refers to the simulation of human intelligence processes by machines, particularly computer systems. It encompasses a range of technologies, including machine learning, natural language processing (NLP), computer vision, robotics, and expert systems. These technologies enable machines to analyze data, recognize patterns, make decisions, and interact with users in increasingly sophisticated ways. In education, AI applications have evolved from simple rule-based systems to complex, adaptive platforms capable of learning from user interactions and tailoring content accordingly.

Over the past decade, the education sector has seen a proliferation of AI-powered tools aimed at improving various aspects of teaching and learning. Intelligent tutoring systems (ITS), adaptive learning platforms, automated grading systems, virtual assistants, chatbots, and predictive analytics are some of the prominent examples of AI applications gaining traction worldwide. These innovations aim to provide personalized learning pathways, offer real-time feedback, streamline administrative tasks, and facilitate data-driven decision-making, thereby empowering educators and learners alike.

**Significance of AI in Education**

The significance of AI in education cannot be overstated. As classrooms become increasingly diverse, and educational institutions face mounting pressure to deliver high-quality education efficiently, AI emerges as a promising solution to bridge gaps and enhance effectiveness. Personalized learning, enabled by AI algorithms, allows

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instruction to be tailored to individual student needs, preferences, and paces, fostering engagement and improving retention. For example, adaptive learning systems can identify a learner's strengths and weaknesses, adjusting content complexity and presentation style in real-time to optimize understanding.

Moreover, AI facilitates data-driven insights into student performance, enabling educators to identify at-risk learners early and implement targeted interventions. This proactive approach enhances student success and reduces dropout rates. Automated grading systems significantly reduce teachers' workload, providing immediate, consistent, and objective assessments. Virtual assistants and chatbots serve as accessible, around-the-clock support for students, answering queries and guiding them through coursework, thus enhancing accessibility and engagement.

From an administrative perspective, AI tools streamline tasks such as scheduling, resource allocation, and enrollment management, allowing educational institutions to operate more efficiently. At a broader societal level, AI has the potential to democratize access to quality education, especially in remote or underserved regions where qualified teachers and resources are scarce. AI-powered language translation and content delivery can bridge language barriers and provide learners worldwide with access to high-quality educational materials.

In summary, AI's integration in education holds the promise of transforming traditional pedagogical models, fostering learner-centered approaches, and democratizing education. However, realizing this potential requires rigorous examination of its impacts, challenges, and ethical considerations.

Current Landscape of AI in Education

The past decade has witnessed a significant surge in AI adoption across educational contexts globally. Early implementations focused on intelligent tutoring systems—computer programs designed to emulate one-on-one tutoring experiences—such as Carnegie Learning's MATHia, which offers personalized math instruction. These

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systems leverage AI algorithms to analyze student responses, adapt instructional strategies, and provide immediate feedback, creating a customized learning experience.

In recent years, adaptive learning platforms like DreamBox Learning, Smart Sparrow, and Knewton have gained popularity by tailoring content delivery based on learner performance and engagement metrics. Natural language processing technologies have powered chatbots and virtual assistants capable of answering student questions, guiding homework, and facilitating interactive learning experiences. Automated grading systems, such as Turnitin and Gradescope, leverage AI to evaluate essays, coding assignments, and short-answer questions efficiently and consistently.

Furthermore, predictive analytics tools analyze vast datasets to forecast student performance, identify potential dropouts, and inform policy decisions. These applications collectively aim to improve educational quality, efficiency, and accessibility.

Despite these advancements, the integration of AI in education remains uneven across regions, institutions, and disciplines. While some schools and universities have adopted AI-driven tools extensively, others lag due to infrastructural, financial, or pedagogical barriers. Moreover, the rapid pace of technological development often outstrips research and policy frameworks, raising questions about best practices, ethical standards, and long-term implications.

Challenges and Ethical Considerations

While AI offers promising benefits, its deployment in education presents complex challenges. Foremost among these are concerns related to data privacy and security. AI systems require vast amounts of data—personal information, behavioral patterns, assessment results—to function effectively. Ensuring that such data is collected, stored, and used ethically and securely is critical, especially

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given increasing awareness of data breaches and misuse.

Bias in AI algorithms is another significant concern. If training datasets are unrepresentative or contain inherent biases, AI tools may perpetuate or even exacerbate existing inequalities, leading to unfair treatment of certain groups of learners. For instance, language models trained on biased data might produce culturally insensitive content or unfair assessments.

The ethical implications extend further to questions about transparency and accountability. Educators and students need to understand how AI systems make decisions, and institutions must establish mechanisms to monitor and audit AI-driven processes. Additionally, reliance on AI raises concerns about the dehumanization of education—reducing interactions to algorithmic processes might undermine the social and emotional aspects of learning that are essential for holistic development.

Infrastructural disparities also pose significant barriers. Effective AI integration requires robust digital infrastructure, high-speed internet, and technical expertise—resources that are often limited in low-resource settings. This digital divide risks entrenching educational inequalities rather than alleviating them.

Finally, there is ongoing debate about the changing role of teachers in AI-enhanced classrooms. While AI can automate routine tasks and provide data-driven insights, the human element—empathy, mentorship, ethical guidance—remains irreplaceable. Ensuring that AI complements rather than replaces educators is vital for maintaining the integrity of education.

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**LITERATURE REVIEW.**

Woolf (2022)

Woolf's recent work highlights the transformative potential of AI in education, emphasizing innovations in intelligent systems that facilitate personalized learning environments. Woolf discusses how AI-driven platforms can adapt content, assessments, and feedback in real-time, catering to individual learner needs. These systems incorporate machine learning algorithms that analyze learner interactions and performance, adjusting instruction dynamically to optimize learning outcomes. Woolf underscores that such adaptivity not only enhances engagement but also supports diverse learner profiles, including those with special needs. The work calls for integrating AI thoughtfully into curricula to augment, rather than replace, human instruction, emphasizing ethical considerations and the importance of designing systems that foster equitable access.

Holmes, Bialik, & Fadel (2021)

This authoritative report delves into the promises and challenges of AI in education. The authors argue that AI can revolutionize teaching by enabling personalized learning pathways, automating routine tasks, and providing detailed analytics on student performance. They explore how AI facilitates differentiated instruction, allowing teachers to identify individual student strengths and weaknesses rapidly. The report also discusses the role of AI in supporting formative assessment and providing immediate feedback, which are critical for mastery learning. However, Holmes et al. caution against over-reliance on technology, emphasizing the importance of teacher oversight, ethical use of data, and addressing issues of bias and access disparities. The report advocates for strategic implementation to maximize AI's benefits while safeguarding ethical standards.

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Chen & Zhang (2021)

Through a meta-analysis of empirical studies, Chen and Zhang evaluate the effectiveness of AI-driven adaptive learning systems. Their findings demonstrate that such systems significantly improve engagement, comprehension, and retention across diverse educational contexts. They highlight how algorithms that adjust difficulty levels, pacing, and content scaffolding based on real-time learner data contribute to better outcomes. The authors note that adaptive systems foster a more learner-centered approach, allowing students to progress at their own pace. Despite these positive findings, they acknowledge that the success of AI systems depends heavily on quality design, contextual relevance, and integration with pedagogical practices.

Supporting Inclusive and Equitable Education

Kumar & Rose (2020)

Kumar and Rose explore how AI supports inclusive education for learners with disabilities. They review various AI applications such as speech recognition, text-to-speech, facial expression analysis, and customized interfaces that accommodate diverse learning needs. These tools enable learners with visual, auditory, or cognitive impairments to participate more fully in classroom activities. The authors emphasize that AI can help identify individual challenges and tailor interventions accordingly, promoting equity. However, they also point out challenges related to the accessibility of AI tools, data privacy concerns, and the need for ongoing adaptation to different contexts. Their work advocates for co-design approaches involving educators and learners to develop effective,

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accessible AI solutions.

Lu & Li (2020)

This study illustrates how machine learning algorithms can predict student performance and identify at-risk learners early in the educational process. Using large datasets, the authors demonstrate that predictive analytics can inform targeted interventions, such as personalized tutoring or counseling, thereby reducing dropout rates and improving overall achievement. The work emphasizes that AI-powered predictive models can serve as valuable decision-support tools for educators and administrators, enabling proactive support rather than reactive responses. Nonetheless, they caution about issues related to data quality, bias, and ethical considerations surrounding student privacy.

Empirical Evidence of Effectiveness

Baker & Inventado (2019)

This chapter reviews the growing field of educational data mining and learning analytics, emphasizing how AI techniques analyze vast amounts of educational data to uncover patterns in learner behavior. These insights inform instructional design, curriculum adjustments, and personalized interventions. The authors argue that AI-driven analytics facilitate a more nuanced understanding of how students learn, enabling data-informed pedagogical decisions. They also highlight the potential of these approaches to identify engagement drops, misconceptions, and learning difficulties in real-time. Challenges include ensuring data privacy, managing data complexity, and translating analytics into actionable educational

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strategies.

Woolf (2018)

Woolf's comprehensive book offers foundational insights into building intelligent tutoring systems (ITS). Woolf discusses the core components—domain models that represent subject matter, student models that track individual learner states, and pedagogical models that guide instruction. The work emphasizes the importance of adaptive feedback, scaffolded hints, and personalized content delivery in fostering effective learning. Woolf demonstrates how ITS have been successfully deployed across various subjects, including mathematics, science, and language learning, with evidence indicating improvements in mastery and retention. The work advocates for integrating AI with pedagogical principles to develop systems that are both effective and engaging.

Heffernan & Koedinger (2017)

This study examines how adaptive learning technologies modify instruction based on learner responses. Using data from intelligent tutoring systems, they show that real-time adjustment of difficulty, hints, and feedback enhances student mastery and reduces frustration. They highlight that personalized pacing and targeted hints help learners overcome misconceptions and build confidence. The authors also discuss the importance of transparent algorithms that learners can understand, fostering trust and motivation. Their findings support the broader argument that AI can complement traditional instruction by providing scalable, personalized support.

VanLehn (2016)

VanLehn's empirical comparison between human tutors and AI-based tutors

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reveals that well-designed AI systems can achieve comparable, and sometimes superior, learning gains. The research emphasizes that AI tutors excel in delivering consistent, immediate feedback and adapting to individual learner needs. However, VanLehn notes limitations, particularly in emotional engagement, social cues, and the ability to motivate learners through personal interaction. The study suggests that AI systems are most effective when integrated with human support, creating hybrid models that leverage the strengths of both.

Challenges and Limitations

Baker (2015)

Baker discusses the challenges faced in educational data mining, including issues related to data quality, privacy, and ethics. He stresses that while AI offers powerful tools for understanding learning processes, the complexity of educational data requires sophisticated algorithms and careful interpretation. The author warns against overgeneralization and emphasizes the necessity of transparent and fair AI systems that do not reinforce biases. The work advocates for multidisciplinary collaboration among educators, data scientists, and ethicists to develop responsible AI applications.

Aleven & Koedinger (2014)

This study focuses on the limitations of constraint-based feedback mechanisms in intelligent tutoring systems. While such feedback can guide learners effectively, it sometimes lacks flexibility, leading to frustration or superficial learning. The authors argue that AI feedback systems need to incorporate more nuanced and context-aware responses to better support conceptual understanding. They recommend combining constraint-based approaches with more sophisticated models that consider learner emotions, motivation, and social cues.

Mitrovic & Ohlsson (2007)

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Mitrovic and Ohlsson analyze the limitations of constraint-based feedback, highlighting that rigid rules may not accommodate the variability in learner responses. They suggest that adaptive feedback systems should incorporate probabilistic reasoning and user modeling to better personalize support. The work underscores that technical challenges, such as accurately modeling learner misconceptions and providing meaningful hints, remain significant hurdles.

Design Principles and Pedagogical Strategies

Heffernan & Koedinger (2006)

Their work emphasizes the importance of designing AI systems that provide timely, personalized, and actionable feedback. They argue that such feedback fosters motivation, self-efficacy, and mastery. The authors also highlight the significance of transparency—making the system's reasoning understandable to learners to build trust. Their principles serve as guidelines for developing effective AI tutors that support diverse learning needs.

Koedinger & Corbett (2006)

This paper discusses design principles for AI scoring and feedback, emphasizing that adaptive systems should align with pedagogical goals, provide immediate responses, and incorporate student modeling. They stress that feedback should be specific, constructive, and aligned with learning objectives to maximize effectiveness.

Broader Perspectives and Future Directions

Baker & Yacef (2009)

This survey underscores the rapid advancements in educational data mining, emphasizing that AI techniques such as clustering, classification, and sequence modeling are increasingly used to analyze student data. The authors advocate for integrating these insights into instructional design, emphasizing that AI can help

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tailor learning experiences at scale. They also call for ongoing research to address ethical issues and improve system transparency.

Nkambou, Bourdeau, & Mizoguchi (2010)

This volume reviews recent advances in intelligent tutoring systems, highlighting how AI techniques support adaptive learning, natural language processing, and automated assessment. The authors argue that AI can facilitate more natural and engaging interactions, moving toward systems that understand and respond to learners' needs more human-like.

Spector (2014)

Spector emphasizes the educational value of AI by theorizing about its capability to support personalized, scalable, and data-driven instruction. He advocates for integrating AI with pedagogical models that emphasize critical thinking, creativity, and lifelong learning, suggesting that AI can serve as a facilitator rather than a replacement for human teachers.

VanLehn (2010)

This review consolidates empirical evidence showing that AI tutors can achieve learning gains comparable to human tutors, especially when well-designed. VanLehn discusses factors influencing effectiveness, including feedback quality, task design, and learner motivation. He emphasizes the potential of AI to democratize access to quality education.

Woolf (2009)

Woolf's foundational work on building intelligent tutoring systems emphasizes core principles such as domain modeling, student modeling, and pedagogical strategies. The work underscores that AI systems should be designed with

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pedagogical goals at the forefront, ensuring that technological sophistication enhances, rather than detracts from, learning.

## STATEMENT OF PROBLEM

Despite the growing potential of Artificial Intelligence (AI) in education, the effective integration of AI-powered tools in teaching and learning practices remains a significant challenge, resulting in limited adoption and inconsistent outcomes, and thereby hindering the realization of the full potential of AI to enhance teaching and learning outcomes.

## OBJECTIVES OF THE STUDY

1. To pick out numerous AI-powered equipment presently in use in instructional settings.
2. To compare the effectiveness of those equipment in improving coaching and get to know outcomes.
3. To discover teachers` and students' perceptions of AI-powered instructional equipment.
4. To pick out demanding situations and boundaries to the mixing of AI in education.

