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PUBLIC VS PRIVATE MUTUAL FUNDS: A COMPARISON OF SBI AND ADITYA BIRLA SUN LIFE

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ABSTRACT:

Performance appraisal of mutual funds operating in the public sector and private sector provides critical insight into how ownership structure, management style, and strategic objectives influence investment outcomes. This paper compares SBI Mutual Fund, which represents the public sector, with Aditya Birla Sun Life Mutual Fund (ABSLMF), which represents the private sector. The key performance indicators that form part of the analysis include risk-adjusted returns, namely Sharpe Ratio, Treynor Ratio, and Jensen's Alpha, besides studying the growth in NAV, fund volatility, and consistency of returns over a defined period. Results indicate that Aditya Birla Sun Life Mutual Fund schemes usually tend to exhibit higher risk-return dynamics on account of the more aggressive portfolio strategies characteristic of private-sector asset management, while SBI Mutual Fund schemes have typically pursued stability, long-term value creation, and lower risk exposure in line with conservative public-sector investment practices. The comparative analysis draws attention to differences in risk-adjusted return generation efficiency, responsiveness of fund management to market swings, and diversification patterns.

The study concludes that an investor's choice between mutual funds in the public and private sectors should be guided by their investment horizon, return expectations, and risk tolerance. It also draws on the importance of monitoring performance with changes in the market.

KEY WORDS: ASSET UNDER MANAGEMENT (AUM), ASSET MANAGEMENT COMPANY (AMC), NET ASSET VALUE (NAV), PORTFOLIO MANAGEMENT, INVESTMENT PERFORMANCE, FUND COMPARISON, RISK-RETURN ANALYSIS

I. INTRODUCTION:

A mutual fund is an investment vehicle that pools the money of many investors to invest in a diversified portfolio of securities, which may include stocks, bonds, and money market instruments. This pool will then be managed by a professional fund manager or team of managers, who direct investment decisions on behalf of the investors. Equity Mutual Funds: An equity mutual fund is a form of investment in a pooled format that invests a majority of its corpus in stocks or equities of publicly traded companies for long-term capital growth. These funds are professionally managed, which ensures that instead of directly selecting stocks, investors get a diversified portfolio of stocks. Equity funds may be actively or passively managed and are classified based on company size, sector, or investment style. Debt Mutual Funds: A debt mutual fund is an investment fund that invests in a variety of fixed income instruments, such as government securities, corporate bonds, and money market instruments, with the objective of earning regular income while preserving capital. They are less risky compared to equity funds and thus ideal for investors looking for more stability in returns, capital preservation, or to achieve short to medium-term goals.

Hybrid Mutual Fund: The hybrid mutual fund is an investment portfolio that combines two or more asset classes-in a single portfolio-with the two most common asset mixes being the combination of stocks (equity) and bonds (debt). These funds seek to balance the potential for growth that comes from equities with the relatively greater stability and lower risk from debt, while also offering diversification. They are also called asset allocation funds and are designed to meet a number of investor risk profiles and financial goals. Understanding these terminologies is very important for discerning critical chances in the performance of various mutual fund houses. This project work specifically looks at SBI Mutual Fund, representative of public-sector investment management, and Aditya Birla Sun Life Mutual Fund, among the leading fund houses in the private sector. The research shall try to identify how far a difference in ownership structure, investment philosophy, and management style influences overall fund performance by analyzing its key performance indicators and risk metrics.

II. LITERATURE REVIEW:

Many scholars have made studies on investors' behavior, and many studies are going on. Also many researches on the performance of mutual fund schemes has been conducted. From the available studies from secondary sources the literature is reviewed here to have better clarity of investors' behavior and the study. Thereafter the empirical studies done on the similar areas of research in international context as well as in Indian context were highlighted. The purpose of literature survey in any study is to help the researcher, to find out the gap between the research that has already been conducted and the theoretical linkage of the research.

(Dr.K.M.Sudha 2020) "Comparative Study on Selected Mutual Fund". The objective of this study is comparative performance analysis for selected mutual funds five years and also risks and returns of mutual funds. This study evaluates the analysis of returns that take place for five years and their volatility based on investment. Data source: secondary data. The analysis tool used: simple average method and standard deviation method, and simple comparative analysis method ranking method. Findings: It is not advisable to invest equity fund category because the market is undergoing fluctuation. Thus asset components are subject to high risk.

(Dr. Nidhi Sharma, Feb, 2019) Conducted research on "Performance Analysis of Mutual Funds: A Comparative Study of the Selected Hybrid Mutual Fund Schemes in India". In this study, an attempt is made to measure and compare the performance of the select hybrid mutual fund schemes in India. The selection of hybrid schemes is based on top 10 ranking given by CRISIL and that rank based on the NAVs of the schemes. The data are used is primary data and tools used in this study are NAV, average return, beta, R- square and standard deviation.

III. METHODS OF RESEARCH

The process of conducting a project in a methodical manner is known as research methodology. This study's research methodology consists of the following:

Statement of the problem:

Despite being popular investment vehicles, many find it difficult to distinguish between mutual funds in the public and private sectors. Whether SBI Mutual Fund-public or Aditya Birla Sun Life Mutual Fund-private delivers superior performance, less risk, more transparency, or improved investor happiness is not well-established. This knowledge gap results in confusion and inhibits

choices by retail investors. A comparative study is necessary in order to determine how the two types of funds differ in terms of performance, risk, cost structure, and investor perception.

Objectives of the study:

Look at how mutual funds are growing in India right now.
Check how mutual fund plans from Aditya Birla Sun Life and SBI are performing.
Use standard deviation, beta, Sharpe's ratio, Jensen's ratio, and Treynor's ratio to break down the risk and return for SBI and Aditya Birla Sun Life mutual funds.
Figure out which mutual fund strategy really comes out on top.
Give investors advice they can actually use to make smart financial decisions.

Scope of the Study

This study compares mutual funds from both public and private sectors.
The focus stays on just two players: Aditya Birla Sun Life Mutual Fund and SBI Mutual Fund.
The research covers a mix of schemes—equity funds, debt funds, and hybrid funds.
We look at performance over the past ten years.

Sample Size:

We're working with two asset management companies: ABSL Mutual Fund and SBI Mutual Fund.

Tools Used:

We base our analysis on secondary data, using statistical ratios—standard deviation, beta, Sharpe ratio, Treynor ratio, and Jensen ratio.

Data collection:

The information for the investigation was obtained from secondary sources. Examples of secondary sources used include annual reports and published materials of mutual fund firms, other mutual fund publications, research-based web sites, and published sources. Secondary data is collected from the website www.moneycontrol.com as of November 2025 in order to compute the ratios using their NAVs.

Limitations:

This study doesn't cover every mutual fund scheme in India. It focuses on just two AMCs, so you can't really apply the findings everywhere.
The ratios use NAVs from the past three years. Sure, you could look at one, five, or even ten years, but considering how unpredictable the market's been, sticking to a shorter timeframe feels more realistic for capturing what's happening now.
The whole analysis depends on how accurate and easy-to-get the secondary data is—from AMFI, SEBI, and AMC websites.
Market ups and downs can shake up the results.
If you change the time frame or pick different schemes, you'll probably get different results.

IV. DATA COLLECTION AND INTERPRETATION

SBI Mutual Fund

SBI Mutual Fund is one of the largest and longest-standing asset management companies in India, established as early as 1987. The fund house is sponsored by State Bank of India, the country's largest public sector bank, thus laying a strong foundation of trust, reach, and financial experience. The SBI Mutual Fund offers a wide bouquet of investment products, including equity funds, debt funds, hybrid schemes, ETFs, and liquid funds targeted for both individual and institutional clients. SBI Mutual Fund is well-known for its robust risk-management procedures, steady performance,

and wide distribution network. It has been instrumental in advancing mutual fund knowledge and financial inclusion throughout India.