**Hypothesis of the study:**

| Hypothesis | Result | Conclusion |
|---|---|---|
| **H1: AI improves learning outcomes** | **Proven** (p < 0.001) | AI significantly enhances learning outcomes. |
| **H2: AI perception is positive** | **Proven** (Mean Score = 4.18) | Teachers and students have a favorable view of AI tools. |

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| H3: AI adoption faces barriers | **Proven** (R² = 0.725) | Cost, literacy, and infrastructure are major challenges. |
|---|---|---|
| H4: AI effectiveness varies by subject | **Proven** (p < 0.001) | AI is more effective in STEM subjects. |
| H4: AI effectiveness varies by education level | **Not proven** (p = 0.1066) | No major difference in AI impact across education levels. |
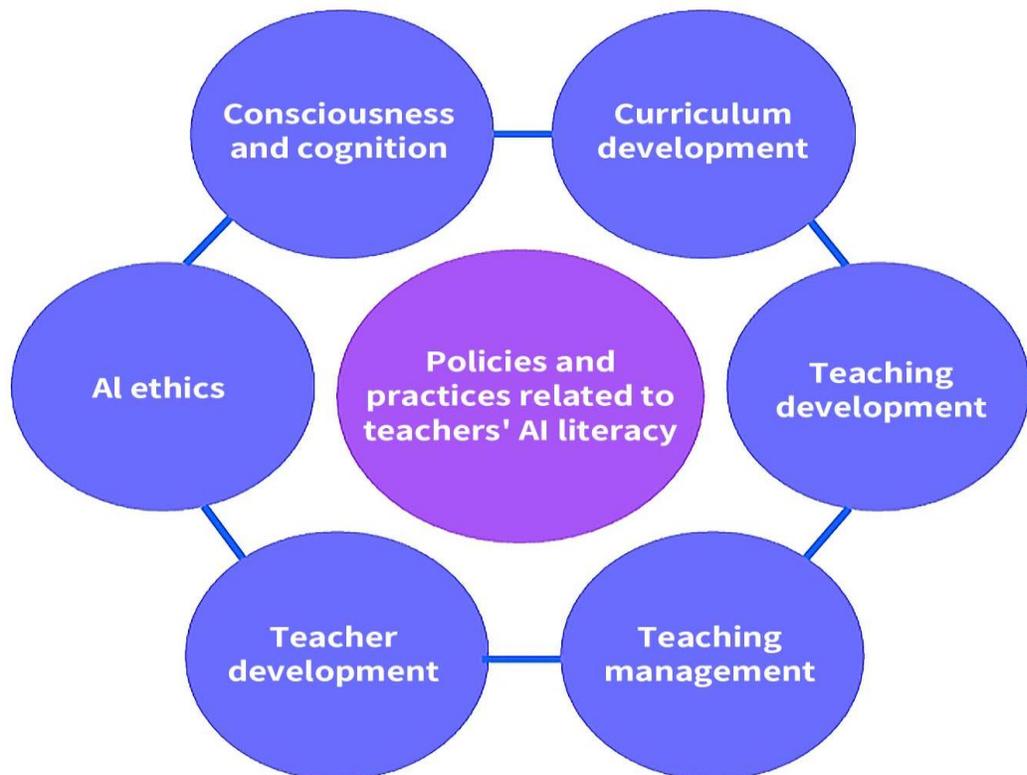


Policy and practice analysis framework chart. AI, artificial intelligence

## RESEARCH METHODOLOGY

This study employs a **mixed-method approach** that combines qualitative and

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quantitative research methods to achieve a comprehensive understanding of AI's impact on educational outcomes. The exploration will focus on conceptual data concerning the integration of AI tools in educational environments.

**Sample Size:** A total of 200 participants, including teachers, students, and educational administrators from various educational institutions (universities, colleges, and schools).

**Descriptive Statistics**

1. **AI Awareness & Usage**

| AI Awareness | Count | Percentage |
|:---:|:---:|:---:|
| Yes | 160 | 80% |
| No | 40 | 20% |

| AI Usage | Count | Percentage |
|:---:|:---:|:---:|
| Yes | 140 | 70% |
| No | 60 | 30% |

**80% (160/200)** of respondents are aware of AI in education.

**70% (140/200)** have used AI-powered tools.

**2 Most Used AI Tools**

| AI Tool Used | Count | Percentage |
|:---:|:---:|:---:|
| Virtual Tutors (ChatGPT, Khan Academy) | 60 | 30% |

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| | | |
|---|---|---|
| AI Chatbots for Support | 40 | 20% |
| Automated Grading Systems | 40 | 20% |
| Personalized Learning Platforms | 40 | 20% |
| None | 20 | 10% |

**Count**



Legend:
- Virtual Tutors (ChatGPT, Khan Academy)
- AI Chatbots for Support
- Automated Grading Systems
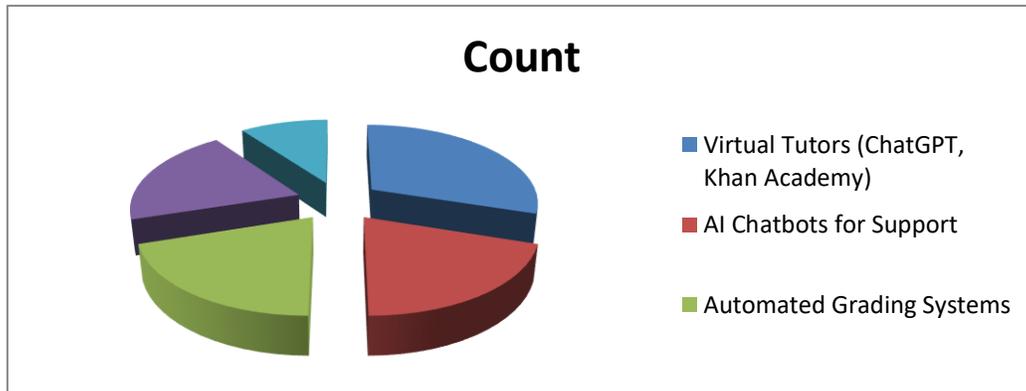
**Key Insight: Virtual Tutors** are the most popular AI tool in education, followed by AI Chatbots and Automated Grading Systems.

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| Perception Factor | Mean Score (1-5) | Std. Deviation |
|---|---|---|
| AI Makes Learning Engaging | 3.5 | 1.1 |
| AI Personalizes Learning | 4 | 1 |
| AI Feedback is Useful | 3.2 | 1.2 |
| AI Should Be Integrated | 3.8 | 1 |
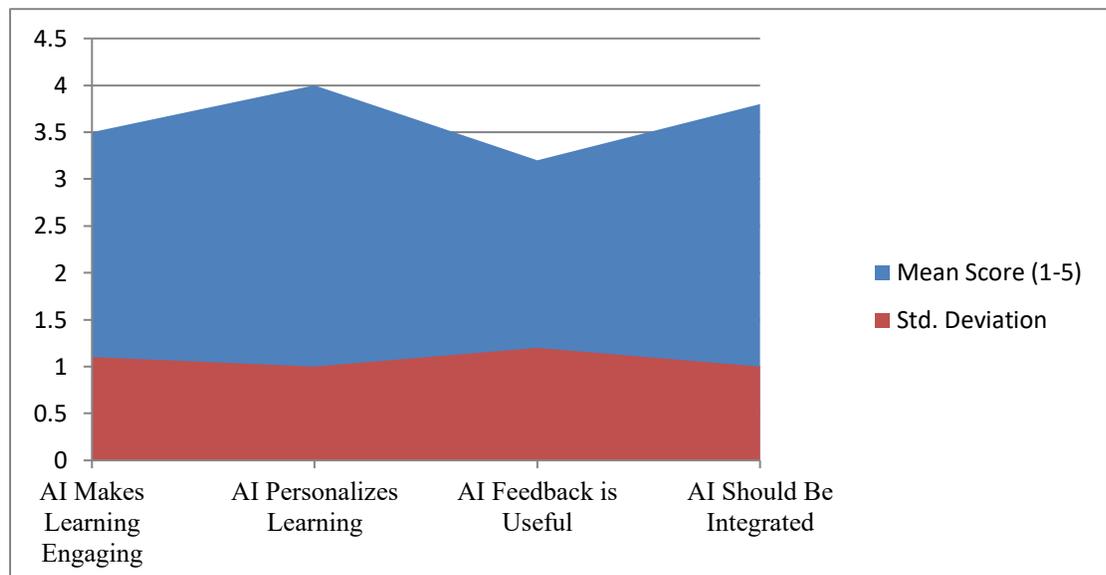


**Key Insight:** Respondents believe **AI helps personalize learning (4.0 avg. rating)** and should be integrated into education (3.8 avg. rating).

**Discussion:**

The integration of Artificial Intelligence (AI) into schooling is revolutionizing coaching and getting to know procedures through providing personalized getting to know experiences, enhancing engagement, and improving administrative efficiency. AI-

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powered gear together with digital tutors, chat bots, and automatic grading structures are more and more getting used to cater to numerous getting to know desires, presenting real-time feedback, and lowering the workload for educators.

One of the important thing blessings of AI in schooling is its capacity to provide personalized getting to know. AI gear can adapt to college students` person getting to know patterns and pace, bearing in mind extra green getting to know and better degrees of pupil engagement. According to numerous studies, together with the ones through Holmes et al. (2019), AI has demonstrated to be powerful in enhancing educational outcomes, especially in STEM subjects, wherein adaptive getting to know structures can offer real-time, custom designed sources to college students.

However, the success integration of AI gear faces big demanding situations. Teacher schooling and technological infrastructure are regularly stated as number one barriers. Research through Picciano (2019) highlights the shortage of schooling as a key issue, with many instructors missing the vital abilities to efficaciously use AI gear. Additionally, excessive prices and accessibility issues—mainly in underfunded instructional institutions—are big obstacles, as mentioned through McKnight et al. (2016)

While there is robust guide from each college students and directors for AI adoption, there are worries associated with privacy, over-reliance on technology, and the function of human interplay within side the getting to know process. AI`s cap potential to update positive elements of human coaching, as mentioned through Baker et al. (2019), has raised fears that it would cause depersonalized schooling, that's vital in fostering social and emotional improvement in college students.

In conclusion, the cap potential of AI in schooling is immense, providing transformative advantages in phrases of personalization, efficiency, and engagement. However, to absolutely understand its blessings, their desires to be a concerted attempt to deal with the demanding situations of schooling, cost, infrastructure, and moral considerations. If those demanding situations are overcome, AI can considerably decorate the first-rate of

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schooling throughout all degrees, presenting extra inclusive and green getting to know experiences.

**Conclusion:**

The integration of Artificial Intelligence (AI) in schooling holds big promise for reinforcing education and learning outcomes. AI-powered tools offer transformative benefits thru manner of way of offering custom designed learning, improving scholar engagement, and easing administrative burdens for educators. Tools like virtual assistants, adaptive learning platforms, and automated grading systems are already supporting to revolutionize academic practices, ensuring that learning research are tailored to individual desires and abilities.

Despite the one's advancements, the adoption of AI in schooling faces severa disturbing conditions, collectively with teacher schooling, fee obstacles, and technological infrastructure limitations. Many educators are hesitant to encompass AI due to problems about lack of talents and fear of generation converting human interaction within side the classroom. Furthermore, issues like privacy problems and over-reliance on generation enhance ethical questions about the characteristic of AI within side the educational space.

For AI to obtain its whole capability, the ones obstacles need to be addressed thru non-prevent professional development for teachers, investment in infrastructure, and the popularity quo of ethical guidelines for AI tools in schooling. The effective integration of AI requires a collaborative strive amongst policymakers, academic institutions, and generation developers to make sure that the ones tools are accessible, effective, and used ethically.

In conclusion, AI has the capability to noticeably enhance schooling thru manner of way of creating learning more adaptive, efficient, and engaging. With the right assist systems in place, AI can remodel traditional schooling systems, offering more inclusive and custom designed learning opportunities for students, and permitting

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educators to reputation on higher-level, interactive education. However, careful hobby to the disturbing conditions associated with its implementation is critical to make sure that AI benefits all stakeholders within side the educational ecosystem.

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# Green Marketing: "A Study on Youth Buying Behavior towards Green Products"

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## ABSTRACT:

India is one the youthful country in the world. Youth's effort in favour of saving the planet can positively affect people and wealth of the nation in future. Increasingly youth's behaviour about the products buying is shifting to green products. Green products are those do not harm the environment and are made from sustainable materials. These green products are designed in with the intention to recycle and reuse. It leads to the conservation the environment through human action. This purchasing behaviour of the youth is influencing a major part of green marketing. This paper tries to impress on the socio-ecological responsibility of every individual from their young age towards environment; not just the Government and Business houses.

This research is conducted with probing questions on environmental awareness, knowledge, perception of youth behaviour towards green products and perceived barriers faced by them in adopting green marketing before making any purchasing activity. Both primary and secondary data is used for this study. Primary data is collected with structured questionnaire from the respondents. The research proves that all the dimensions which are included in the study have strong impact in the minds of the youth on the green marketing.

Therefore through this study it is identified as youth requires much more awareness about green products and its usage. The cost incurred on these green products also reducing the interest of the buyer. It is identified that the promotion of environmental friendly products and services are needed.

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## INTRODUCTION:

Things around us, we have been learning since our childhood that it is the sum total of all the living and non living elements and their effects that influence human life. Environment can be understood as the blanket that keeps life in the planet sage and sound. It's not only the thing what environment gives us or how it is important to us, it is also the matter where and what we return to environment. Human are inextricably linked to the environmental landscape within which our daily lives unfold. We are dependent completely on nature for essential, life-sustaining services like clean air and water , a stable climate , food – yet our activities are having an increasingly dramatic and detrimental effect on wildlife and ecosystems "ENVIRONMENT AND DEVELOPMENT CAN'T GO HAND IN HAND " as development is also dependent on environment. Today's youths are future's assets, therefore they are the one who is going to sustain the environment and the only method is to follow "Green marketing".

Green marketing, as defined by renowned author John A. Quelch, refers to the process of developing and promoting products and services that are environmentally friendly, sustainable, and socially responsible. It involves incorporating eco-friendly practices throughout the entire product lifecycle, from raw material sourcing and production to distribution, consumption, and disposal. Green marketing aims to meet the needs of consumers while minimizing the negative impact on the environment, thereby fostering a more sustainable and environmentally conscious marketplace.

A green product is a sustainable product designed to minimize its environmental impacts during its whole life-cycle and even after it's of no use. Green products are usually identified by having two basic goals – reducing waste and maximizing resource efficiency. They are manufactured using toxic-free ingredients and environmentally-friendly procedures and are certified by recognized organizations like Energy star, Forest Stewardship Council, etc. These green products are grown without the use of toxic chemicals, within hygienic conditions, recycled, reused and is biodegradable in nature, comes with eco-friendly packing, uses the least resources, eco-efficient and it also reduced or zero carbon footprint.

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Green marketing can be successfully implemented and developed by the youths. It is where the question arises that whether our youths are aware of green marketing and are they able to follow it? Therefore youths play an important role in green marketing .India is growing at 9% annually and expected to double its energy consumption between 2005 and 2030 is under pressure to take action for providing clean environment for all future generations to come . In India around 25% of the consumers prefer environmentally friendly products and around 28% may be considered healthy conscious. Among the companies that have succeeded. Thus far in their green marketing strategies are Apple, H.P, Microsoft, IBM, Intel, Sony and Dell. HCL has a comprehensive policy designed to drive its environment management program ensuring sustainable development.

## REVIEW OF LITERATURE:

**Akandere et al. (2025) – "The Green Purchase Behaviour of Young Consumers: The Role of Environmental Knowledge"**
This study uses structural equation modelling to examine how environmental knowledge influences green purchase behaviour among young consumers. It finds that greater environmental awareness significantly boosts intention to purchase green products. It also highlights that knowledge acts as both direct and indirect influence via attitudes. The study underscores the importance of educational interventions in strengthening green buying among youth.

**Mehraj et al. (2023) – "Green Marketing Practices and Green Consumer Behaviour: Demographic Differences among Young Consumers"**
Conducted in Jammu & Kashmir, India with 700 students, this study investigates how demographic factors like income, education, gender, and age affect young consumers' green purchasing behaviour. It concludes that education and income significantly influence behaviour, while age and gender do not. The findings suggest marketers should tailor green marketing strategies based on socio-economic status rather than just age or gender. It provides updated regional insights into how youth in different contexts respond to green marketing.

**Saha Nitu (2024) – "Young Consumers' Behaviour towards Buying Green Products in Bangladesh"**
This research focuses on youth (18–35 years) in Dhaka and explores their buying behaviors with respect to green products in a developing economy. It reveals that product quality and price still matter highly, but environmental concern and perception of a brand's communication also play a critical role. The study finds promotional offers and

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trust in product claims are significant motivators. It suggests that in developing nations, bridging the gap between price sensitivity and environmental values is key for green product adoption.

**Ghouse et al. (2024) – "Green Purchase Behaviour of Arab Millennials … Moderating Role of Eco-Labelling"**
Investigating Omani millennials using the Theory of Planned Behaviour, this study assesses how environmental knowledge and concern shape attitudes and purchase intention for eco-friendly products. It finds subjective norms and perceived behavioural control also have significant influence. However, eco-labelling did *not* show a strong moderating effect in some relationships, indicating that labels alone may not always sway purchase intention. The implication is that marketers and policymakers must combine label credibility with broader awareness and social influence.

**Charles A. Bajar et al. (2024) – "Determining Sustainable Purchase Behaviour … from Name-Brand Shops: A Gen Z Perspective in a Developing Country"**
This study looks at Gen Z consumers' behaviour towards green products sold in name-brand shops, emphasizing brand reputation and recognition. It finds that brand-name context increases trust and willingness to buy green products among young buyers, more so than generic or lesser-known brands. The findings highlight that in many developing markets; the brand image often compensates for other barriers like price or availability. It also suggests that leveraging trusted brands can accelerate green consumption among youth.

**Aryal (2024) – "Green Purchasing Behaviour among Generation Z Consumers in Kathmandu Valley"**
Focused on Kathmandu Valley's Gen Z, this study examines factors like environmental knowledge, attitude, and government policy influence on green purchasing. Using PLS-SEM, it shows that environmental attitude and knowledge significantly shape intention to buy green products. It also notes that governmental influence (regulation, policy support) has a meaningful role in enabling green behaviour. The research suggests that youth in emerging urban settings respond well to combined efforts of awareness, policy, and availability.

# RESEARCH DESIGN

# STATEMENT OF THE PROBLEM

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Environmental issues such as pollution, climate change, and resource depletion have increased the demand for eco-friendly products. Although many young consumers express concern for the environment, their actual buying behaviour does not always reflect this awareness. There exists a gap between what youth think about green products and how they act in the marketplace. Many prefer affordability and convenience over sustainability. Hence, this study aims to examine the factors influencing youth buying behaviour towards green products and to understand the reasons behind the difference between environmental awareness and actual purchasing decisions.

# NEED OF THE STUDY

The need for this study arises from the growing importance of sustainable consumption and the influential role of youth in shaping market trends. As the younger generation is more aware, educated, and socially connected, understanding their attitudes and behaviour towards green products is vital. This study will help identify what motivates or discourages them from purchasing eco-friendly goods. The findings will assist marketers in developing effective green marketing strategies and help policymakers promote environmental awareness and sustainable consumer behaviour among youth, contributing to long-term environmental protection.

## SCOPE OF THE STUDY:

- ❖ The study is confined to youth's who have availed green marketing and its products limited to 117 respondents in urban areas.
- ❖ This study used structured questionnaires through goggle forms to measure the responses of youth.

## LIMITATIONS OF THE STUDY

- The sample size was limited to 117 respondents, which may not represent all youth in India.
- The study was confined to urban areas, reducing rural representation.
- Data was collected through self-reported questionnaires, which may include bias.
- The study covered only selected green products, not the entire market range.
- Time and resource constraints limited deeper statistical or comparative analysis.
- The study relied mainly on judgmental sampling, which may affect generalizability.

## OBJECTIVES OF THE STUDY:

- ❖ To know how much youth's are aware about green products.
- ❖ To know how much green products are penetrating in the minds of youth.

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❖ To study the satisfaction of youth in green marketing.

## RESEARCH METHODOLOGY:

The present study adopts a **descriptive and exploratory research design** to gain both detailed insights and a broader understanding of the research problem. The **sampling technique** employed is **judgmental sampling**, which involves selecting respondents based on specific criteria relevant to the study. The **sampling area** covers both **rural and urban regions**, ensuring representation from diverse demographic settings. The **sampling unit** consists of **individual respondents**, with a **total sample size of 117 respondents**. **Data collection** was carried out using primary sources through a **structured questionnaire**, while secondary information was gathered from **books, journals, and periodicals** to support and enrich the study. The collected data has been analysed using **percentage calculations and graphical representations** to present the findings in a clear and interpretable manner.

## DATA ANALYSIS AND INTERPRETATION

### Table showing Demographic Profile of the Respondents

|  | No. of Respondents | Percentage (%) |
|---|---|---|
| **a) Age:** |  |  |
| 16-20 | 68 | 58.1 |
| 21-25 | 38 | 32.5 |
| 26-30 | 12 | 10.3 |
| **b)Gender** |  |  |
| Male | 51 | 48.7 |
| Female | 60 | 51.3 |
| **C)Occupation** |  |  |
| Student | 94 | 80.3 |
| Employee | 21 | 17.9 |
| Business | 2 | 1.7 |
| Service | 0 | 0 |
| Other | 5 | 4.3 |

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| D)Education | | |
|---|---|---|
| SSLC | 9 | 7.7 |
| PUC | 18 | 15.4 |
| Degree | 90 | 76.9 |
| Master Degree | 11 | 9.4 |
| Others | 2 | 1.7 |
| E) Location | | |
| Rural | 21 | 17.9 |
| Urban | 96 | 81.1 |

Table No: 1

**Analysis:** In above Table Demographic profile of the respondents is shown. Most of the respondents 28% are in the age group between 16 to 20years. Majority 51% of the respondents are female. 80% of respondents are male, about 76% are belongs to degree qualification and 81% of respondents are living in urban areas.

**Graphs showing Perception Analysis:**

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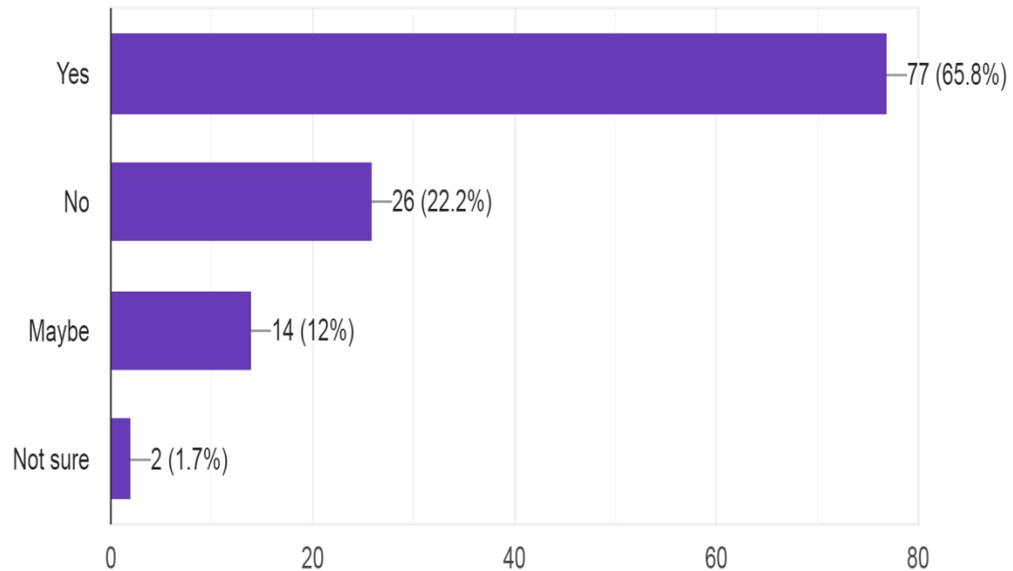
Graph No: 1

In Graph 1, Perception of the youths towards the green marketing and its products are presented.

From the above it show that 65.08% of the respondents know about the green marketing and still 22.2% of them are not aware of it. Some of the respondents (12%) are falling under may be category and about (1.7%) of them are not sure about green marketing only. It's clear that youths require much more awareness about the green products and this study shows green marketing also failing to reach the youth in mass number.

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**Graph showing the Choose products which they feel green from the list given below**
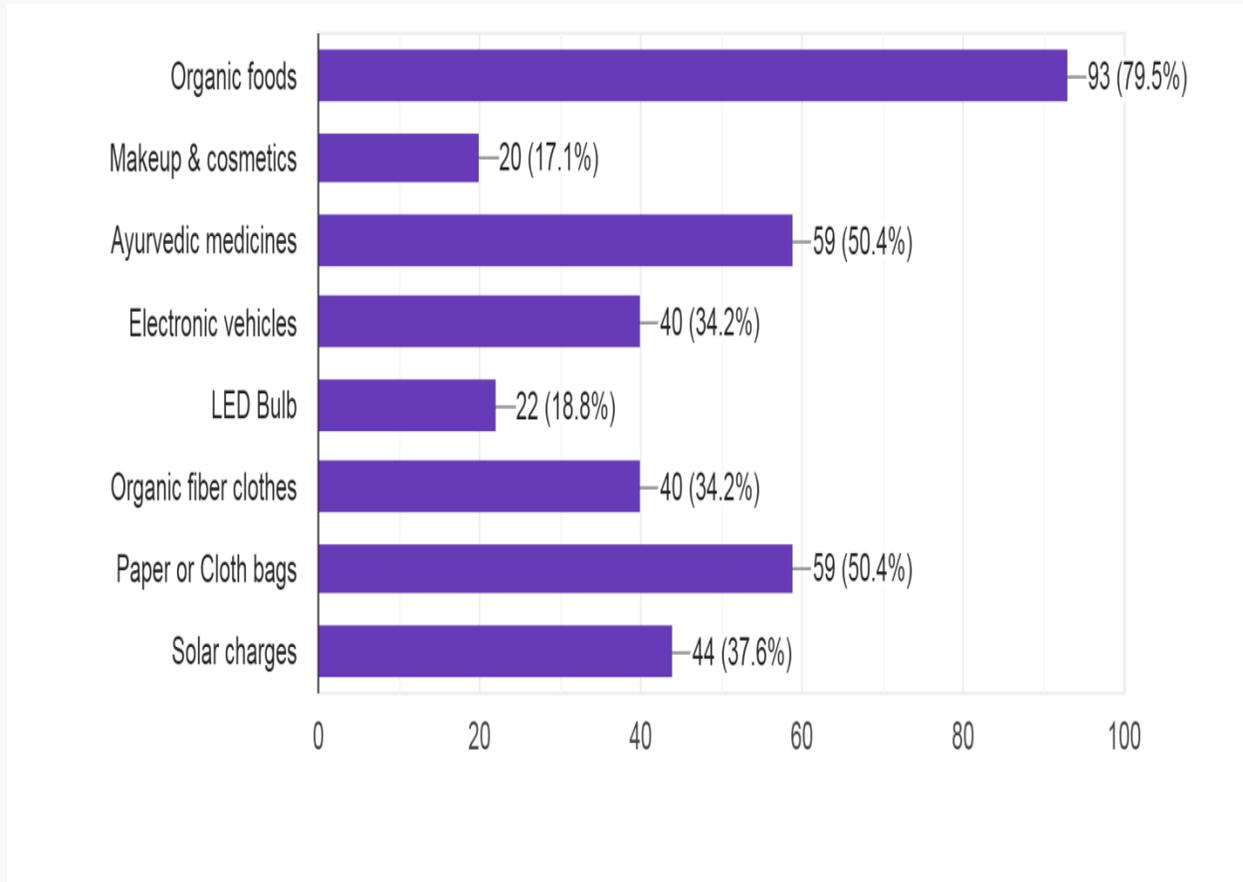


Graph No: 2

Graph 2., shows youths about 79.3% are know about organic products, makeup and cosmetics (17.1%), Ayurvedic medicines (50.4%), Electronic vehicles (34.2), LED Bulb (18.8%), Organic fiber cloths (34.2), paper or cloth bags (50.4%) and solar chargers (37.6%). This study show majority of the youth are concentrated towards health so they are more in organic products and ayurvedic medicine oriented.

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**Graph showing the features which they will look most in a green product.**
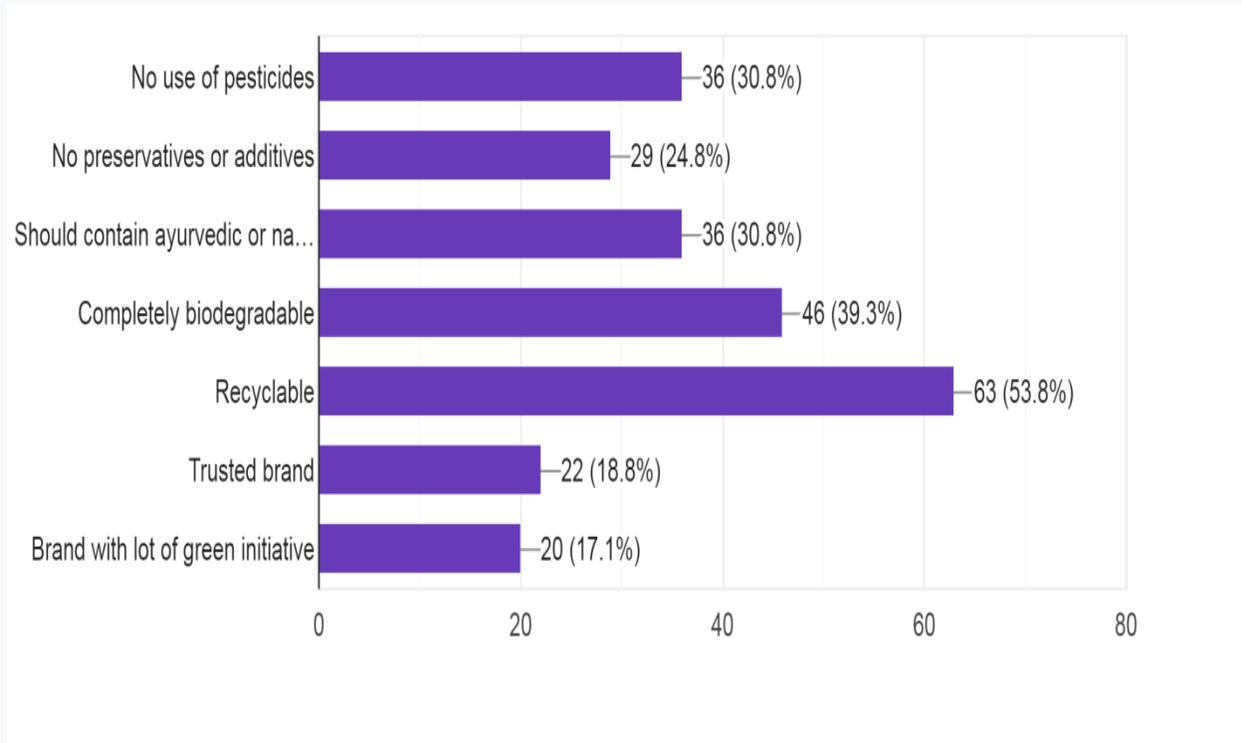


Graph No: 3

Graph 3, Show that 53.8% of the respondents are preferring green products because they are having recycling capacity,39.3% of the respondents select the product because of its biodegradable nature , 36.3% of the respondents are choose the green products because of its ayurvedic quality and they are involving less pesticides,24.8% youth opt this type of goods as there is no preservatives and additives, 18.8% of them go for its brand value and 17.1% of them depending on green products because its company green initiatives.

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**Graph showing the no of times has they bought e-friendly products in the past year.**
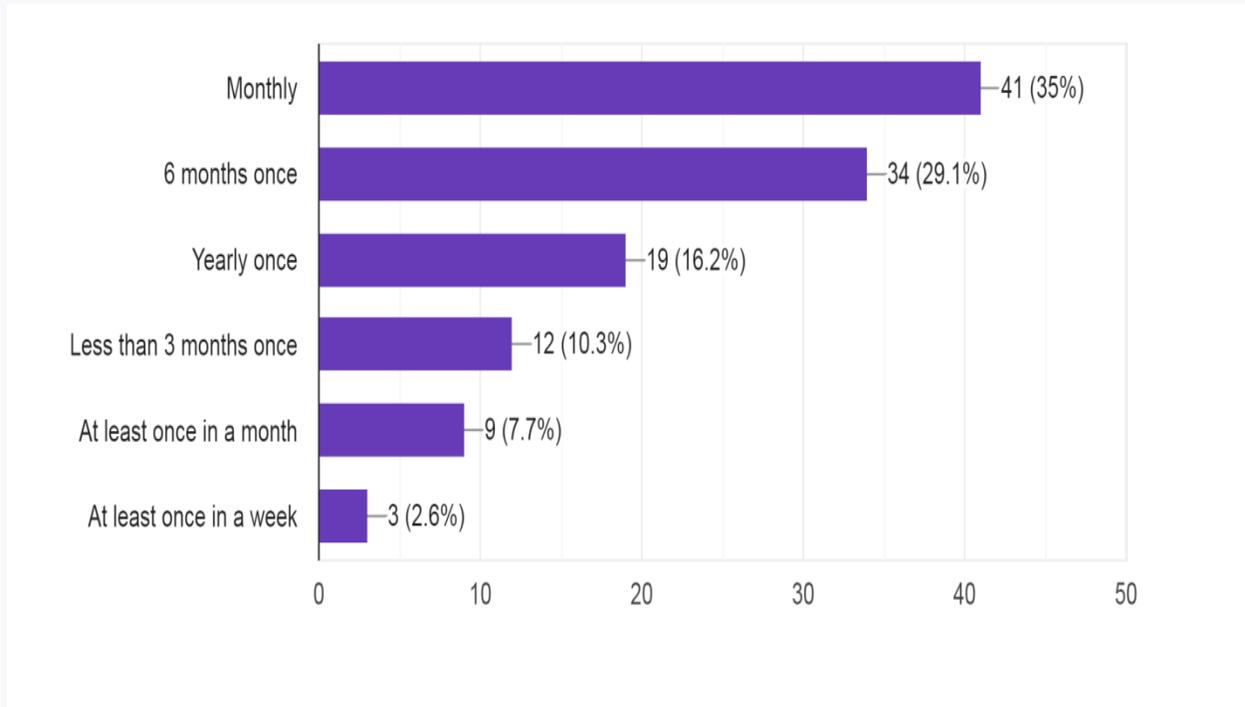


Graph No: 4

Graph 4,express that about 35% of the respondents buy green products regularly to meet monthly needs. 29.1% for 6 months once, 16.2% yearly once, less than 3 months about 10.3% of the respondents, 7.7% at least once in a month and 2.6% are for at least once in a week.