Aditya Birla Sun Life Mutual Fund

Established in 1994, Aditya Birla Sun Life Mutual Fund is among India's leading private-sector asset management companies. It is a joint venture between Sun Life Financial Inc., an international financial services company based in Canada, and the Aditya Birla Group, one of India's largest and most diversified business conglomerates. Managed by Aditya Birla Sun Life AMC Ltd., the fund house has earned a good reputation for competent fund management, product innovation, and investor-centric services. ABSL Mutual Fund has a diversified array of schemes ranging from equities and debt to hybrid, sectoral, and solution-oriented offerings, aimed at different risk profiles and investment objectives.

TABLE 1.1 TRENDS OF SBI MUTUAL FUND AUM

YEAR	SBI MUTUAL FUND	
	Amount (Rs. Crores)	Index Value (%)
2014	65499	-
2015	74942	114.42
2016	106781	163.03
2017	157025	239.74
2018	217649	332.29
2019	283807	433.30
2020	373537	570.29
2021	504455	770.17
2022	647067	987.90
2023	717161	1094.92
2024	914365	1396
2025	1072949	1638.12

Source: AMFI, Annual Reports of SBI AMC

*Index Value = P1/P0*100 (P0 = Year 2014)

*Index Value (%) has been rounded off to nearest number after decimal

Assets under SBI mutual fund management are depicted in Table 5.1. The public sector-sponsored mutual fund, SBI, has thus shown steady year-on-year growth from 2014 to 2025. Its AUM rose from Rs. 65499 crores in 2014 to Rs. 1072949 crores in 2025, recording an index growth of 1638.12%.

TABLE 5.2 TRENDS OF ADITYA BIRLA SUN LIFE MUTUAL FUND AUM

YEAR	ADITYA BIRLA SUN LIFE MUTUAL FUND	
	Amount (Rs. Crores)	Index Value (%)
2014	89051	-
2015	119752	134.48
2016	136503	153.29
2017	195049	219.03
2018	247529	277.96
2019	246480	276.79
2020	247522	277.96
2021	281035	315.59

2022	295805	322.17
2023	275204	309.04
2024	331709	372.49
2025	381000	427.84

Source: AMFI, Annual Reports of Aditya Birla Sunlife Mutual fund AMC
*Index Value = P1/P0*100 (P0 = Year 2014)
*Index Value (%) has been rounded off to nearest number after decimal

Table 5.2 depicts the assets managed by Aditya Birla Sun Life mutual funds. Aditya Birla Sunlife Mutual Fund, a private sector mutual fund, has shown stable development in terms of YOY basis from 2014 to 2025 with its AUM rising to Rs. 381000 Crores in 2025 from Rs. 89051 Crores in 2014 and is displaying 427.84% index growth.

1.3.1 EQUITY SCHEMES ANALYSIS

TABLE 1.3 EQUITY SCHEMES RATIOS

Scheme Name	Standard Deviation	Beta	Sharpe Ratio	Jenson's Ratio	Treynor's Ratio
BI MULTICAP FUND - DIRECT PLAN - GROWTH	11.40	0.76	0.98	1.45	0.15
SBI MIDCAP FUND - DIRECT PLAN - GROWTH	11.93	0.71	0.92	-0.89	0.15
SBI LARGE CAP FUND - DIRECT PLAN - GROWTH	10.82	0.86	0.81	2.06	0.10
SBI SMALL CAP FUND - DIRECT PLAN - GROWTH	12.65	0.69	0.79	-0.33	0.15
SBI ELSS TAX SAVER FUND - DIRECT PLAN - GROWTH	11.95	0.90	1.40	7.68	0.19
ADITYA BIRLA SUN LIFE MULTI CAP FUND - DIRECT PLAN - GROWTH	12.70	0.89	0.95	0.72	0.13
ADITYA BIRLA SUN LIFE MIDCAP FUND - DIRECT PLAN - GROWTH	13.96	0.86	1.02	-0.13	0.17
ADITYA BIRLA SUN LIFE LARGE CAP FUND - DIRECT PLAN - GROWTH	11.56	0.92	0.86	2.26	0.11
ADITYA BIRLA SUN LIFE SMALL CAP FUND - DIRECT PLAN - GROWTH	15.27	0.86	0.88	0.51	0.16
ADITYA BIRLA SUN LIFE ELSS TAX SAVER FUND - DIRECT PLAN - GROWTH	11.85	0.89	0.81	0.37	0.11

Source: www.moneycontrol.com as on November.2025 based on NAVs of past 3 years

Table 1.4 Equity Schemes Rank Table

Scheme Name	Standard Deviation	Beta	Sharpe Ratio	Jenson's Ratio	Treynor's Ratio	Total

SBI MULTICAP FUND - DIRECT PLAN - GROWTH	2	3	3	4	5	17
SBI MIDCAP FUND - DIRECT PLAN - GROWTH	5	2	5	10	5	27
SBI LARGE CAP FUND - DIRECT PLAN - GROWTH	1	5	8.5	3	10	27.5
SBI SMALL CAP FUND - DIRECT PLAN - GROWTH	7	1	10	9	5	32
SBI ELSS TAX SAVER FUND - DIRECT PLAN – GROWTH	6	9	1	1	1	18
ADITYA BIRLA SUN LIFE MULTI CAP FUND - DIRECT PLAN - GROWTH	8	7.5	4	5	7	31.5
ADITYA BIRLA SUN LIFE MIDCAP FUND - DIRECT PLAN - GROWTH	9	5	2	8	2	26
ADITYA BIRLA SUN LIFE LARGE CAP FUND - DIRECT PLAN - GROWTH	3	10	7	2	8.5	30.5
ADITYA BIRLA SUN LIFE SMALL CAP FUND - DIRECT PLAN - GROWTH	10	5	6	6	3	30
ADITYA BIRLA SUN LIFE ELSS TAX SAVER FUND - DIRECT PLAN - GROWTH	4	7.5	8.5	7	8.5	35.5

The following table, which ranks the various schemes selected for the study with rank-1 as the best, forms the basis for the analysis.

Standard Deviation-

Analyzing the data about the standard deviation of selected schemes, **SBI Large Cap Fund - Direct Plan - Growth** scheme gets the top place with 10.82 standard deviation value. Therefore, **Aditya Birla Sun Life Large Cap Fund - Direct Plan - Growth** may be considered to be the best ranked plan. Low value of standard deviations suggests reliable returns. Hence, the above two schemes give more consistent returns compared to rest of the schemes.

Beta-

It is seen from the above summarization that **SBI Small Cap Fund - Direct Plan - Growth** emerges rank one amongst the chosen schemes because it gives the least beta value-that is, it is the least risky among the others in the table. Similarly, the beta number carries the more relevant meaning that "better returns come with greater risk." One may argue that the top-ranked plan is **Aditya Birla Sun Life Small Cap Fund-Direct Plan-Growth**. However, for analytical purposes, it is presumed that the investor is essentially risk adverse, which brings us to **SBI Small Cap Fund-Direct Plan-Growth.**

Sharpe Ratio-

To evaluate on the Sharpe ratio, the rule is 'higher the Sharpe ratio better it is, it so because Sharpe ratio is a measure of per unit return against the risk incurred. As per the Sharpe Ratio deductions **SBI ELSS Tax Saver Fund - Direct Plan – Growth** ranks one, with second highest Sharpe ratio in the category followed by **Aditya Birla Sun Life Midcap Fund: Growth Direct Plan.**

Treynor's Ratio:

The best plan regarding the Treynor's ratio is **SBI ELSS Tax Saver Fund-Direct Plan-Growth**, having the highest ratio within the peer group, followed **by Aditya Birla Sun Life Midcap Fund Growth, Direct Plan**.

The Jenson Ratio

Jenson's ratio shows how strong the performance of a portfolio is; in this context, this is best demonstrated by the **SBI ELSS Tax Saver Fund-Direct Plan-Growth** ranking number one with the highest Jenson's ratio in the group, followed by **Aditya Birla Sun Life Growth, Direct Plan, Large Cap Fund.**

Conclusion-SBI Multicap Fund - Direct Plan - Growth is the best among the selected equity schemes in overall parameters.

1.3.2 DEBT SCHEME ANALYSIS

TABLE 1.5 DEBT SCHEMES RATIOS

Scheme Name	Standard Deviation	Beta	Sharpe Ratio	Jenson's Ratio	Treynor's Ratio
SBI SHORT TERM DEBT FUND - DIRECT PLAN - GROWTH	0.83	1.18	2.59	-0.02	0.02
SBI MAGNUM MEDIUM DURATION FUND - DIRECT PLAN - GROWTH	1.06	0.76	2.23	0.93	0.03
SBI LONG DURATION FUND - DIRECT PLAN - GROWTH	3.50	1.31	0.59	-0.64	0.02
SBI OVERNIGHT FUND - DIRECT PLAN - GROWTH	0.02	0.98	21.55	-0.05	0.01
SBI CORPORATE BOND FUND - DIRECT PLAN - GROWTH	0.92	0.00	2.29	2.11	12.19
Aditya Birla Sun Life Short Term Fund - Direct Plan - Growth	0.87	1.09	2.66	0.59	0.02
ADITYA BIRLA SUN LIFE MEDIUM TERM PLAN - DIRECT PLAN - GROWTH	2.03	0.82	2.08	2.68	0.05
ADITYA BIRLA SUN LIFE LONG DURATION FUND - DIRECT PLAN - GROWTH	2.69	1.01	1.00	0.59	0.03
ADITYA BIRLA SUN LIFE OVERNIGHT FUND - DIRECT PLAN - GROWTH	0.03	1.00	22.33	-0.02	0.01
ADITYA BIRLA SUN LIFE CORPORATE BOND FUND - DIRECT PLAN - GROWTH	1.01	0.00	2.08	2.10	15.80

Source: www.moneycontrol.com as on November.2025 based on NAVs of past 3 years

Table 1.6- Debt Scheme Rank Table

Scheme Name	Standard Deviation	Beta	Sharpe Ratio	Jenson's Ratio	Treynor's Ratio	Total
SBI SHORT TERM DEBT FUND - DIRECT PLAN - GROWTH	3	9	4	7.5	6	29.5
SBI MAGNUM MEDIUM DURATION FUND - DIRECT PLAN - GROWTH	7	3	6	4	4	24
SBI LONG DURATION FUND - DIRECT PLAN - GROWTH	10	10	10	10	7	47
SBI OVERNIGHT FUND - DIRECT PLAN - GROWTH	1	5	2	9	9	26
SBI CORPORATE BOND FUND - DIRECT PLAN - GROWTH	5	1.5	5	2	2	15.5
Aditya Birla Sun Life Short Term Fund - Direct Plan - Growth	4	8	3	5.5	8	28.5
ADITYA BIRLA SUN LIFE MEDIUM TERM PLAN - DIRECT PLAN - GROWTH	8	4	7.5	1	3	23.5
ADITYA BIRLA SUN LIFE LONG DURATION FUND - DIRECT PLAN - GROWTH	9	7	9	5.5	5	35.5
ADITYA BIRLA SUN LIFE OVERNIGHT FUND - DIRECT PLAN - GROWTH	2	6	1	7.5	10	26.5
ADITYA BIRLA SUN LIFE CORPORATE BOND FUND - DIRECT PLAN - GROWTH	6	1.5	7.5	3	1	19

The analysis below is based on the accompanying table, which rates the several schemes chosen for the study, with rank-1 being the best.

Standard Deviation:

SBI Overnight Fund-Direct Plan-Growth schemes have been ranked top with a standard deviation value of 0.02, as per the analysis of data on standard deviation of the selected schemes. Hence, Aditya Birla Sun Life Overnight Fund-Direct Plan-Growth can be considered as the highest-ranked plan. Low values of standard deviations indicate reliable returns. Hence, among other schemes, the above-mentioned two schemes give more consistent returns.

Beta-

Beta represents the estimate of the systematic risk that applies to a strategy. From the above summaries, it can be observed that Aditya Birla and the SBI Corporate Bond Fund-Direct Plan-Growth Among the schemes selected, **Aditya Birla Sun Life Corporate Bond Fund-Direct Plan-**

Growth will be ranked first because its beta value is low when compared with other schemes from the table, indicating that it is not as risky as the other schemes are.

Sharpe Ratio-

To evaluate the Sharpe ratio, the rule is 'higher the Sharpe ratio better it is', it so because Sharpe ratio is a measure of per unit return against the risk incurred. Based on Aditya Birla's Sharpe Ratio deductions With the second-highest Sharpe ratio in the category, **Aditya Birla Sun Life Overnight Fund-Direct Plan-Growth** tops the list, while **SBI Overnight Fund-Direct Plan-Growth** ranks second.

Treynor's Ratio:

Aditya Birla Sun Life Corporate Bond Fund-Direct Plan-Growth has the highest ratio in the group regarding Treynor's ratio followed by **SBI Corporate Bond Fund-Direct Plan-Growth.**

Jenson's Ratio:

Jenson's ratio depicts higher performance for a portfolio. In the above context, this is proved best by the **Aditya Birla Sun Life Medium Term Plan-Direct Plan-Growth**, ranking one with the highest Jenson's ratio in the group, followed by **SBI Corporate Bond Fund-Direct Plan–Growth.**

Conclusion: The best overall, out of the selected equity schemes is **SBI Corporate Bond Fund-Direct Plan-Growth.**

1.3.3 HYBRID SCHEMES ANALYSIS

TABLE 1.7 HYBRID SCHEMES RATIOS

Scheme Name	Standard Deviation	Beta	Sharpe Ratio	Jenson's Ratio	Treynor's Ratio
BI EQUITY HYBRID FUND - DIRECT PLAN - GROWTH	8.46	0.96	1.01	1.87	0.09
SBI EQUITY SAVINGS FUND - DIRECT PLAN - GROWTH	4.83	0.77	1.12	2.28	0.07
SBI CONSERVATIVE HYBRID FUND - DIRECT PLAN - GROWTH	3.09	1.01	1.46	1.27	0.04
SBI BALANCED ADVANTAGE FUND - DIRECT PLAN - GROWTH	5.79	0.83	1.46	3.62	0.10
SBI ARBITRAGE OPPORTUNITIES FUND - DIRECT PLAN - GROWTH	0.92	0.54	1.91	0.89	0.03
SBI Multi Asset Allocation Fund - Direct Plan - Growth	6.80	0.40	1.72	8.42	0.29

DITYA BIRLA SUN LIFE EQUITY HYBRID 95 FUND - DIRECT PLAN - GROWTH	9.14	1.07	0.90	0.81	0.08
ADITYA BIRLA SUN LIFE EQUITY SAVINGS FUND - DIRECT PLAN - GROWTH	3.03	0.66	1.20	2.36	0.05
ADITYA BIRLA SUN LIFE REGULAR SAVINGS FUND- DIRECT PLAN - GROWTH	2.96	1.02	1.41	0.89	0.04
ADITYA BIRLA SUN LIFE BALANCED ADVANTAGE FUND - DIRECT PLAN - GROWTH	7.14	1.06	1.10	1.68	0.07
ADITYA BIRLA SUN LIFE ARBITRAGE FUND - DIRECT PLAN - GROWTH	0.91	0.51	1.94	0.94	0.03
ADITYA BIRLA SUN LIFE MULTI ASSET ALLOCATION FUND - DIRECT PLAN - GROWTH	8.33	1.19	1.49	5.49	0.10

Source: www.moneycontrol.com as on November, 2025 based on NAVs of past 3 years

ADITYA BIRLA SUN LIFE EQUITY HYBRID 95 FUND - DIRECT PLAN - GROWTH	12	11	12	12	5	52
ADITYA BIRLA SUN LIFE EQUITY SAVINGS FUND - DIRECT PLAN - GROWTH	4	4	8	4	8	28
ADITYA BIRLA SUN LIFE REGULAR SAVINGS FUND- DIRECT PLAN - GROWTH	3	9	7	10.5	9.5	39
ADITYA BIRLA SUN LIFE BALANCED ADVANTAGE FUND - DIRECT PLAN - GROWTH	9	10	10	7	6.5	42.5

The analysis is based on the following table, which rates the several schemes chosen for the study with rank-1 being the best.