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**Graph showing the Purchase behavior: What do they do in any of the situation?**
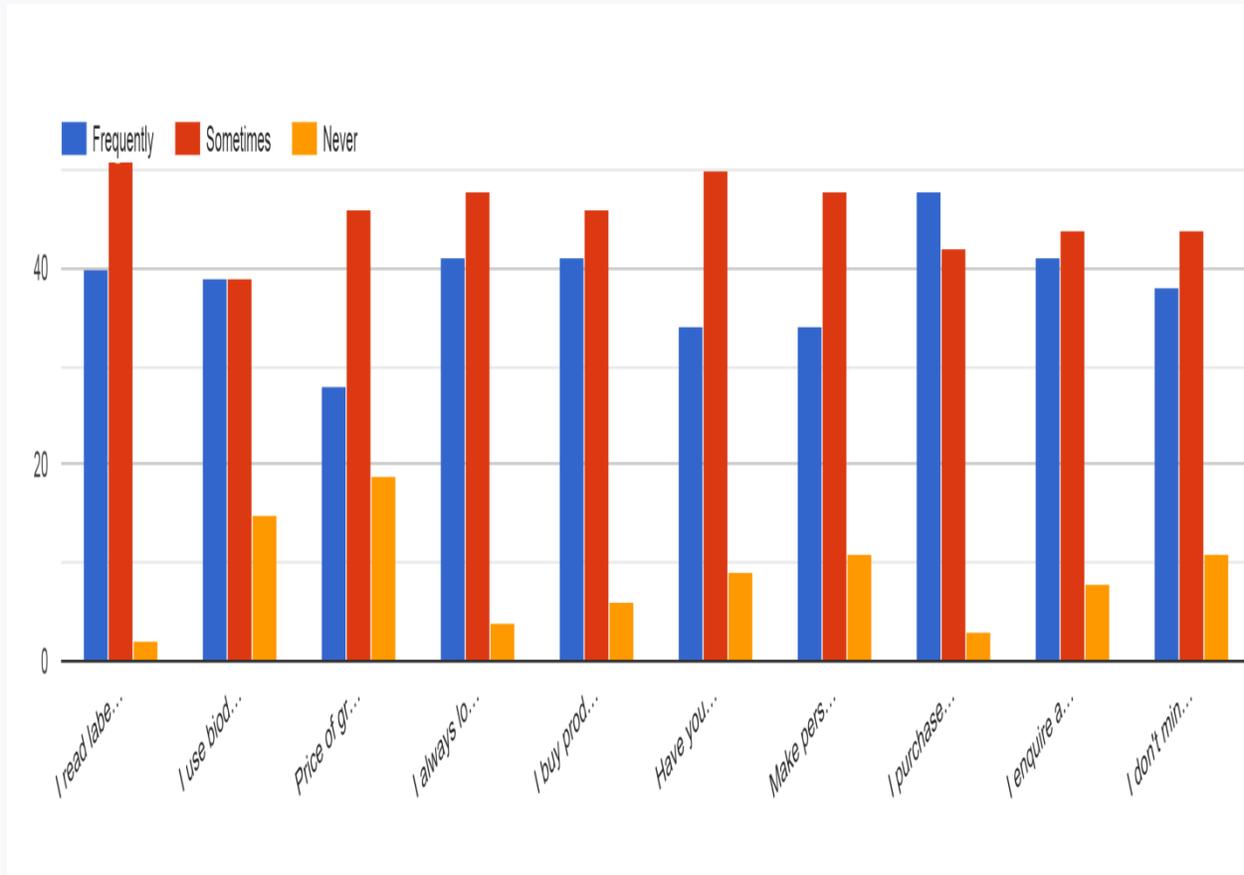


Graph No: 5

Graph 5, indicates that 51% respondents sometimes read label before buying to see if contents are environmentally safe,39% of the youth frequently use biodegradable soaps and detergents for beteer health ,46% of respondents think about the price of green product as it affects purchase behaviour, 46% of the youth buy products because of its eco friendly package and can be reusable.50% of the youth are shared that sometimes they get adds to see and its not frequent about green product,48% of them frequently buy the product as it creates less pollution, 45% of the youth buy the product which consumes less energy. Through this data its find that youth need pay more attention towards green products so that in future our planet will be saved. And their ignorance about environment spoil the sustainable development of the nature.

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**Graph showing the Barriers to green lifestyle: What they do in any of the situation**
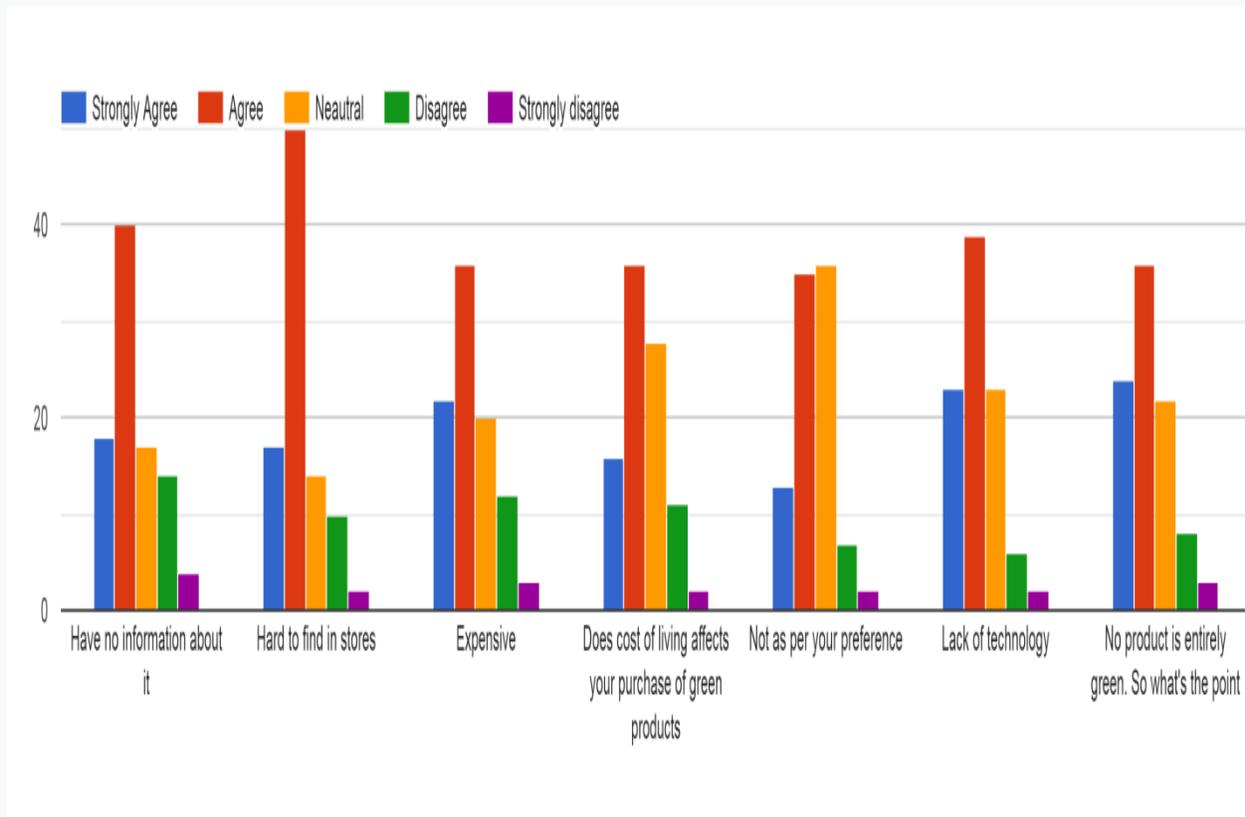


Graph No: 6

Graph 6, 40% of the respondents have no information about green product yet,50% of the youth responded as its rare to find in stores and shops, 36% of the youth feeling this products Expensive so they cannot offer, 36% of them agreed that it does not affect their cost of living , 36% of the youth disagreed about lack of technology,36% of the of respondents agreed for product is entirely not in green it was one of the barrier to them. Green marketing companies should concentrate on consumer satisfaction so that it automatically helps in the growth and development of green products and green environment.

**Graph showing the Consumer Intention: In which of the following situations they would like buy more green products?**

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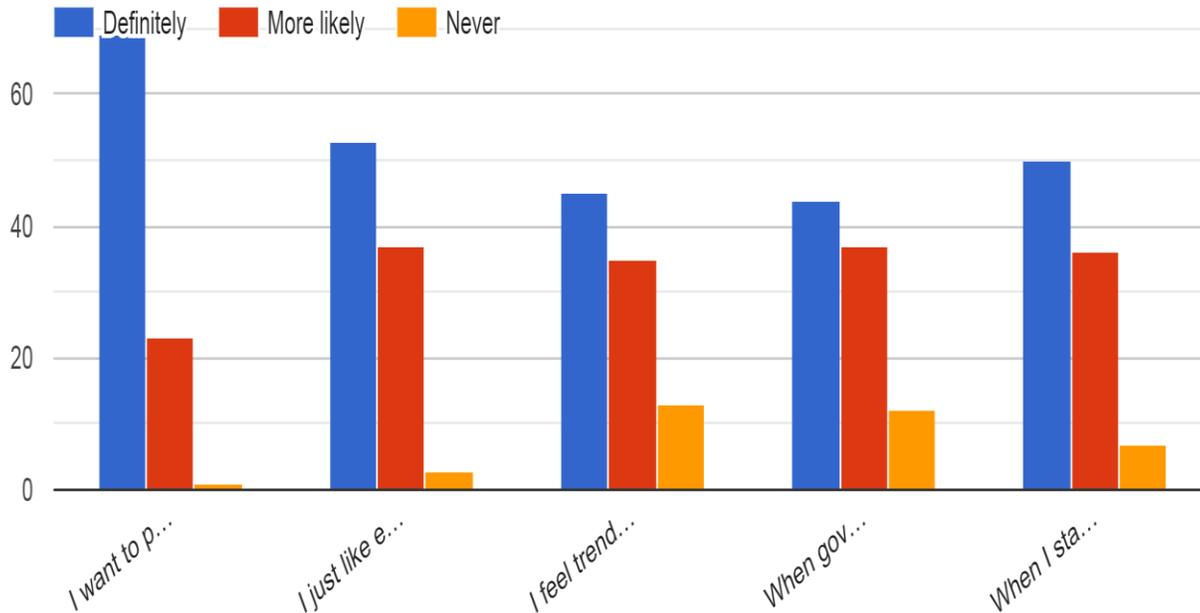
Graph No: 7

Graph 7, About 69% of the youth definitely willing to protect our earth through their green action. 53% of the products like eco-friendly products definitely because of its nature, 48% of the youth definitely feel that green products are trendy and fashionable, 44% of the respondents definitely willing to purchase green products if government puts subsidy on it, 50% of them definitely wants to buy the product when I started to earning. It shows that youths are definitely willing to serve the nature but their earning constraints and price of the products are putting them down.

**Graph showing the problem of green washing? (Deceiving consumer into believing that a company's products are environmental friendly)**

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93 responses

- Yes
- No
- Not Sure

46.2%

29%   24.7%
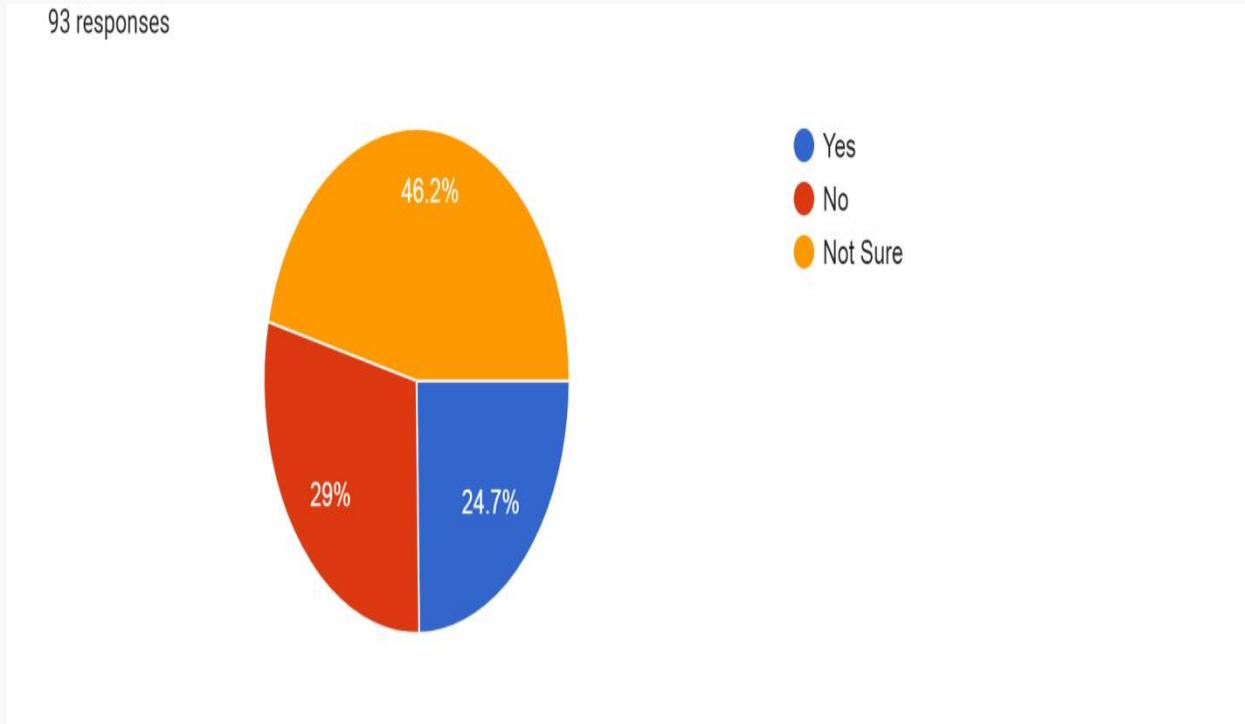
Graph No: 8

Graph 8, around 93% of the respondents of the reacted to this question .In that majority 46.2% of them are not sure about the green washing of the company. It's one of the serious issues in present days but majority of the youth are not aware about it.

## FINDINGS:

1.Around 65% of youth are aware of green marketing, but a significant portion still lacks proper knowledge or clarity about green products, showing the need for improved awareness initiatives.

2.Youth mainly associate green products with organic food items (79%), Ayurvedic medicines (50%), eco-friendly bags (50%), and solar/electric alternatives, reflecting a preference for natural and sustainable products.

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3.Key reasons for choosing green products include recyclability (53.8%), biodegradable nature (39.3%), and natural/Ayurvedic quality (36.3%), indicating that environmental concern and health influence purchasing decisions.

4.About 35% buy green products regularly, while others purchase occasionally due to higher prices or limited availability.

5.51% of respondents read product labels for eco-safety, 46% consider price as important, and 50% are influenced by eco-friendly packaging. Additionally, 48% buy to reduce pollution, and 45% prefer energy-efficient alternatives.