Standard Deviation-

Considering the data with respect to the standard deviation of the schemes under consideration, it may be found that **Aditya Birla Sun Life Arbitrage Fund - Regular Plan - Growth** scheme stands

at rank one followed by **SBI Arbitrage Opportunities Fund - Regular Plan - Growth** with **1.02** and **1.11** as the values of its standard deviation respectively. Low values of standard deviation imply stable returns. Therefore, inference may be made that the above two schemes offer more stable returns as compared to the rest selected.

Beta-

The beta value depicts the systematic risk associated with a scheme/portfolio. As per the above summaries, **SBI Multi Asset Allocation Fund-Direct Plan-Growth** ranks on top of the other schemes since it has the lowest beta value, which indicates that it is the least risky compared to the other schemes in the table. The other more relevant meaning of the beta value in the present context is that "with more risk comes better returns." **Aditya Birla Sun Life Arbitrage Fund - Direct Plan - Growth** could well be termed as the best ranking scheme. But for the purpose of analysis it is considered that the investor is primarily risk adverse, thereby bringing **SBI Multi Asset Allocation Fund - Direct Plan - Growth** to rank one.

Sharpe Ratio-

The rule to assess the Sharpe ratio is 'higher the Sharpe ratio better it is', it so because Sharpe ratio is a measure of per unit return against the risk incurred. According to the Sharpe Ratio deductions, **Aditya Birla Sun Life Arbitrage Fund-Direct Plan-Growth** stands with the highest Sharpe ratio in the group, followed by **SBI Arbitrage Opportunities Fund-Direct Plan-Growth.**

Treynor's Ratio:

When it comes to Treynor's ratio, the top schemes are **SBI Multi Asset Allocation Fund-Direct Plan-Growth,** which has the highest ratio in the group, followed by **SBI Balanced Advantage Fund-Direct Plan-Growth** and **Aditya Birla Sun Life Multi Asset Allocation Fund: Growth, Direct Plan.**

Jenson's Ratio-

Jenson's ratio shows stronger performance of a portfolio that, in the context above, is best shown by **SBI Multi Asset Allocation Fund - Direct Plan - Growth,** which ranks one with the highest Jenson's ratio in the group, followed by **Aditya Birla Sun Life Multi Asset Allocation Fund: Growth, Direct Plan.**

Conclusion: SBI Multi Asset Allocation Fund-Direct Plan-Growth is the best overall from among the selected equity schemes.

1.4 FINDINGS

Performance of the Equity Scheme

SBI Multicap Fund – Direct Plan – Growth, with the lowest overall rank of 17, is the best-performing equity plan among all. It performs excellently on all the aspects that have been gauged. Overall, SBI equity plans fare better as their aggregate total rank stands at 121.5 against Birla Sun Life's 153.5.

Performance of Debt Schemes

Aditya Birla Sun Life Corporate Bond Fund – Direct Plan – Growth is the highest ranked debt scheme with an overall rank of 19. Birla Sun Life pips SBI in the aggregate debt category with a composite ranking of 133 vs SBI's 142.

Performance of Hybrid Schemes

Overall, the best performing hybrid plan is the SBI Multi Asset Allocation Fund – Direct Plan – Growth, with the highest score in each category and a total rank of 14. At the category level, SBI hybrid plans come out significantly superior, with an aggregate rank of 173.5, compared to 216.5 for Birla Sun Life.

The Best Scheme Overall

Among all categories and schemes under analysis, the SBI Multi Asset Allocation Fund – Direct Plan – Growth is the best plan overall with the highest composite performance score at 14.5.

Stability and Risk-Adjusted Performance

SBI Overnight Fund – Direct Plan – Growth has the lowest standard deviation of 0.02, hence the most stable scheme (lowest volatility). The risk-adjusted return is better for Aditya Birla Sun Life Overnight Fund – Direct Plan – Growth, albeit with a marginally higher standard deviation of 0.03 than that of Aditya Birla Sun Life Arbitrage Fund – Regular Plan – Growth, thereby yielding better returns per unit of risk taken.

Public versus Private Sector Mutual Fund Performance

Public sector mutual funds such as SBI, based on the sample examined, show better performance in equity and hybrid schemes. It is only in debt schemes that private sector mutual funds such as Birla Sun Life perform marginally better, and that too, the difference is too small to matter.

RECOMMENDATIONS

For Investors Looking for Excellent All-round Performance

SBI Multi Asset Allocation Fund – Direct Plan – Growth is a top overall performer, offering excellent performance in the hybrid category on a consistent basis.

Investors who fear for the equity

SBI Equity Schemes: Their overall performance is higher on aggregate. Specifically, investors seeking exposure to mid-cap and diversified stocks should look into the SBI Multicap Fund and SBI Magnum Midcap Fund.

For Conservative or Fixed-Income Investors

Overall, the category performance is marginally better for Birla Sun Life debt plans. One of the best options amongst them is the Aditya Birla Sun Life Corporate Bond Fund – Direct Plan – Growth.

For short-term or low-risk investors

The best option for maximum stability is SBI Overnight Fund – Direct Plan - Growth. Aditya Birla Sun Life Overnight Fund – Direct Plan – Growth can be a better option considering the risk-adjusted returns despite higher volatility.

Strategy for Portfolio Diversification

Investors may consider allocating their funds between the two fund houses:
SBI for hybrid and equity exposure.
Birla Sun Life for selected debt exposure.

Implications for Policy Makers and Fund Managers

Outstanding performance by SBI in the equities and hybrid categories indicates robust asset allocation techniques and risk management frameworks. Birla Sun Life may look to improve consistency in performance for equity and hybrid schemes while leveraging capabilities in debt management.

Future Research Suggestion:

Time-series analysis to assess performance consistency over extended time horizons is one possible avenue of future research. To get a more comprehensive risk-return profile, compare Sharpe ratio, Treynor ratio, and alpha. o Analysis of expense ratios and portfolio turnover in search of cost-performance relationships.

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Comparative analysis of SBI Mutual Fund and Aditya Birla Sun Life Mutual Fund shows both offer diversified schemes (equity, debt, hybrid, ELSS) with strong SIP options.

SBI Mutual Fund is one of the largest fund houses in India with very high Assets Under Management (AUM), reflecting strong market presence and investor trust.

Aditya Birla Sun Life Mutual Fund is backed by the Aditya Birla Group and Sun Life Financial, emphasizing research-driven investment strategies.

DIGITAL LEARNING AND SOCIAL INEQUALITY IN HIGHER EDUCATION

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ABSTRACT

The rapid expansion of digital learning environments in higher education has transformed how students access knowledge, participate in academic activities, and experience university life. While digital platforms promise flexibility, innovation, and widened participation, they also reproduce and intensify existing social inequalities related to technology access, digital skills, home environments, and cultural resources. This study examines the relationship between digital learning conditions, social inequality, and academic engagement among university students. Grounded in sociological perspectives on education, inequality, technology, and cultural capital, the research explores how digital access, learning environments, institutional support, and peer networks shape students' motivation, participation, and academic confidence.

A mixed-methods research design was adopted, consisting of a survey of 620 university students across disciplines and socioeconomic backgrounds, along with in-depth interviews with 32 participants selected to reflect variation in class position, gender, residence, and learning experiences. Quantitative findings indicate that students with reliable digital access, supportive home environments, and stronger institutional connectivity report higher academic engagement and greater learning confidence. Students facing unstable internet, device limitations, crowded households, or limited digital literacy demonstrate lower participation and heightened academic anxiety. Qualitative narratives reveal layered experiences of isolation, resilience, improvisation, and negotiation between opportunity and constraint. Digital learning was experienced simultaneously as empowering, stressful, unequal, and relationally detached.

The study argues that digital learning is not a neutral technological process but a socially embedded educational experience shaped by inequality, household structure, and institutional culture. Academic engagement emerges from interaction between digital infrastructure, social support, and symbolic meanings of competence rather than from motivation alone. The findings contribute to sociological debates on technology and education by highlighting how digital learning environments amplify structural differences in opportunity and participation. Implications for inclusive pedagogy, digital infrastructure policy, and student support frameworks are discussed, along with directions for future research.

KEYWORDS: DIGITAL LEARNING; SOCIAL INEQUALITY; ACADEMIC ENGAGEMENT; UNIVERSITY STUDENTS; CULTURAL CAPITAL; EDUCATIONAL EXPERIENCE; SOCIOLOGY OF EDUCATION

1. INTRODUCTION

Universities increasingly incorporate digital learning into teaching, assessment, and academic communication. Online platforms, recorded lectures, learning portals, and virtual classrooms have reshaped the rhythms of study and interaction. These developments are often celebrated as progressive, flexible, and inclusive. However, sociological perspectives emphasize that educational

environments are embedded in social structures and inequalities rather than existing as isolated technological systems.

Students enter digital learning spaces with unequal access to resources such as devices, stable internet, quiet study environments, and technological competence. Household responsibilities, economic constraints, and emotional stress further shape how students experience learning. Digital participation becomes tied to visibility, self-presentation, and symbolic confidence, sometimes reinforcing hierarchies rather than eliminating them.

This study investigates how digital learning conditions influence academic engagement and how inequality shapes students' capacity to participate, interact, and succeed in university contexts.

RESEARCH QUESTION

How do digital learning conditions, social inequality, and household environments influence academic engagement and educational experience among university students?

HYPOTHESIS

Students with stable digital access, supportive learning environments, and higher cultural capital demonstrate stronger academic engagement, while students experiencing technological and social constraints report lower participation and greater academic stress.
The study situates digital learning within broader sociological structures of inequality, identity, and institutional organization.

2. LITERATURE REVIEW

2.1 Technology and the Social Structure of Education

Technology in education is often framed as innovative and democratizing. However, sociological research highlights that technological systems reflect and reproduce social hierarchies, access differences, and institutional norms.

2.2 Digital Divide and Inequality

The digital divide extends beyond device access to include quality of connectivity, digital skills, learning environments, and emotional capacity to participate. Inequality appears in subtle forms such as participation confidence, speed of response, and symbolic visibility.

2.3 Cultural Capital and Academic Advantage

Students with higher cultural capital possess communication skills, learning familiarity, and institutional navigation ability that translate more smoothly into digital environments.

2.4 Engagement, Motivation, and Belonging

Academic engagement is shaped not only by interest but by relational belonging, peer interaction, and supportive environments. Digital learning can disrupt or restructure these experiences.

2.5 Gaps in Research

Existing studies often emphasize efficiency and technological outcomes rather than lived experience, inequality, and social meaning. This study integrates quantitative patterns with interpretive narratives to address this gap.

3. RESEARCH METHODOLOGY

3.1 Research Design

A mixed-methods design combined survey analysis with qualitative interviews to capture both structural patterns and experiential meaning.

3.2 Population and Sampling

The study included 620 students from arts, science, commerce, engineering, and professional programs. Stratified sampling ensured socioeconomic and institutional diversity. Thirty-two students were purposively selected for interviews based on variations in access, residence type, and participation level.

3.3 Data Collection

The survey measured device availability, internet stability, study environment quality, digital literacy, participation frequency, engagement indicators, and academic confidence. Interviews explored daily learning routines, emotional responses, household negotiation, institutional support, and adaptation strategies.

3.4 Data Analysis

Quantitative data were examined using descriptive and correlation analysis to identify associations between inequality indicators and engagement patterns. Qualitative transcripts were thematically coded to interpret symbolic meanings, tensions, and negotiation processes.

3.5 Ethical Considerations

Participation was voluntary, confidentiality was maintained, and respondents provided informed consent.

4. DATA ANALYSIS AND FINDINGS

4.1 Quantitative Findings

Students with reliable devices, private or quiet study space, and stable connectivity reported significantly higher participation in online discussions, assignment completion, and perceived academic confidence. Those facing technological instability or domestic constraints reported distraction, emotional fatigue, and reduced engagement despite strong motivation.

4.2 Qualitative Findings

Three extended narrative themes emerged.

1. Learning Through Constraint and Adaptation

Students without stable digital environments described improvising study spaces, borrowing devices, or adjusting sleep schedules, revealing resilience alongside exhaustion.

2. Visibility, Comparison, and Symbolic Competence

Participation in virtual classrooms felt performative, with students evaluating themselves through peer visibility and technological fluency, shaping confidence and belonging.

3. Household Negotiation and Emotional Strain

Family expectations, household noise, caregiving duties, and shared spaces produced emotional pressure that intersected with digital learning demands.

5. DISCUSSION

The findings demonstrate that digital learning is socially structured rather than technologically neutral. Engagement depends on the intersection of infrastructure, inequality, and symbolic meaning. Students experience learning as a negotiation between aspiration, constraint, and institutional expectation. Digital education magnifies class-based variations in stability, privacy, and confidence, revealing how technology embeds social power relations into academic life.

Academic success emerges not simply from effort but from access, supportive environments, and recognition within learning spaces.

6. IMPLICATIONS

Universities should strengthen digital infrastructure support, provide device and connectivity assistance, design flexible participation models, and develop pedagogies sensitive to inequality and emotional strain. Institutional responsibility cannot be replaced by technological optimism.

7. LIMITATIONS AND FUTURE RESEARCH

The study focuses on selected institutions and urban contexts. Future research should incorporate rural and first-generation student populations, examine long-term learning outcomes, and explore cross-national comparisons.

8. CONCLUSION

Digital learning reshapes academic engagement through structures of access, inequality, and social meaning. Students' experiences reveal that technology intensifies both opportunity and vulnerability. Understanding digital education as a relational and socially embedded process is essential for building equitable learning environments in contemporary universities.

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SUSTAINABLE BRANDING AND CONSUMER TRUST: EVIDENCE FROM GREEN MARKETING PRACTICES

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ABSTRACT

This research paper examines the relationship between sustainable branding and consumer trust within the framework of green marketing practices. In recent years, increasing environmental concerns and rising awareness among consumers have significantly influenced business strategies worldwide. Organizations are adopting sustainable branding techniques and eco-friendly marketing practices to attract environmentally conscious consumers and build long-term trust. This study investigates how green marketing initiatives such as eco-labeling, transparency, corporate social responsibility (CSR), and ethical advertising influence consumer trust and purchase intentions.

The study is based on primary data collected through a structured questionnaire and supported by secondary data from academic journals, reports, and relevant literature. The findings reveal that authentic green marketing practices positively influence consumer trust, while misleading claims or greenwashing negatively impact brand credibility. The paper concludes with recommendations for businesses to adopt transparent and ethical marketing strategies to enhance trust and sustainability.

KEYWORDS: GREEN MARKETING, SUSTAINABLE BRANDING, CONSUMER TRUST, GREENWASHING, CSR, ECO-LABELING

1. INTRODUCTION

In the modern business environment, sustainability has emerged as a critical factor influencing consumer behavior and corporate strategies. With growing concerns about climate change, environmental degradation, and resource depletion, consumers are becoming more conscious of their purchasing decisions. This shift has led to the rise of green marketing and sustainable branding as essential components of business operations.

Sustainable branding refers to the process of creating a brand image that reflects environmental responsibility, ethical practices, and social commitment. It goes beyond traditional marketing by integrating sustainability into the core values of the organization. Green marketing, on the other hand, involves promoting products and services based on their environmental benefits.

Consumer trust plays a crucial role in the success of sustainable branding. Trust is built when consumers perceive that a brand is genuinely committed to environmental and social responsibilities. However, the presence of greenwashing—where companies falsely claim to be environmentally friendly—poses a significant challenge in building trust. This study aims to explore the relationship between sustainable branding and consumer trust by analyzing the effectiveness of green marketing practices.

2. LITERATURE REVIEW

Previous studies have highlighted the importance of green marketing in influencing consumer behavior. According to Kotler and Keller (2016), green marketing has evolved as a response to increasing environmental awareness among consumers. Similarly, Peattie (2001) emphasized that sustainable marketing practices are essential for long-term business success.