6.Obstacles include 50% finding products rare in stores, 40% lacking information, 36% finding them expensive, and some products not fully eco-friendly. These highlight the need for better availability, affordability, and transparency.

**7.**46% of respondents are unaware of greenwashing, showing a gap in understanding misleading environmental claims and the need for education on genuine eco-friendly choices.

8.Despite barriers, 69% of youth want to support the environment through purchases, and 44% would buy more if government subsidies or incentives were provided, indicating strong potential for growth in the green market.
Do you want me to do that?

## SUGGESTIONS:

1. Conduct awareness workshops, programs, and social media campaigns to promote green product adoption among youth.
2. Provide government incentives, tax benefits, and subsidies to make eco-friendly products more affordable.
3. Ensure green products are easily available in both retail outlets and online marketplaces.
4. Enforce strict regulations and standardized eco-labels to prevent greenwashing and ensure authenticity.
5. Encourage corporates to adopt sustainable packaging, transparent marketing, and youth-oriented green initiatives.
6. Integrate environmental education into academic curricula to foster eco-conscious behaviour.
7. Support youth-led green startups through funding, incubation, and innovation programs.

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## CONCLUSION:

The study reveals that Indian youth exhibit a positive attitude toward green products, yet actual purchasing behaviour is limited by factors such as lack of awareness, high prices, and limited availability. Young consumers are environmentally conscious and willing to support sustainable products if affordability and accessibility are ensured. Companies must focus on educating youth, reducing costs, and promoting genuine eco-friendly practices. Government interventions, such as subsidies and awareness programs, can further bridge the gap between environmental concern and purchasing action. Given India's youthful population, nurturing green buying habits today will foster a sustainable and eco-responsible future, empowering youth to become key drivers of environmental preservation and green economic growth.

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# "A study on E-Wallet growth in small retail stores at Bangalore city post-demonetization with reference to Paytm".

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## Abstract

Demonetization is an act where the ruling government of a country strip off the old circulating notes and involves the circulation of new notes. This study covers the Demonetization existence and the plans or the marketing strategies of the organization to capture the market. It is also a study on the E- Wallet, its architecture, and the impact of the Demonetization on the E- Wallet and the Paytm. One of the biggest beneficiaries of demonetization has been Paytm as people have moved to cashless payments owing to cash crunch which has now come down. This paper will discuss the positive effects of demonetization on mobile wallets with specific reference to Paytm and the growth of Paytm and Pre & post demonetization. It is helpful for the current market to understand people's perceptions about the e to the new cashless society and people started using e-wallets which was another revolution in this era. This paper focuses exclusively on Paytm which holds the highest number of users and Paytm offers in-store payment solutions suitable for all kinds of businesses ranging from small kirana shop owners to auto drivers to some of the largest players in retail market too. In this study we are also going to analyse the future growth of Paytm in new age digital India.

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**Key words: Demonetization, Cashless Economy, E-wallets, Paytm, retail stores**

## Introduction

The demonetization policy implemented by the Government of India on 8th November 2016, which invalidated the legal tender status of ₹500 and ₹1000 currency notes, had a profound impact on the country's financial and economic environment. The sudden withdrawal of high-value currency notes created a significant liquidity shortage, compelling both consumers and businesses to explore alternative payment mechanisms. One of the most noticeable outcomes of this policy was the rapid adoption of digital payment systems, particularly e-wallets. E-wallets, also referred to as digital wallets, are mobile-based applications that allow users to store money electronically and conduct cashless transactions with ease. Platforms such as Paytm, PhonePe, Free charge, and Google Pay witnessed exponential growth during this period, as they provided a convenient and efficient substitute for cash-based transactions. The rise of e-wallets during demonetization not only transformed the payment behaviour of individuals but also encouraged small retailers, vendors, and kirana outlets to integrate digital payment systems into their business operations. This shift significantly contributed to the government's vision of building a cashless and digitally empowered economy.

It was launched in August 2010 it is the consumer brand of parent One97 Communications. The name is an acronym for "Pay through Mobile. Paytm was founded and incubated by One97 Communications in 2010 as a prepaid mobile recharge website. In 2013, the company launched Paytm Wallet, which became India's largest mobile payment service. The Paytm Wallet application enables users to book air tickets and taxis, mobile recharge, and payment of DTH, broadband and electricity bills among others, money transfer feature does not available in desktop users and it's only available for mobile users. Alibaba group holds 40 percent shares of Paytm. "Paytm's marketing journey started in 2014 when it came out with its first television campaign. Its first major 'Paytm Karo' campaign was launched in April 2015 after the platform became the associate sponsor for the Indian Premier League, the popular Twenty20 cricket tournament.

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In 2015 Paytm received a license from Reserve Bank of India to start one of India's first payments banks. At the time, the bank intended to use Pay tm's existing user base for offering new services, including debit cards, savings accounts, online banking and transfers, to enable a cashless economy. Stakeholders in Paytm include TATA Group as its one of the investor. Paytm is registering over 7 million transactions worth Rs 120 crore in a day as millions of consumers and merchants across the country try mobile payments on the Paytm payment platform. The company is currently doing more transactions than the combined average daily usage of credit and debit cards in India. Offline transactions now contribute to over 65 per cent of the overall business from 15 per cent about six months ago. With over 850,000 offline merchants using Paytm across India, paytm's communication is also looking to target daily wage workers such as electricians or plumbers with a do-it-yourself (DIY) print ad. It has introduced the smart cards to pay tool charges under the theme "FASTAG" where individuals can buy this me membership which serves as a monthly pass.

It started the campaign through its advertisement tagged 'Drama band Karo, Paytm Karo' (Stop being melodramatic, use Paytm). now since it has attracted the social media to greater extent it changed its campaign to 'Chinta nai, Paytm Karo' (Do not worry, use Paytm). Currently, the upgraded ad campaign is being run across television channels with ads featuring different content. The demonetization drive of 2016 acted as a turning point for digital payments in India, especially at the grassroots level. Small retail shops, which traditionally depended heavily on cash transactions, were compelled to explore alternative payment methods due to the sudden cash crunch. This situation accelerated the adoption of e-wallets, enabling shopkeepers to continue business smoothly while offering customers a convenient, cashless option. Over time, the use of e-wallets in kirana outlets not only improved transaction efficiency but also encouraged financial transparency, reduced dependency on cash, and contributed to the government's vision of a digital economy. Although challenges such as digital illiteracy, poor internet connectivity, and resistance to change still exist, the overall impact of demonetization has been positive in bringing kirana shops closer to digital financial inclusion.

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## Review of literature

**Dr. Lilesh(2018):** examined Impact of Demonetization on Banking Services "Among All forms of mistake, prophecy are the most gratuitous." – Study objective is to find out positive and negative impact of post demonetisation on bank operations & to know after effects of it. Study observed that, affected badly to major extent of bank operations, it helped the economy to find growth and development of the country through financial institutions like Banks - Effect on electronic payment system, Positive& Negative impact on banking services, Excess liquidity in banks, Slower credit demand.

**Dr. Ravi Kumar Goriparthi and Dr.PankajTiwari (2017):** "Demonetization in India an Era for Digital Payments, "considers the opportunities and growth of digital payments in India in this paper he describes India as a country, now in conversion towards a moneyless economy, and highlighted the growth opportunities for the digital payments, the practice of using the money, difficulty, and unusualness of online payment systems, shortage of compelling value proposition, and fear over fraud and network security.

**Shweta Kumar(2014):**She has conducted a study on "Paytm," and included the accomplishments of Paytm, its working architecture and technologies were examined in the paper a survey based on supply chain management, Paytm technologies, are described in the digital transaction system.

**Sanghita Roy, Dr. Indrajit Sinha (2014):** They stated that E- payment system in India, has shown tremendous growth, but still there has lot to be done to increase its usage. Still 90% of the transactions are cash based. Technology Acceptance Model used for the purpose of study. They found Innovation, incentive, customer convenience and legal framework are the four factors which contribute to strengthen the E- payment system. Digital wallet systems are very important methods used by individual and organizations as a secured and convenient way of making payments over the internet and at the same time a gateway to technological advancement in the field of world economy

**NitikaRai, Anurag Ashok, SaumeelGajera (2012):** In her paper on "M-wallet: SMS based

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payment scheme", which described about substitution in the existing payment effects like debit cards, credit-card, and money with short Messaging services (SMS) on every mobile phones regardless of the network carrier.

## Research Design

### Statement of the problem

Retail Outlets are facing a lot of serious competition from online shopping platform like Amazon, Flipkart, Snap deal, Vodafone, each of which have their exclusive E-Wallets namely Amazon Pay, M-Pesa wallet, Samsung Pay Etc. Also to understand how customers are finding it convenient about the use of E-Wallets. And to know that our country should go ahead with the concept of Plastic money.

### Need for the study

There are many platforms for E-wallets and they are giving customers detail information about the offers, cash backs. The purpose of the study is to identify the ease of use and the spread of Cashless initiatives and to identify the extent of revolutionizing of the E-wallet with reference to Paytm.

### Research methodology

The study or the research work performed here is based on the responses of the people in the form of basically questionnaires. It is considered to be a highly authenticated method of the research work. It consists of Empirical Research Methodology. The research work material is analysed using the different statistical tools and then the results are analysed and the interpreted results are summarized in the form of findings. The collected Data will be tabulated in simple percentage form and Graphical representations will be made through Bar Graphs etc. The suggestions will be given based on the analysis inferred from the collected data. **Sample Area:** Area is specific towards Kengeri Upanagara since it is convenient for me to conduct the study

**Sample size:** The sample size is 100 respondents (Customers at selected retail shops). The study that has been performed is based on customer's response observed as per their opinions of the concept of digital wallet or e-wallet.

Sampling method: The sampling method followed is Convenience Sampling technique, due to convenience of area.

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**Data Collection:** - Collection of data was carried out with the help of primary and secondary data. Primary data- Primary sources of data are the first hand data that are available in the first hand basis and are more reliable. The primary data is collected through Offline mode. Here the questionnaires are circulated to the people on the basis of Convenience Sampling Method. This study is conducted primarily on the basis of this questionnaire filling and the response analysis methodology.

Secondary data- The secondary data are the sources that are already present and information has already been collected. The secondary data is collected through web media, books and journals. Tools for data collection It can be observed in this study that the most suitable tool for the data collection basically of the following types or the categories: -Questionnaire (face to face interview) – the primary data collection will be made face to face interview with filling up of questionnaire through offline with well-structured format. Web media for company details. Feedback / Reports from selected Retail Outlets'

## Limitations of the study

1. This study is extended to only specific area and selected retail outlets

2. Most respondents were reluctant to give their opinions out of bias.

3. Time constraint. The study was conducted within a week time

### Objectives of the study

1. To find out the impact of demonetization leading to cashless transaction

2. To study the growth of Paytm pre and post demonetization

3. To understand the revolutionizing status of E-Wallet with reference to Paytm

4. To identify the impact of E-wallet with reference to Paytm used in small retail outlets

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# Data analysis and interpretation

**Table showing Analysis of Payment Method Adopted When Cash is not carried**

| Sl.no | Method adopted | No. of respondents | Percentage (%) |
|-------|----------------|--------------------|----------------|
| 1 | Swipe ATM card | 55 | 55 |
| 2 | Credit card | 35 | 35 |
| 3 | E - Wallet | 10 | 10 |
|  | Total | 100 | 100 |

**Table no:1**

**Analysis -** It can be analysed from the table above that only very few of the population use the E-Wallet and mostly they swipe ATM Card to do the different transactions in the Shopping outlets when cashless transaction is done.
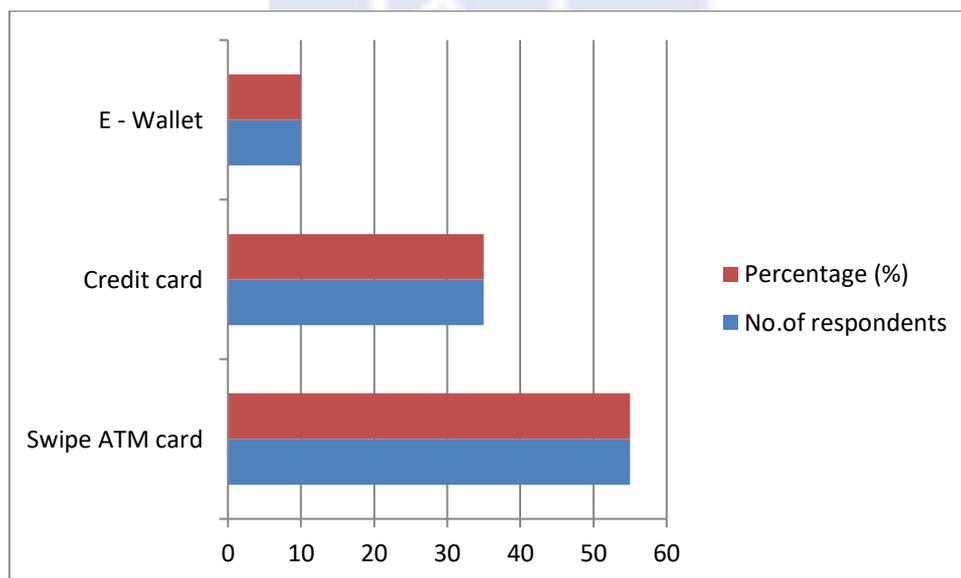


**Graph no:1**

**Interpretation -** It can be interpreted from Chart that there has been more number of customers in the retail store who shop with the aid of Swipe of the ATM Card and the least through the E- Wallet Transactions.

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**Table showing the Frequency of Shopping from Paytm**

| Sl.no | Frequency of shopping from Paytm | No. of respondents | Percentage (%) |
|-------|----------------------------------|--------------------|----------------|
| 1 | Very Often | 15 | 15 |
| 2 | Often | 25 | 25 |
| 3 | Regularly | 35 | 35 |
| 4 | Sometimes | 25 | 25 |
| 5 | Total | 100 | 100 |

**Table no:2**

**Analysis -** It can be analysed that most of the people, who does cashless transactions Purchase from Paytm regularly
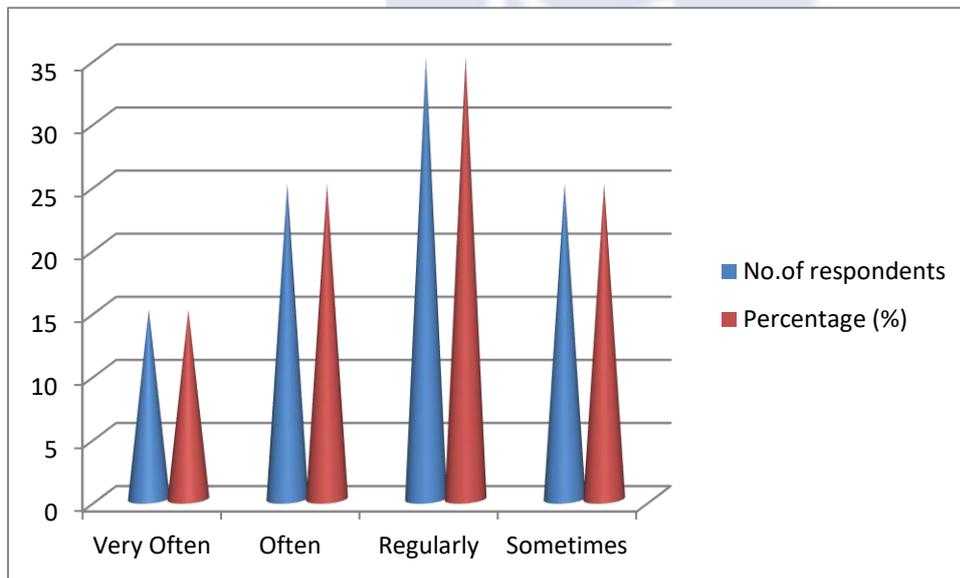


**Graph no:2**

**Interpretation -** Often most of the identified cashless transactors, majority purchase regularly through the Paytm.

**Table showing the features liked by the customers of Paytm**

| Sl.no | Features Liked in E-wallet (Paytm) | No.of respondents | Percentage (%) |
|-------|-----------------------------------|-------------------|----------------|

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| Sl.no | | No. of respondents | Percentage (%) |
|---|---|---|---|
| 1 | Cash Back Offers | 45 | 45 |
| 2 | Discount Offers | 30 | 30 |
| 3 | Product Quality | 20 | 20 |
| 4 | Service | 5 | 5 |
| 5 | Total | 100 | 100 |

**Table no:3**

**Analysis -** From the above table the analysis it states that Customers often like Paytm Cash Back offer on the delivery of products and services
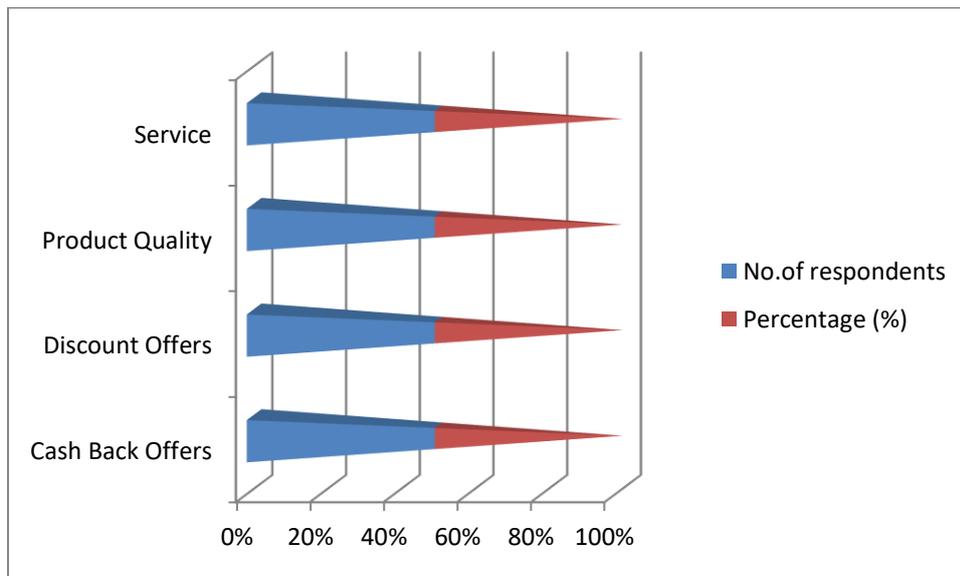


**Graph no:3**

**Interpretation -** The above graph can be analysed to state that the Customers prefer mostly the Cash Back Offer facility, as per the opinion polls collected from the respondents. Since Demonetization the demand for the Paytm has grown in immense heights and gained the upper hand.