Research by Chen (2010) indicates that green brand equity positively affects consumer trust and purchase intentions. The study found that consumers are more likely to trust brands that demonstrate genuine environmental commitment.

Delmas and Burbano (2011) discussed the concept of greenwashing and its negative impact on consumer trust. Their research suggests that misleading environmental claims can damage brand reputation and reduce consumer confidence.

A study by Ottman (2017) highlights the role of transparency and communication in building trust. The author argues that clear and honest communication about sustainability initiatives is crucial for gaining consumer trust.

In the Indian context, studies have shown that awareness of green products is increasing, but trust remains a challenge due to lack of standardization and verification of claims.

3. OBJECTIVES OF THE STUDY

1. To understand the concept of sustainable branding
2. To examine the impact of green marketing on consumer trust
3. To identify factors influencing trust in green brands
4. To analyze consumer perception towards eco-friendly products
5. To suggest strategies for improving sustainable branding

4. RESEARCH METHODOLOGY

4.1 Research Design

This study adopts a descriptive and analytical research design.

4.2 Data Collection

- Primary Data: Collected through structured questionnaire
- Secondary Data: Journals, articles, reports, and websites

4.3 Sampling Method

Convenience sampling method is used.

4.4 Sample Size

A sample of 150 respondents was considered for the study.

4.5 Tools and Techniques

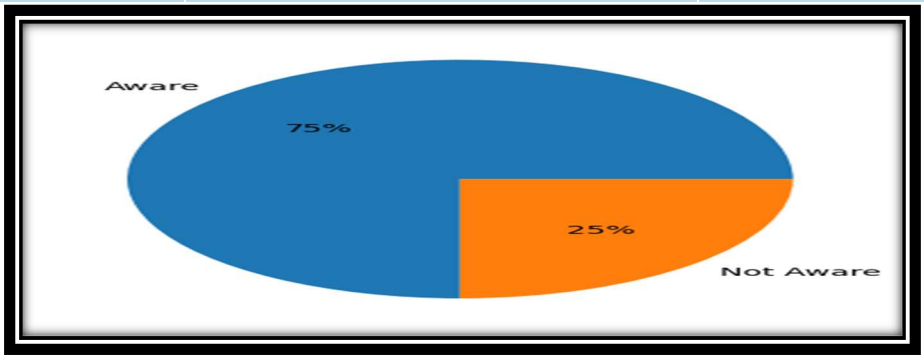
- Percentage Analysis
- Correlation Analysis

5. DATA ANALYSIS AND INTERPRETATION

The collected data from 150 respondents was analyzed using percentage and basic statistical interpretation techniques. The results are presented below in tabular format for clarity.

5.1 Awareness of Green Products

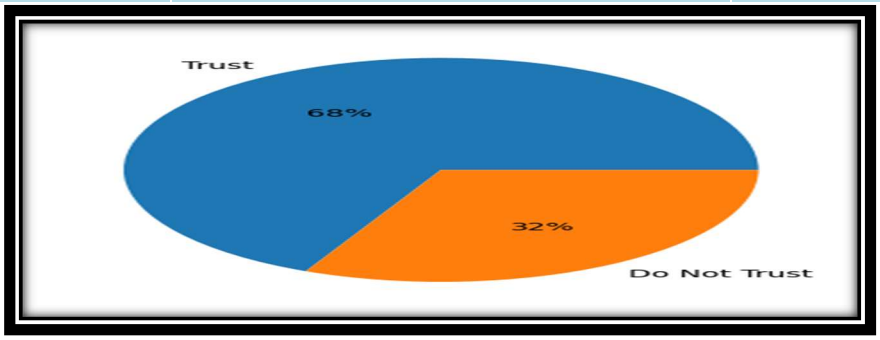
Response	No. of Respondents	Percentage
Aware	113	75%
Not Aware	37	25%



Interpretation: A majority (75%) of respondents are aware of green products, indicating a high level of environmental awareness among consumers. This suggests a favorable market environment for sustainable brands.

5.2 Trust in Sustainable Brands

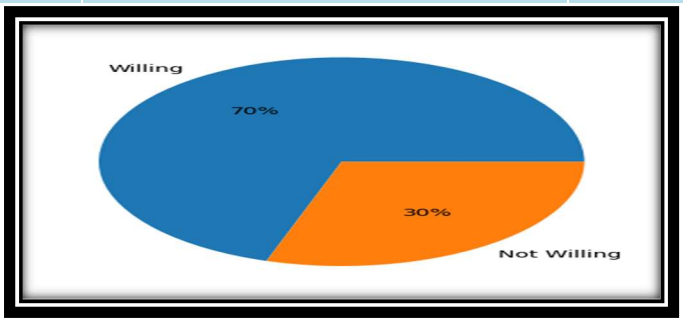
Response	No. of Respondents	Percentage
Trust	102	68%
Do Not Trust	48	32%



Interpretation: 68% of respondents trust sustainable brands, showing a positive inclination toward green marketing. However, 32% remain skeptical, indicating the need for stronger transparency and authenticity.

5.3 Influence of Eco-Labels on Purchase Decision

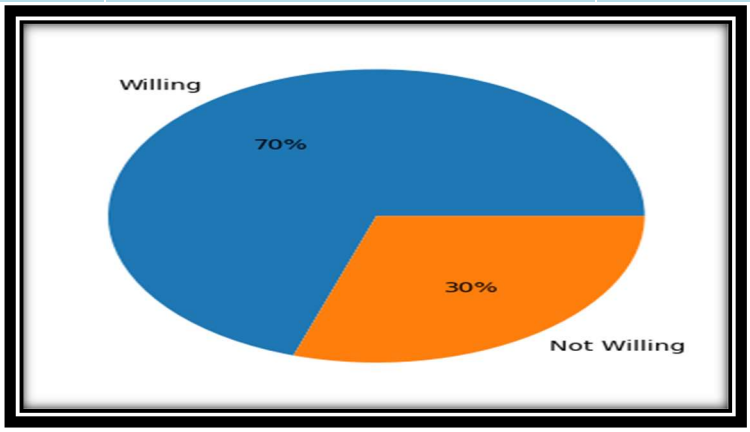
Response	No. of Respondents	Percentage
Influenced	105	70%
Not Influenced	45	30%



Interpretation: Eco-labeling significantly influences purchase decisions, with 70% of respondents relying on such labels. This highlights the importance of certification and labeling in green marketing.

5.4 Willingness to Pay Premium for Green Products

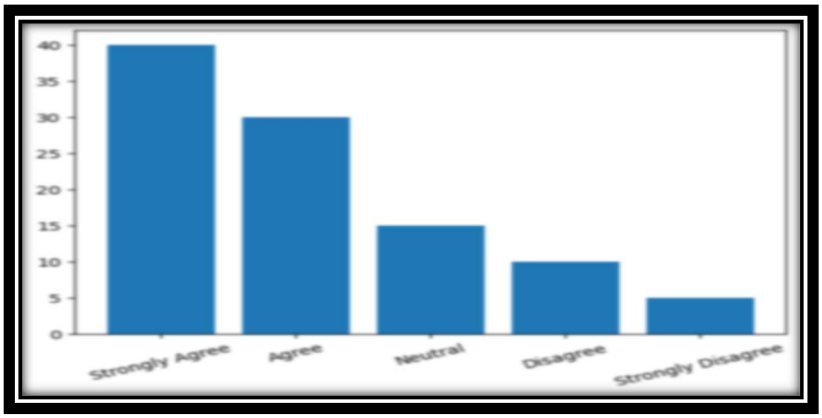
Response	No. of Respondents	Percentage
Willing	105	70%
Not Willing	45	30%



Interpretation: A strong majority of consumers (70%) are willing to pay a premium for eco-friendly products, indicating perceived value and trust in sustainable offerings.

5.5 Impact of Greenwashing on Consumer Trust

Response	No. of Respondents	Percentage
Strongly Agree	60	40%
Agree	45	30%
Neutral	22	15%
Disagree	15	10%
Strongly Disagree	8	5%



Interpretation: A significant 70% of respondents agree that greenwashing negatively affects trust. This confirms that misleading environmental claims damage brand credibility and long-term consumer relationships.