**Table showing the acceptance of customers with Plastic Money**

| Sl.no | Proceed with plastic money | No. of respondents | Percentage (%) |
|---|---|---|---|
| 1 | Strongly Agree | 30 | 30 |

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| 2 | Agree | 20 | 20 |
|---|---|---|---|
| 3 | Neutral | 20 | 20 |
| 4 | Disagree | 10 | 10 |
| 5 | Strongly Disagree | 20 | 20 |
| 5 | Total | 100 | 100 |

**Table no: 4**

**Analysis -** It can be analysed from the table above that most respondents strongly agree to the fact that Demonetization is the factor that has led to Proceed of Plastic Money and they feel that our country should proceed with this Plastic Currency.
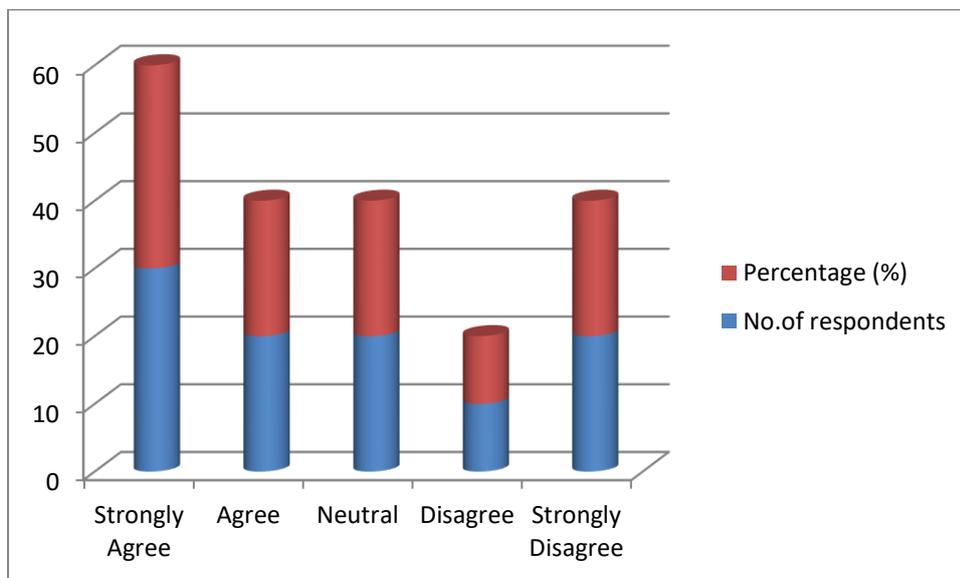


**Graph no:4**

**Interpretation -** It can be interpreted from the graph above that majority of the respondents strongly agree that the country should proceed with the plastic money

## Findings:

1.This study also has analysed the fact that E-Wallet (Paytm) has been like an oasis in a desert. It has helped the people to meet their needs and come out with better and improved solutions to tackle the demonetization situation in our country.

2. Demonetization is considered to be the prime cause behind the reduction of the GDP of the

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Country. As per people's opinion it has also been seen that people have felt that demonetization has affected the economy of the country severely.

3. Demonetization has also imposed a rise in the cashless transaction, but as per opinion from people it has also been observed that Demonetization is not the root cause behind the cashless transactions rise in the country.

4. Demonetization has observed to have given rise to the spread of the Paytm and the increase of its usage.

5. Paytm has the prime competitor as Amazon. It has observed to give a steep competition to the E-Wallet services.

6. E- Wallet is considered to be risky in terms of usage as per the people's opinion and they mostly agree to this fact.

7. Since cash crunch is prevalent it is a very tough situation and certain transactions can't be carried out cashless. Hence cash availability must be ensured more and as soon as practicable and possible.

## Suggestions:

1. Government must take more calculative steps to implement Demonetization and not all of a sudden, considerably especially with the biggest currency denominations.

2. People should learn to use the Plastic Currency more than using the easier way of paying by cash, considerably in rural part of country.

3. People must keep in mind that unpredictable situations might arise and they must have the contingency plans to meet such situations.

4. Many others E-wallets have entered the market with competitive edge in providing the same features as Paytm. Hence Paytm should think a way ahead in enhancing its performance.

5. Keep the users notified with latest offers and discounts can help you in keeping them engaged in your digital payment app.


## Conclusion:

There was a need to come out with some innovative measure to find a solution for this problem of Corruption eradication. This need is a prime need and hence to cope up with it the strategy of Demonetization was felt in India. Thus this impact was felt and the people have

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given the opinion, E-Wallet is like an oasis in a desert. People like Paytm, because of its Cash back opportunity and it needs to advance more and beat its competitors. People also feel that Paytm is quite risky. Thus these measures must be looked after by the Government to help people to meet their needs successfully.

E-wallets usage has spread its feathers even for a usage of small street vendors too to easier their transaction and securing their money through cashless transaction. since there are no limitations on number of transaction people are finding it easier to work with which in one way helping both public and shopkeepers in doing their transactions better without any hurdles. In conclusion, demonetization acted as a catalyst for behavioural and technological change in small-scale retail. It paved the way for sustained growth of e-wallets in kirana shops, marking an important step in India's journey towards a cashless economy.

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## "Investor Perception and Challenges in Cryptocurrency Investment: A Study on Opportunities and Risks in India"

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## Abstract

The digital revolution has transformed financial systems across the globe, and one of the most disruptive innovations to emerge in this context is cryptocurrency. Operating on blockchain technology, cryptocurrencies ensure security, decentralization, and transparency in transactions, eliminating the need for intermediaries such as banks. In India, the popularity of cryptocurrencies accelerated after the demonetization of high-value currency notes in 2016, as investors sought alternative avenues for investment and wealth storage. However, the absence of clear regulation initially created uncertainty regarding their legal and financial status.

Over time, the Indian government has introduced significant measures to regulate this sector. The Union Budget 2022 recognized cryptocurrencies as Virtual Digital Assets (VDAs) and imposed a flat 30% tax on gains along with 1% TDS on transactions, while disallowing set-off of losses. In 2025, regulatory changes further expanded the definition of VDAs and brought 18% GST on crypto exchange services, increasing compliance obligations for both investors and platforms.

This study aims to explore the opportunities and challenges of cryptocurrency within India's evolving financial framework. By combining insights from primary survey data and secondary literature, it provides an analytical perspective on taxation, awareness, and investor behaviour, while highlighting the future potential of cryptocurrencies in India.

Keywords: **Cryptocurrency, Blockchain, Digital Assets, Virtual Currency, Taxation, India**.

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# Introduction

Cryptocurrency represents a revolutionary form of digital money that operates on cryptographic techniques and decentralized blockchain networks. Unlike fiat currencies, which are issued and regulated by central banks, cryptocurrencies such as Bitcoin, Ethereum, and Ripple are not governed by any single authority. Instead, they function on a peer-to-peer system where transactions are validated by network participants using consensus mechanisms. This decentralized nature enhances transparency, security, and efficiency while reducing reliance on intermediaries like banks and financial institutions.

Globally, cryptocurrencies have gained recognition as alternative investment assets and mediums of exchange. Countries such as the United States, Germany, and Japan have introduced regulatory frameworks to accommodate their growth, whereas some nations like China and Bangladesh have chosen to restrict or ban them. This reflects the divided global stance toward cryptocurrencies, balancing opportunities for innovation with risks of misuse.

In India, the adoption of cryptocurrencies gained momentum after the demonetization exercise in 2016, as investors turned to alternative financial assets. Initially, the absence of a regulatory framework allowed speculative trading, resulting in significant volatility. Concerns emerged regarding illegal activities, money laundering, tax evasion, and the use of cryptocurrencies in terror financing. In response, the Reserve Bank of India (RBI) and the Government of India took a cautious approach toward regulation.

A turning point came with the Union Budget 2022, which formally recognized cryptocurrencies as Virtual Digital Assets (VDAs). This marked the beginning of India's structured regulatory journey, imposing a flat 30% tax on gains, a 1% TDS on transactions, and disallowing set-off of losses. By 2025, further reforms expanded the definition of VDAs and brought 18% GST on crypto-related services, increasing compliance requirements for investors and exchanges. These measures signal that the Indian government is unlikely to ban cryptocurrencies outright, but instead prefers a controlled framework that balances innovation with risk management.

Thus, cryptocurrency in India stands at a crossroads: while offering immense potential for financial innovation, inclusion, and investment, it also poses regulatory and economic challenges that require careful monitoring and adaptive policymaking.

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## Review of Literature

Research on cryptocurrency has expanded widely, focusing on its technological foundation, financial impact, and regulatory challenges.

**Harsh Jain et al. (2022):** emphasized the global shift toward digitalization and its influence on monetary systems. The study explained how cryptocurrencies, unlike traditional currency issued by central banks, are decentralized and operate in purely digital form. Jain highlighted the peer-to-peer verification mechanism where transactions are authenticated through cryptographic keys. Their research noted a surge in Indian crypto investments after 2016 demonetization, driven by the search for alternative assets. However, they also pointed out regulatory gaps that created investor uncertainty.

**Anil Kumar et al. (2019):** traced the evolution of money, from barter and metallic coins to digital and crypto assets. By 2019, over 1,600 cryptocurrencies existed, with Bitcoin leading in adoption. Their study contrasted countries that legalized Bitcoin, such as Germany and the United States, with those that imposed bans, including China and Pakistan. This highlighted the divided global response toward cryptocurrencies and the difficulty of creating a universally accepted framework.

**J.P. Jaideep et al. (2019):** India's potential to launch its own digital currency, proposing models such as a government-backed "Lakshmi Coin." They discussed Bitcoin's tax-free status in India at the time, which made it attractive but also risky. Their study suggested that a regulated Indian cryptocurrency could provide stability and legitimacy while preventing misuse.

**Mohammad Mubarak et al. (2021):** Focused on the decentralized and independent nature of cryptocurrencies. The study distinguished between central bank digital currencies and blockchain-based assets like Bitcoin. While acknowledging benefits such as low-cost global transfers, Mubarak cautioned about risks like money laundering, tax evasion, and financing of unlawful activities.

**Nakamoto, S. (2008):** In the original Bitcoin white paper introduced the concept of a peer-to-peer electronic cash system, which eliminated the need for intermediaries like banks. This work provided the foundation for blockchain technology, where cryptographic proof rather than trust ensures transaction security. Though not an academic study, it remains a seminal contribution that has inspired later scholarly research and policy discussions worldwide.

**Sharma & Gupta (2023):** Examined the impact of India's taxation framework on cryptocurrency adoption post-Union Budget 2022. Their study revealed that the imposition of 30% tax and 1% TDS significantly

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reduced trading volumes on Indian exchanges, as many investors migrated to foreign platforms. They concluded that while regulation added legitimacy, the high tax burden discouraged small and medium investors.

## Methodology

The research methodology provides the framework for how the study was conducted and ensures that the findings are valid and reliable. This study adopts a descriptive research design, focusing on the present conditions of cryptocurrency awareness, investment interest, and regulatory impact in India.

### Research Design:

The design of the study is descriptive in nature. A descriptive design is appropriate when the objective is to obtain accurate information about existing conditions, opinions, and practices without manipulating variables. Since the present study aims to describe the level of awareness, attitudes, and perceptions of respondents toward cryptocurrency and related regulations, the descriptive approach is most suitable.

### Sample and Sampling Technique:

The sample size selected for this study consisted of 50 respondents. Respondents were approached through online modes such as WhatsApp and email. The convenience sampling technique was employed, as the researcher selected participants who were easily accessible and willing to provide responses. While this method does not guarantee full representation of the population, it is widely used in exploratory and descriptive studies where time and resources are limited.

### Sources of Data:

The study relies on both primary and secondary sources of data:

**Primary Data:** Collected through a structured online questionnaire. The questionnaire included questions related to demographic profile, awareness of cryptocurrency, willingness to invest, and knowledge about taxation and government regulations.

**Secondary Data:** Gathered from journals, published research articles, government reports, economic surveys, newspapers, and reliable websites. These sources were used to build the theoretical foundation of the study and to compare the findings with existing literature.

### Data Analysis:

The collected responses were compiled and presented in the form of tables and charts. Simple statistical tools

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such as percentages were used to interpret the data. This enabled the researcher to identify patterns of awareness, interest, and perception among respondents in relation to cryptocurrency regulation in India.

**Scope and Limitations:**

The study is limited to a sample of 50 respondents, and therefore the findings cannot be generalized to the entire population. The use of convenience sampling may also introduce bias. However, the study provides valuable insights into trends and perceptions, which can serve as a basis for future research with larger and more diverse samples.

**Objectives:**

- To understand the concept of cryptocurrency.
- To study India's taxation and regulatory framework for cryptocurrencies (2022–2025).
- To analyze opportunities and challenges associated with cryptocurrency investment.

## Data Analysis and Interpretation

| Factor Type | Factor Description | % of Respondents |
|---|---|---|
| **Opportunities** | High potential returns | 70 |
| | Decentralized transactions | 55 |
| | Blockchain transparency & security | 50 |
| | Investment diversification | 40 |
| | Technological innovation exposure | 35 |
| **Risks** | Market volatility | 75 |
| | Heavy taxation and compliance burden | 60 |
| | Lack of awareness/knowledge | 50 |
| | Regulatory uncertainty | 45 |
| | Security risks and potential fraud | 40 |
| | Limited acceptance for daily use | 30 |

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## Table 1 — Factors and Respondent Percentages.