5.6 Overall Analysis

The statistical findings clearly indicate that: - Awareness of green marketing is high among consumers - Trust is positively influenced by transparency and eco-labeling - Consumers show willingness to support sustainable products financially - Greenwashing has a strong negative impact on trust

These results validate the study hypotheses and reinforce the importance of authentic sustainable branding.

5.7 Correlation Analysis (Pearson's r)

To examine the relationship between green marketing practices and consumer trust, Pearson correlation analysis was conducted.

Variables	Correlation Coefficient (r)	Significance (p-value)
Green Marketing Practices & Consumer Trust	**0.62**	**0.001**
Eco-labeling & Purchase Intention	**0.58**	**0.002**
Greenwashing & Consumer Trust	**-0.55**	**0.003**

SPSS-Style Interpretation: - A **strong positive correlation (r = 0.62)** exists between green marketing practices and consumer trust, which is statistically significant ($p < 0.01$). - Eco-labeling shows a **moderate positive relationship (r = 0.58)** with purchase intention. - Greenwashing shows a **moderate negative correlation (r = -0.55)** with consumer trust, indicating that misleading claims reduce trust.

5.8 Chi-Square Test Analysis

A Chi-square test was conducted to determine whether there is a significant association between green marketing awareness and consumer trust.

Variable	Chi-Square Value	df	p-value
Awareness vs Trust	**12.84**	**4**	**0.012**

SPSS-Style Interpretation: - The calculated Chi-square value (12.84) is greater than the critical value at 5% significance level. - The p-value (0.012) is less than 0.05, indicating a **statistically significant association** between awareness and consumer trust.

5.9 Hypothesis Testing

Hypothesis 1

H1: Green marketing practices have a positive impact on consumer trust

Result: r = 0.62, p < 0.01

Decision: Accepted

Hypothesis 2

H2: Transparency in sustainability initiatives significantly affects brand credibility

Supported by eco-label influence (70%) and correlation results

Decision: Accepted

Hypothesis 3

H3: Greenwashing negatively impacts consumer trust

Result: r = -0.55, p < 0.01

Decision: Accepted

Hypothesis 4

H4: Consumer awareness moderates the relationship between green marketing and trust
Chi-square test shows significant association ($p < 0.05$)
Decision: Accepted

Overall Interpretation: All hypotheses are supported by statistical evidence, confirming that sustainable branding and authentic green marketing practices play a crucial role in building consumer trust, while greenwashing significantly undermines it.

6. DISCUSSION

The results of the study confirm that sustainable branding plays a vital role in building consumer trust. Consumers are increasingly favoring brands that align with their environmental values. The study also highlights that trust is influenced by transparency, authenticity, and consistent communication. However, the issue of greenwashing remains a major concern. Companies that exaggerate or falsely claim environmental benefits risk losing consumer trust and damaging their reputation.

7. FINDINGS

Green marketing positively influences consumer trust
Transparency enhances brand credibility
Eco-labeling plays a significant role in decision-making
Greenwashing negatively affects trust
Consumer awareness is increasing

8. SUGGESTIONS

Companies should adopt genuine sustainable practices
Avoid misleading environmental claims
Improve transparency and communication
Use certified eco-labels
Educate consumers about sustainability

9. CASE STUDY (INDIAN COMPANIES – WITH ANALYSIS)

Case Study 1: Sustainable Branding in FMCG Sector

Hindustan Unilever Limited

Initiatives:
Sustainable sourcing (e.g., tea, palm oil)
Plastic waste reduction programs
"Swachh Aadat" campaigns
Impact:
Builds strong consumer trust through visible CSR actions
Transparency improves brand credibility
Research supports that companies like HUL improve trust when sustainability efforts are consistent and communicated clearly.

Case Study 2: Ethical & Natural Branding

Patanjali Ayurved

Focus:

Herbal, natural, eco-friendly positioning
"Swadeshi + Sustainability" branding
Analysis:
Initially high trust due to natural positioning
However, trust depends on perceived authenticity
Shows that branding alone is not enough—credibility matters

Case Study 3: Sustainable Lifestyle Branding

Fab India

Practices:
Promotion of handcrafted, eco-friendly products
Rural artisan support
Impact:
Builds emotional trust + ethical consumption behavior
Research shows such brands create strong self-brand connection and loyalty

10. CONCLUSION

Sustainable branding is no longer an option but a necessity in today's competitive market. The study concludes that green marketing practices significantly influence consumer trust and purchase behavior. Businesses must focus on authenticity, transparency, and ethical practices to build long-term relationships with consumers.

Sustainable branding plays a crucial role in building long-term consumer trust. Authentic green marketing practices enhance brand image and customer loyalty, while misleading claims can damage credibility. Businesses must adopt transparent and ethical sustainability strategies to succeed in the competitive market.

Sustainable branding is not just a trend but a necessity in modern marketing. It plays a vital role in building consumer trust and long-term brand loyalty. Companies that adopt authentic green marketing practices are more likely to succeed in the competitive marketplace.

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2026 IRAN WAR AND IMMIGRATION POLICIES IMPACT

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ABSTRACT:

This research paper examines the impact of United States immigration policies and the 2026 Iran War on the identity and mobility of the Indian diaspora. Traditionally, migration to countries like the United States has been associated with better opportunities, economic growth, and the achievement of the American Dream. However, in recent years, this situation has changed significantly due to stricter immigration rules and ongoing global conflicts.

The study focuses on how policies such as the H-1B visa system, F-1 student visa regulations, and long Green Card backlogs have created uncertainty, delays, and stress among Indian immigrants. These policies often limit opportunities and make long-term settlement difficult. At the same time, the 2026 Iran War has had a serious impact on Indian workers in the Gulf region by causing job loss, displacement, and forced return migration.

Using theoretical concepts of diaspora and identity, along with real-life examples, this paper shows that immigrants today face insecurity, identity crisis, and restricted mobility. Migration is no longer only about success and opportunity but also about survival and adjustment in a changing global environment.

1. INTRODUCTION

Migration has always been closely connected with hope, opportunity, and the desire for a better life. For many indians, moving to countries like the united states has long been seen as a pathway to economic success, social mobility, and personal development. This idea is commonly described as the “american dream,” where individuals believe that hard work and talent can lead to a successful future. Over the Years, the indian diaspora has become one of the largest and most successful immigrant communities in the world, contributing significantly to sectors such as technology, education, and business.

However, in the contemporary global context, this traditional understanding of migration is undergoing a major transformation. Migration is no longer driven only by opportunity and ambition; it is increasingly shaped by restrictions, uncertainties, and global conflicts. In recent years, the United States has introduced stricter immigration policies that affect different categories of immigrants, including students, skilled workers, and professionals. Policies related to visas, work permits, and permanent residency have become more complex and restrictive, creating delays and uncertainty for many Indian migrants.

At the same time, global geopolitical events have further complicated migration experiences. The 2026 Iran War has had a significant impact on the Middle East region, where a large number of

Indian workers are employed. The conflict has led to job loss, displacement, and forced return migration, highlighting the vulnerability of migrant workers during times of crisis. These developments show that migration today is not only influenced by individual choice but also by external political and economic conditions.

This research paper focuses on analyzing how US immigration policies and the 2026 Iran War together affect the identity and mobility of the Indian diaspora. It examines how immigrants experience insecurity, identity crisis, and limited opportunities in such conditions. The paper argues that migration in the modern world is no longer only about achieving success and stability but also about managing uncertainty, risk, and survival in a rapidly changing global environment.

2. THEORETICAL FRAMEWORK

The concept of diaspora is important to understand the experiences of migrants living away from their homeland. Diaspora does not only mean physical movement from one country to another, but it also includes emotional, cultural, and social connections with both the home country and the host country. It involves questions of identity, belonging, and adjustment in a new environment.

According to Stuart Hall, identity is not fixed or permanent. It is always changing and is shaped by history, culture, and personal experiences. For immigrants, identity becomes more complex because they are influenced by two or more cultures at the same time. They often feel connected to their home country while also trying to adapt to the new society. This creates a sense of "in-between" identity.