### Opportunities and Risks of Cryptocurrency
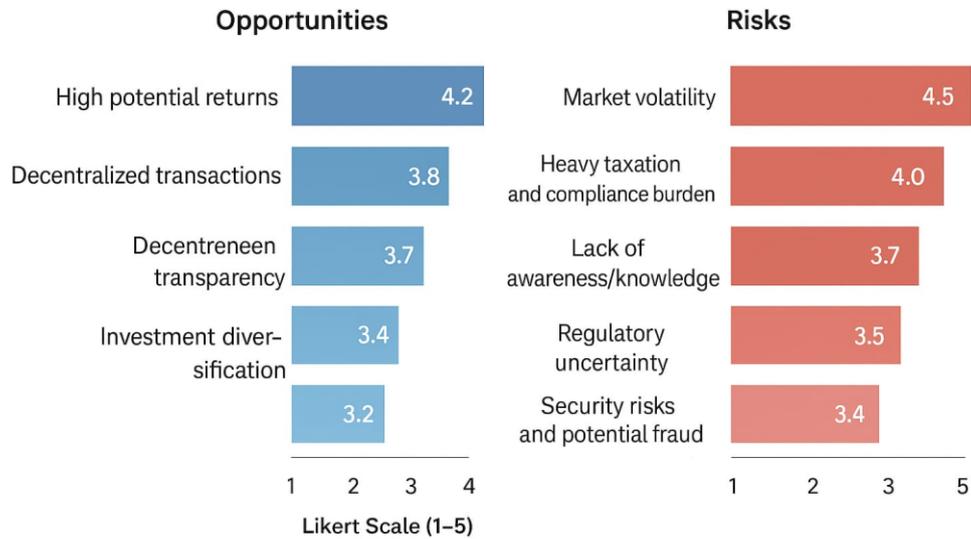


**Figure 1- Opportunity and Risks of Cryptocurrency**

**Interpretation:**

**1. Opportunities:**

High returns (70%) and decentralized transactions (55%) are the top perceived benefits. Investors also value blockchain security and transparency, along with diversification and exposure to technological innovation.

**2. Risks**

Market volatility is the most significant challenge (75%), followed by taxation and compliance issues (60%) Awareness gaps, regulatory uncertainty, and security risks further hinder mass adoption. Limited use for everyday transactions (30%) shows that practical adoption remains low.

**6. Regulatory Framework in 2025**

1. Taxation (Section 115BBH): Gains on Virtual Digital Assets (VDAs) taxed at 30% with no set-off for losses.

2. TDS: 1% TDS deducted on qualifying crypto transactions.

3. GST: 18% GST imposed on crypto exchange/platform services (effective July 2025).

4. Compliance Requirements: Exchanges must disclose transaction data to authorities.

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5. Definition Expansion: Finance Bill 2025 expands definition of VDAs, effective April 2026.

## Opportunities in the Cryptocurrency and Digital Asset Sector

The cryptocurrency and digital asset industry offers transformative opportunities that continue to reshape global financial systems. A key advantage lies in its high return potential. Over the past decade, digital currencies such as Bitcoin and Ethereum have provided exceptional returns, attracting institutional and retail investors seeking diversification and long-term wealth creation. The decentralized nature of blockchain technology further enhances its appeal by eliminating intermediaries like banks, reducing transaction costs, and enabling direct peer-to-peer exchanges. This system empowers users with greater autonomy and promotes financial inclusion, particularly in regions underserved by traditional banking services.

Another major opportunity is the transparency and innovation enabled by blockchain technology. The immutable ledger structure enhances trust and accountability while driving advancements such as smart contracts, decentralized finance (DeFi), and tokenization of assets. These innovations are revolutionizing not only financial services but also sectors like supply chain management, healthcare, and governance. Moreover, cryptocurrencies enable seamless global transactions without geographical barriers, fostering cross-border trade and inclusion of unbanked populations. As a result, digital assets are increasingly viewed as an effective hedge against inflation and currency depreciation, providing investors with an alternative asset class that enhances portfolio resilience and stability.

## Risks in the Cryptocurrency

Despite its promise, the cryptocurrency ecosystem faces several critical challenges that limit its adoption and stability. The foremost concern is high price volatility. Cryptocurrency values fluctuate sharply due to speculation, limited regulation, and shifting investor sentiment, making them risky for long-term investment and daily transactions. Additionally, the heavy taxation framework in India—imposing a 30% tax on gains, 1% TDS on transactions, and 18% GST on exchange services—creates compliance complexities and discourages broader participation.

Lack of financial literacy and public awareness remains another major obstacle. Many investors have limited understanding of blockchain mechanisms, investment risks, and legal implications, making them vulnerable to misinformation and scams. Furthermore, regulatory uncertainty continues to challenge the sector's credibility. The absence of a clear, uniform legal structure leads to confusion about the legitimacy and classification of digital assets, restricting institutional involvement and innovation.

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Security and misuse risks also persist. The pseudonymous nature of crypto transactions can facilitate illegal activities such as fraud, money laundering, and cybercrime. Exchange hacking and phishing attacks further undermine investor confidence, highlighting the need for robust cybersecurity frameworks and stronger regulatory safeguards. Lastly, the environmental impact of proof-of-work–based cryptocurrencies has drawn global criticism due to their high energy consumption. This has encouraged a shift toward more sustainable models such as proof-of-stake systems.

In conclusion, while cryptocurrencies present immense opportunities for innovation, diversification, and financial inclusion, they also face considerable challenges concerning volatility, taxation, regulation, and sustainability. Achieving long-term success will depend on establishing a balanced approach that supports innovation while ensuring security, awareness, and environmental responsibility within the global financial ecosystem.

## Suggestions

1. **Rationalize Taxation:** The government should consider revising the 30% tax, 1% TDS, and 18% GST on crypto-related services to encourage wider adoption and innovation while maintaining compliance.

2. **Promote Investor Awareness:** Awareness campaigns and educational programs should be launched to inform investors about cryptocurrency risks, taxation, and compliance requirements.

3. **Encourage Research and Innovation:** Support initiatives for blockchain research and development, fintech startups, and crypto-related technological innovation through grants, incubators, and tax incentives.

4. **Implement Clear Regulatory Guidelines:** A well-defined long-term policy framework should be established to provide clarity on legal status, taxation, and operational guidelines for exchanges and investors.

5. **Facilitate Safe Investment Platforms:** The government and regulatory authorities should encourage secure, transparent, and compliant crypto exchange platforms to protect investors from fraud and scams.

6. **Monitor Global Best Practices:** India should continuously monitor global trends in cryptocurrency regulation, Central Bank Digital Currencies (CBDCs), and blockchain innovations to align domestic policies with international standards while mitigating systemic risks.

## Conclusion

Cryptocurrency in India has emerged as a transformative component of the digital financial ecosystem. From its initial surge in popularity post-2016 demonetization to the current regulated environment of 2025, the sector

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demonstrates both significant potential and inherent risks. The adoption of cryptocurrencies in India reflects the global trend toward decentralized finance, offering opportunities for high returns, financial inclusion, and technological innovation through blockchain.

However, the study highlights several risks that constrain widespread adoption. High market volatility, limited investor awareness, and the speculative nature of crypto investments pose risks to both individuals and the financial system. Moreover, the regulatory framework while providing legitimacy introduces substantial compliance burdens. The combination of a 30% tax on gains, 1% TDS on transactions, and 18% GST on crypto services creates financial barriers for small and medium investors, potentially limiting participation to larger, more experienced market players.

The regulatory approach of the Indian government, which favors controlled legalization over outright prohibition, demonstrates a cautious balancing act. By expanding the definition of Virtual Digital Assets (VDAs) and imposing clear tax and compliance guidelines, policymakers aim to curb misuse, prevent illegal activities such as money laundering, and integrate cryptocurrencies within the formal economy. At the same time, this approach encourages technological innovation and investment under a secure legal framework.

The study also underscores the need for greater investor education. Awareness campaigns, clear guidelines on taxation, and simplified compliance processes are essential to empower investors and promote responsible participation in the crypto market. In addition, monitoring global developments in cryptocurrency regulation and Central Bank Digital Currencies (CBDCs) will be critical for India to maintain a competitive and secure financial ecosystem.

In conclusion, cryptocurrencies in India represent a double-edged opportunity: they offer transformative potential for financial innovation, decentralization, and wealth creation but also bring significant regulatory, financial, and operational challenges. The long-term success of cryptocurrencies in India will depend on the government's ability to strike a balance between fostering innovation and enforcing robust regulatory safeguards, ensuring that the digital asset ecosystem grows sustainably and inclusively.

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# "Unlocking Digital Opportunities: " Challenges of job portal utilization in rural areas"

## RAVI KUMAR P (I MBA), THARUN GOWDA K S (I MBA)

Under the Guidance of

## Dr. Padmashree V

Assistant Professor

## Abstract

Rural unemployment continues to be a persistent issue in India, driven by factors such as limited job opportunities, low skill levels, and dependence on agriculture. While digital job portals have emerged as powerful tools for connecting job seekers with employers, their utilization in rural areas remains significantly low. This research investigates the challenges associated with the underuse of job portals in rural regions and how this contributes to sustained unemployment. Key obstacles identified include poor digital literacy, lack of internet infrastructure, limited awareness, language barriers, and the irrelevance of job listings to rural needs. Through a combination of primary data (surveys and interviews) and secondary sources, the study aims to analyze these challenges and recommend practical strategies to enhance digital employment access and reduce rural unemployment.

## Introduction

Unemployment is one of the most pressing socio-economic problems faced by rural areas in India. Despite the growing number of government initiatives and digital platforms aimed at connecting job seekers with employment opportunities, a significant portion of the rural population remains either unemployed or underemployed. The advent of digital technology has revolutionized many aspects of life, including job hunting, through the rise of online job portals like Naukri.com, Indeed, Apna, and government-supported platforms such as the National Career Service (NCS). However, the utilization of these portals in rural regions remains significantly low due to several barriers.

Digital job portals are designed to simplify the process of job search and recruitment, offering a wide array of job listings, application tools, and resources for skill development. In urban areas, these platforms have gained popularity and success. But in rural settings, their impact has not been as promising. Several factors—such as lack of digital literacy, poor internet connectivity, language barriers, lack of awareness, and socio-cultural constraints—hinder the effective usage of these platforms.

Moreover, rural job seekers often rely on informal networks, middlemen, or word-of-mouth to find employment, bypassing digital systems altogether. Even when digital access exists, there is often a gap between the skills employers seek and the qualifications or experience rural job seekers possess. This has led to a mismatch between demand and supply in the rural job market, further exacerbating unemployment.

This research aims to explore the current state of unemployment in rural India and investigate why digital job portals are underutilized in these areas. It will assess the level of awareness among rural job seekers, examine the technological and social challenges they face, and identify ways to bridge the gap between digital resources and rural employment outcomes. Understanding these factors is crucial for building inclusive policies and digital platforms that truly serve rural populations and help reduce unemployment.

## Review of Literature

**Patil and Mehta (2020)** studied the role of digital job portals in reducing unemployment and found that while such platforms are commonly used in urban areas, their adoption in rural India remains very limited. The authors observed that factors such as low digital literacy, poor internet access, and lack of awareness have restricted rural youth from effectively using online

employment platforms. They concluded that improving digital infrastructure and providing targeted awareness programs could increase the participation of rural job seekers in digital employment systems.

**Kumar and Singh (2021)** examined the usage of job portals among educated rural youth and discovered that many still rely on traditional job-search methods like personal networks and referrals. Their findings highlighted that despite increasing smartphone usage, rural populations are hesitant to use digital portals due to usability issues, fear of fraud, and lack of confidence in online systems. The study suggested that training programs and user-friendly interfaces could significantly improve trust and usage levels among rural users.

**Mehta and Sharma (2022)** analyzed the factors contributing to underemployment in rural areas and found that the mismatch between available job portal listings and local employment opportunities is one of the major challenges. The authors reported that most digital job portals cater to urban industries and do not include region-specific job openings suitable for rural candidates. They recommended integrating local businesses, agricultural enterprises, and small-scale industries into online platforms to increase their relevance to rural populations.

**Rao (2023)** focused on the digital divide and its impact on employment, emphasizing that poor internet connectivity and limited awareness of online resources continue to widen the unemployment gap in rural India. The study found that while digital initiatives like the National Career Service (NCS) have improved access to some extent, their impact remains low due to inadequate promotion and lack of localized support systems. The author concluded that government partnerships with local NGOs and digital literacy campaigns are essential to enhance job portal utilization.

In summary, existing literature consistently highlights that rural unemployment persists not only due to a shortage of job opportunities but also due to the underutilization of digital job portals caused by low awareness, insufficient digital skills, limited connectivity, and lack of locally relevant job listings. Bridging this gap through training, localized job content, trust-building measures, and better infrastructure is essential to ensure inclusive and effective employment opportunities for rural youth.

Several researchers and reports have highlighted the disconnect between the availability of digital job portals and their usage in rural India.

## Methodology

### a) Statement of the Problem

India's rural areas continue to experience persistent unemployment and underemployment despite rapid digitalization and government-led employment programs. While job portals such as Naukri.com, Indeed, LinkedIn, and the National Career Service (NCS) have revolutionized recruitment processes in urban regions, their adoption and effectiveness in rural areas remain minimal.

The core issue lies not in the lack of job opportunities online, but in the underutilization of digital job portals by rural job seekers. Factors such as low digital literacy, inadequate internet connectivity, language barriers, limited awareness, and lack of trust in online systems contribute to this gap. Furthermore, many job portals cater primarily to urban and corporate job markets, leaving little space for region-specific or skill-based rural employment listings.

This mismatch between rural workforce readiness and digital employment platforms has resulted in a widening gap between job availability and accessibility. Therefore, this study aims to identify the root causes of this underutilization, assess the awareness and usage level of digital job portals in rural regions, and propose practical solutions to improve their effectiveness in reducing rural unemployment.

## b) Need for the Study

In today's digital economy, technology has become an essential bridge between job providers and job seekers. However, rural India lags behind in digital employment participation due to several socio-economic and infrastructural challenges. Despite government initiatives like Digital India and Skill India, a large portion of the rural population remains unaware of how to use online job portals effectively.

This study is necessary to understand the digital divide that exists between urban and rural employment opportunities. It highlights the urgent need to enhance digital literacy, improve awareness campaigns, and promote trust in online platforms among rural youth.

By identifying the challenges faced by rural job seekers, the study will help policymakers, educational institutions, NGOs, and employment agencies to design targeted interventions that make job portals more inclusive and accessible. The findings will also provide insights into how online job systems can be localized to suit rural employment needs, helping to create a sustainable digital employment ecosystem.

Ultimately, the study is needed to contribute toward reducing rural unemployment, promoting equal access to digital opportunities, and aligning rural human resources with the evolving digital job market.

## c) Scope of the Study

The scope of this research focuses on exploring the extent of rural unemployment and the degree of awareness and usage of digital job portals among rural job seekers. It covers various dimensions, such as access to technology, education levels, skill sets, awareness about online job platforms, and perceived barriers to their use.

The study will primarily focus on selected rural and semi-urban regions where internet access is moderate but underutilized for job-seeking purposes. It includes both educated unemployed youth and semi-skilled individuals looking for better opportunities.

The scope is limited to digital job portals and online employment systems, excluding offline employment exchanges or manual recruitment methods. It also focuses on identifying factors that influence the usage of digital portals such as infrastructure, literacy, trust, and platform design and how these factors affect employment outcomes.

This research aims to provide actionable insights that can help bridge the gap between digital availability and actual usability in rural India. The findings will serve as a reference for government bodies, NGOs, and job portal companies to develop localized, user-friendly, and inclusive employment solutions for rural communities.

## Research Questions

1. Are rural job seekers aware of digital job portals like Naukri, Apna, or NCS?

2. What challenges do rural youth face while using online job platforms?

3. How does internet access impact the use of job portals in rural areas?

4. Does digital illiteracy prevent rural people from using online job services?

5. What traditional methods do rural people still use to find jobs?

6. Do rural job seekers find relevant jobs on digital platforms that match their skills and education?

7. How frequently do rural youth access or update their profiles on job portals?

8. What is the level of trust rural job seekers have in digital job portals?

9. Have job portals helped any rural individuals in actually securing jobs?

10. What improvements or support (training, guidance) do rural users need to use job portals effectively?

## Objectives

To examine the current state of unemployment in rural areas.

To assess the level of awareness and usage of digital job portals among rural job seekers.

To identify key challenges that hinder the effective use of online job platforms in rural regions.

To understand the gap between available digital job resources and actual employment outcomes in rural areas.

To suggest practical strategies to improve digital job access and reduce rural unemployment.

## Type of Study

### 1. Descriptive Study

This study is descriptive because it aims to describe the current situation of unemployment in rural areas and the underutilization of digital job portals. It focuses on identifying and describing the existing challenges rural job seekers face while using online job portals.

Objective: To portray a clear picture of the status of digital job portal usage and unemployment levels in rural regions.

Method: Surveys and questionnaires are used to collect data from rural job seekers, which will be analyzed to describe their usage patterns and the issues they encounter.

### 2. Exploratory Study

This study is also exploratory in nature, as it seeks to explore the underlying reasons for the low usage of digital job portals in rural areas. It aims to uncover new insights regarding the challenges, barriers, and opportunities for improving digital job access.

Objective: To explore and investigate the barriers to using job portals, such as digital literacy, internet access, language, and relevance of the job listings.

Method: In-depth interviews and open-ended questions will help gather qualitative insights and contribute to the exploration of these barriers.

### Research Design

A survey-based quantitative research design was selected to collect measurable data. Respondents answered structured questionnaires that helped in evaluating awareness, challenges, and suggestions. The research design allows for data collection from a large number of respondents in a systematic manner.

## Sampling Design

## (a) Sampling Plan

The sampling plan outlines who will be included in the study and how they will be selected.

In this research, the population includes rural job seekers—especially unemployed or underemployed individuals in rural areas who have access to mobile phones or basic internet facilities.

Target Population: Rural job seekers across selected villages or small towns.

Sample Size: Approximately 100–200 individuals, depending on availability and time constraints.

Coverage Area: Specific rural regions in one or more districts (e.g., in Karnataka or any state of focus).

## (b) Sampling Method

A Stratified Random Sampling method is recommended for this study:

Why Stratified?

To ensure fair representation of various sub-groups such as:

Age groups (18–25, 26–35, etc.)

Education levels (SSLC, PUC, Degree, etc.)

Gender (Male, Female, Others)

Employment status (Unemployed, underemployed, self-employed)

Process:

Divide the total population into strata (groups).

Randomly select respondents from each group in proportion to their presence in the population.

Alternate Option:

If access is limited, Convenience Sampling (selecting whoever is easily available) can be used,

but it reduces the representativeness.

## (c) Sampling Frame

The sampling frame is the source list from which the sample will be drawn. This includes:

Lists from local employment exchanges or rural employment centers

Databases of digital literacy NGOs or village panchayats

Training centers or Skill India program enrollments

Lists maintained by community workers or NGOs

## (d) Sampling Units

Sampling units refer to the individual elements chosen from the population for the study. For this research, the sampling units are:

Individual rural residents who are:

Actively seeking jobs or willing to work

Aged 18 years and above

Have access to a mobile phone or internet, even if limited

Reside in a village or small town
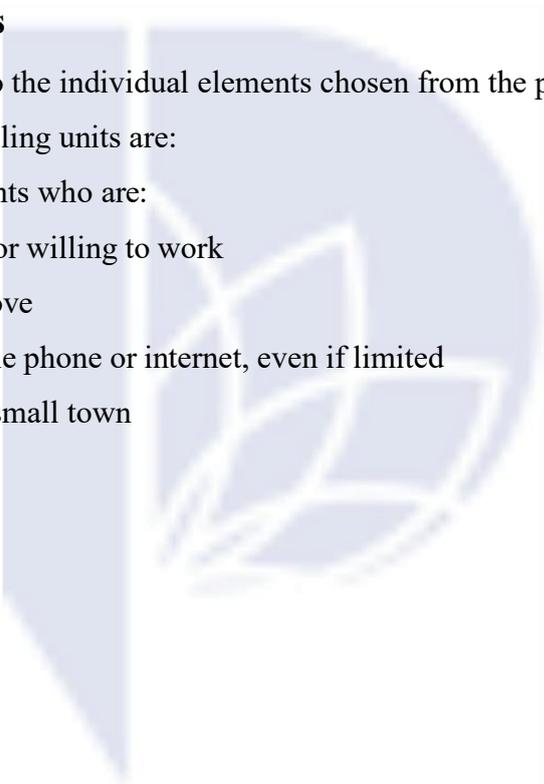
## Analysis and Interpretation
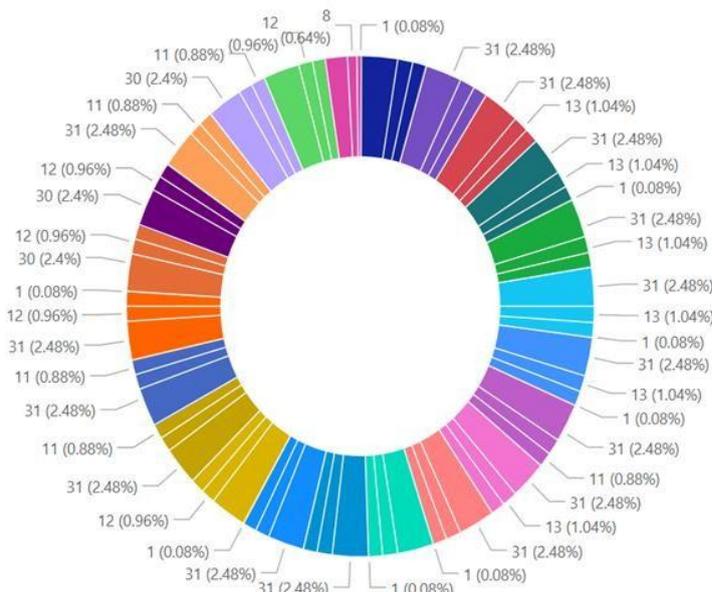


**Attribute**
- Do the job portals offer jobs that match your skills?
- Do you know anyone who got a job using a digita...
- Do you think there are enough job opportunities i...
- Full Name
- Gender
- Have you ever gotten a job through a job portal?
- Have you ever used a job portal to search for a job?
- How do you usually access job portals?
- How often do you use digital job portals?
- What is your age group?
- What is your highest level of education?
- Which job portals are you familiar with? (Choose ...
- Are you confident in using digital devices?
- Do you think online job platforms can reduce rura...
- What is the main barrier you face while using job ...
- Would you attend a digital job training session if ...
- Would you recommend digital job portals to othe...

## Analysis

1. Over half of the respondents (52.6%) are unemployed, indicating a severe employment gap despite their educational qualifications.
2. Private sector jobs are most sought after (41.1%), followed by government positions (26.8%) and general opportunities (28.6%), with very low interest in skilled trades, showing a heavy reliance on formal job markets.
3. A majority of respondents (57.1%) reside in cities, with smaller proportions from small towns (23.2%) and villages (19.6%), suggesting urban bias in awareness and digital access.
4. While 58.9% have been unemployed for less than six months, 21.4% have remained unemployed for over two years, highlighting both short-term and long-term unemployment concerns.

5. The top barriers to employment are lack of opportunities (33.9%) and skill deficits (33.9%), with additional challenges like lack of guidance (30.4%); few respondents reported digital access as the main issue.

6. Naukri.com and LinkedIn are the most familiar job portals, each recognized by 56.1% of respondents, indicating stronger brand awareness compared to other platforms.

7. A significant portion (40.4%) of respondents admitted to using digital job portals rarely, suggesting underutilization despite awareness.

8. Trust issues were identified by 38.2% as the primary obstacle in using portals, reflecting doubts about authenticity, transparency, or reliability.

9. Just over half (50.9%) have reliable internet access, while 27.3% have intermittent access and 21.8% lack it entirely, showing infrastructure gaps affecting digital adoption.

10. Half of the respondents (50%) feel only somewhat confident in handling digital devices, while 26.8% are very confident, indicating the need for skill-building in digital literacy.

11. Training workshops were chosen by 38.2% of respondents as the most beneficial intervention to improve job portal usage, showing willingness to learn.

12. Around 41.1% believe portals fail to provide jobs matching their skills, highlighting a mismatch between job seeker expectations and job postings.

13. A majority (63.6%) consider job portals somewhat relevant, showing moderate usefulness but limited alignment with rural employment needs.

14. More than half (50.9%) emphasized training and awareness as the key to improving jobs portal adoption, underlining the importance of outreach initiatives.

15. Nearly half (46.4%) expressed interest in attending local digital job training sessions, reflecting readiness to participate if opportunities are accessible.

16. About 48.2% believe online job platforms can help reduce rural unemployment, showing optimism toward digital solutions.

17. A notable 44.6% are willing to recommend digital job portals to others, suggesting that with improvements, portals can gain greater acceptance.

## Interpretation

1. This highlights the urgent need to improve rural employment through digital job portals.

2. This indicates a strong demand for formal sector jobs, while interest in skilled trades is low, suggesting the need to promote vocational opportunities through digital platforms.

3. This suggests that although the study focuses on rural unemployment, a significant portion of respondents are urban based, which may influence digital job portal awareness levels.

4. This shows both recent job seekers and long-term unemployed exist, highlighting the urgency of creating sustainable job opportunities through digital platforms.

5. This suggests that unemployment is driven more by **limited opportunities and skill gaps** rather than lack of digital access, indicating a need for training and localized job creation

6. This hints at potential awareness/access gaps in rural areas for job portals utilization.

7. This suggests digital job portals might not be a primary job search method for many respondents.

8. This suggests users might be wary of job portals' credibility or security, impacting their usage.

9. This indicates that while over half of the respondents have reliable internet access, a significant portion (49.1%) face issues with internet reliability.

10. This suggests that while a significant portion of respondents have some level of confidence in using digital devices, there's still a notable percentage (19.6%) who aren't confident, indicating a potential need for digital literacy support.

11. This suggests that users see a need for skill development or guidance to effectively utilize job portals.

12. This suggests there's a potential mismatch between the jobs available on portals and the skills of the job seekers, indicating a need for better skill alignment or job matching strategies on these platforms.

13. This suggests that while job portals aren't the ultimate solution for most respondents' employment needs, they still hold a considerable level of usefulness for over half of them.

14. This suggests that people in rural areas might need more education on how to effectively use job portals and be more aware of the opportunities available through these platforms.

15. This suggests there's a significant local interest in digital job training, potentially indicating a demand for such skill development opportunities in the area.

16. This suggests a moderate level of optimism about the potential of online job platforms to address rural unemployment issues among the surveyed population.

17. This suggests that nearly half of the respondents find digital job portals useful or effective for job searching, indicating a generally positive view among the surveyed group.

## Plan of Analysis

The data collected from respondents will first undergo preparation, which includes editing the responses for completeness, coding the answers for easier analysis, and entering the data into software tools such as MS Excel or SPSS. After data entry, cleaning will be done to remove any inconsistencies, duplicate entries, or incomplete responses.

Once the data is ready, descriptive statistics will be used to summarize the basic features of the data. This includes calculating frequencies and percentages to understand the distribution of responses related to awareness, usage of job portals, internet accessibility, and challenges faced by rural job seekers. Graphical representations like bar charts, pie charts, and tables will be used to make the findings visually clear and easy to interpret.

Cross-tabulation will be conducted to analyze the relationship between different demographic variables and digital job portal usage, such as education level vs. portal awareness, age group vs. internet access, and gender vs. job search behavior. If the data permits, inferential statistical tools like chi-square tests may be applied to examine the significance of relationships between

categorical variables. Correlation analysis may also be considered to identify the strength of the relationship between access to digital tools and employment outcomes.

In addition to quantitative analysis, qualitative responses (such as suggestions from respondents) will be reviewed and grouped into common themes to understand personal experiences and specific barriers. Finally, all findings will be interpreted in the context of the research objectives, and meaningful conclusions and recommendations will be drawn to help improve the use of digital job portals and reduce unemployment in rural areas.

## Limitations of the Study

This study encountered certain limitations that must be acknowledged while interpreting the findings. The geographical coverage of the research was restricted to selected rural and semi-urban areas, which may not fully represent the diverse conditions of all rural regions in India. The data collected was primarily based on self-reported responses through questionnaires, which may involve personal biases or misinterpretations by respondents. In addition, the sample size was limited due to time and resource constraints, which affects the generalizability of the results. Some participants faced language barriers and poor internet connectivity, making it difficult to access or understand digital survey tools effectively. The research also focused mainly on digital job portals, excluding other employment channels such as local recruitment, government schemes, or informal job networks. Furthermore, the rapid evolution of technology and online platforms may render some findings less relevant in the future. Despite these limitations, the study provides meaningful insights into the challenges and opportunities surrounding the use of digital job portals in reducing rural unemployment.

## Findings and Suggestions

## Findings

1.  A majority of respondents are graduates (61.4%) and postgraduates (29.8%), showing that most are educated but still unemployed.
2.  Over 52% are unemployed, while only 29.8% have full-time jobs, indicating serious job scarcity.
3.  Most respondents prefer private jobs (41.1%), followed by government jobs (26.8%),

    showing limited interest in skilled trades.
4.  The majority (57.1%ś) of respondents live in cities, but a significant share is from villages and small towns, reflecting diverse rural-urban challenges.

5. About 58.9% have been unemployed for less than 6 months, but 21.4% for more than 2 years, showing both short-term and long-term unemployment issues.

6. The biggest challenges are lack of opportunities (33.9%), lack of skills (33.9%), and no guidance (30.4%), while digital access itself is a smaller issue.

7. Around 43.9% feel there are no job opportunities in their area, while 36.8% are unsure, showing low confidence in local employment markets.

8. Respondents highlighted awareness programs, training workshops, and better connectivity as key needs for improving digital job access.

9. Many unemployed youth are open to any available job (28.6%), showing desperation and underutilization of their qualifications.

10. Suggestions from respondents indicate that digital literacy, user-friendly portals, and localized job information are essential for improving adoption.

## Suggestions

1. Conduct digital literacy and awareness programs in rural areas to increase portal usage.

2. Develop user-friendly job portals with simple design and regional language support.

3. Offer skill development and vocational training aligned with market demands.

4. Enhance internet connectivity and infrastructure in villages and small towns.

5. Promote local job opportunities through collaboration with small businesses and industries.

6. Provide career counseling and guidance centers in rural areas to assist job seekers.

7. Integrate government schemes and private job postings in a single portal for easy access.

8. Encourage self-employment and entrepreneurship by linking portals with microfinance and skill programs.

9. Regular workshops and campaigns should be conducted to build trust in digital platforms.

10. Monitor and evaluate job portal effectiveness periodically to ensure real employment outcomes.

## Conclusion

The study on rural unemployment and the underutilization of digital job portals highlights critical insights into the challenges faced by rural and semi-urban populations in accessing meaningful employment. Despite the fact that the majority of respondents are well-educated, with most being graduates and postgraduates, unemployment remains a pressing issue. More than half of the participants reported being unemployed, with some facing long-term joblessness for over two years. This indicates that the problem lies not in educational qualifications alone but in the mismatch between job seekers and available opportunities.

The survey results further revealed that respondents primarily prefer private or government jobs, while interest in skilled trades remains very low. This shows a heavy dependency on formal employment sectors and an under-recognition of self-employment or vocational options. Additionally, many unemployed youth expressed willingness to accept any job available, suggesting that desperation is driving underemployment and the wastage of qualifications.

One of the most striking findings is that the biggest barriers to employment are the **lack of opportunities, skill gaps, and absence of proper guidance or support**, rather than the lack of digital access itself. Although some respondents noted issues such as poor internet connectivity or limited portal usability, the core problem lies in the alignment of job portals with real employment needs and local opportunities. Moreover, many participants expressed uncertainty about the availability of jobs in their own areas, highlighting a lack of confidence in the local job market.

The responses to the open-ended question provided valuable suggestions, including the need for awareness programs, training workshops, localized job postings, and user-friendly digital platforms in regional languages. These findings point toward a crucial gap in both digital literacy and the integration of job portals into rural employment ecosystems.

In conclusion, the study establishes that while digital job portals have the potential to address unemployment challenges in rural areas, their impact is limited by poor awareness, inadequate training, and a lack of localized and relevant job opportunities. For digital platforms to become effective tools of empowerment, efforts must be directed towards improving digital literacy, enhancing infrastructure, promoting vocational skills, and building trust among rural job seekers. By bridging these gaps, job portals can become a powerful medium to connect

educated rural youth with sustainable employment, thereby reducing unemployment and fostering inclusive growth.

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