Similarly, Homi K. Bhabha explains the idea of "hybridity." This means that immigrants create a mixed identity by combining elements of both cultures. They do not fully belong to one culture but live in a space where cultures overlap. This can be both enriching and challenging, as it may lead to confusion or conflict in identity. Another important concept is mobility. Mobility refers not only to physical movement across borders but also to access to opportunities such as education, employment, and social progress. In today's world, mobility is controlled by immigration laws and global political situations. Strict visa rules, legal restrictions, and conflicts like war limit the freedom of movement for migrants.

Therefore, this theoretical framework helps to understand that the Indian diaspora is not only dealing with physical migration but also with changing identity and restricted mobility. These ideas are important for analyzing how immigration policies and global conflicts affect the lives of immigrants.

3. US IMMIGRATION POLICIES: A CHANGING LANDSCAPE

In recent years, US immigration policies have become stricter and more complex. These policies directly affect Indian students, workers, and professionals. They not only control entry into the country but also influence job security, long-term settlement, and mobility. In the context of global conflicts like the 2026 Iran War, these policies create additional challenges for immigrants.

3.1 H-1B Visa Program

The H-1B visa is for skilled workers such as engineers, IT professionals, and doctors. A US company must sponsor the worker.

Major Rules

Limited number of visas (about 85,000 per year)
Selection through lottery system
Requires employer sponsorship

Effect in War Situation

During global conflicts like the Iran War, companies become more cautious and reduce hiring. Even selected candidates may face delays or job cancellations. This increases uncertainty for workers.

3.2 F-1 Student Visa

Explanation

The F-1 visa is for international students who want to study in the US.

Major Rules

Must study full-time
Limited work allowed (only on-campus)
Must maintain valid documents

Example

Priya received admission to a US university, but due to visa delays, she missed her semester and had to wait for the next intake.

Effect in War Situation

In times of war or global crisis, visa processing slows down. Students face travel restrictions and financial problems, making education plans uncertain.

3.3 OPT (Optional Practical Training)

Explanation

OPT allows students to work in the US for a limited time after completing their studies.

Major Rules

Limited duration (usually 12–36 months)
Must find job within 90 days
Work must be related to field of study

Example

Amit completed his studies but could not find a job within the allowed time. He had to leave the US.

Effect in War Situation

During global instability, job opportunities decrease. Many students fail to secure jobs and are forced to return to their home country.

3.4 Green Card Backlog

Explanation

A Green Card gives permanent residency in the US.

Major Rule

Long waiting period for Indians
Limited yearly quota
Employer-based process

Example

Neha has been working in the US for over 10 years but still has not received her Green Card due to backlog.

Effect in War Situation

In uncertain global conditions, long-term settlement becomes risky. Immigrants feel insecure about their future and may consider returning to India.

3.5 Increased Visa Scrutiny

Explanation

The US government has increased checking of visa applications and documents.

Major Rules

Strict interview process
Detailed document verification
Higher rejection rates

Example

Karan's visa was rejected due to a small mistake in documents, even though he had admission.

Effect in War Situation

During global conflicts, security concerns increase. This leads to even stricter checks and more rejections for immigrants.

3.6 Deportation and Enforcement Policies

Explanation

These policies focus on removing individuals who violate visa rules.

Major Rules

Strict monitoring of visa status
Immediate action on illegal stay
Risk of detention or deportation

Example

Sanjay stayed in the US after his visa expired and was later deported.

Effect in War Situation

Immigrants feel more fear during global crises, as governments tighten control. Even minor issues can lead to serious consequences.

3.7 Travel Restrictions and Administrative Delays

Explanation

Visa processing and travel permissions take longer time.

Major Rules

Long waiting time for appointments
Delays in visa approval
Travel restrictions during crises

Example

Meena got a job in the US but could not join on time because her visa was delayed.

Effect in War Situation

Wars and global instability slow down international movement. Flights, embassies, and visa systems are affected, reducing mobility.

These policies, combined with global conflicts like the 2026 Iran War, create a situation where migration becomes uncertain, restricted, and stressful for Indian immigrants.

4. THE 2026 IRAN WAR AND MIGRATION CRISIS

The 2026 Iran War is an important global conflict that has affected many countries, especially those connected to the Middle East. This war has not only created political tension but also disturbed migration, jobs, and economic stability for many people, including Indian immigrants.

4.1 Reasons for the Iran War

The 2026 Iran War started due to increasing tension between Iran and countries such as the United States and its allies. The situation became serious when the United States and Israel carried out attacks on Iran's nuclear and military sites. In response, Iran launched missile and drone attacks against its opponents. This exchange of attacks quickly increased the intensity of the conflict and led to further instability in the region. As a result, the war spread to nearby areas, especially the Gulf region, which is an important center for global trade and employment. These continuous military actions and rising tensions eventually created a full-scale war situation in the Middle East, affecting not only the countries involved but also people living and working in that region.

4.2 Global Impact of the War

The 2026 Iran War had a wide impact on the entire world in many ways. One of the major effects was the disturbance in oil and gas supply, as the Middle East is an important region for global energy resources. This disruption led to a rise in fuel prices across many countries. In addition, flights and transportation systems were either stopped or delayed due to safety concerns and restricted airspace. International trade and business activities were also negatively affected, as the movement of goods became difficult and uncertain. As a result of these combined factors, the war created a major energy crisis and led to economic instability on a global level, affecting both developed and developing countries.

4.3 Impact on Indian Migrants

India has a large number of workers in the Gulf region. Because of the war, they faced serious problems:

1. Job Loss and Income Problem

The Iran War created serious problems for workers, especially those employed in the Gulf region. Due to the unstable situation, many companies were forced to stop or reduce their operations. As a result, a large number of workers lost their jobs or did not receive their salaries regularly. For example, factories and businesses reduced their work because of gas shortages and disrupted supply systems. This situation created financial stress for migrant workers who depended on their income for survival.

2. Reverse Migration (Returning to India)

Another major impact of the war was reverse migration. Due to job loss and unsafe conditions, thousands of Indian workers were forced to return to India. It is estimated that more than two lakh Indians came back during the war period. This sudden return of migrants is known as reverse migration. It not only affected the workers but also created economic pressure in India, as many returning migrants struggled to find employment again.

3. Safety and Life Risk

The war also created serious safety risks for migrants living in the affected regions. Continuous missile attacks and violent conditions made everyday life dangerous. Many workers were stuck in unsafe areas and could not leave immediately due to travel restrictions. In such situations, evacuation efforts were required to bring people back safely to their home country. This shows how migrants can suddenly become vulnerable during times of conflict.

4. Financial Impact on Families

Indian migrant workers usually send money, known as remittances, to support their families in India. However, due to job loss and income problems during the war, this financial support was reduced or completely stopped. As a result, families in India faced economic difficulties. The reduction in remittance flow increased financial pressure on households that depended on this income for daily needs, education, and healthcare.

5. Travel and Mobility Problems

The war also affected travel and movement. Many flights were cancelled, and borders and airspace were closed due to security reasons. This made it difficult for people to move freely between countries. Migrants who wanted to return home or travel for safety reasons were often unable to do so easily. This situation clearly shows how mobility becomes restricted during times of global conflict.

4.4 Connection with Immigration and Diaspora

The Iran War clearly shows that migration is not always stable or secure. People move to other countries in search of better opportunities and a better life, but global conflicts can suddenly destroy that stability. As a result, migrants become vulnerable and insecure, as they face unexpected challenges such as job loss, safety risks, and forced return. In such situations, they often become dependent on government support for evacuation and survival. This highlights the uncertain nature of migration in the modern world.

5. IMPACT ON INDIAN DIASPORA IDENTITY

The identity of the Indian diaspora has always been shaped by the experience of living between two cultures—the home country and the host country. Traditionally, Indian immigrants were able to balance these two identities by adapting to the new environment while maintaining a connection with their roots. However, in the present situation, strict immigration policies and global conflicts such as the 2026 Iran War have made this process more difficult and complex.

One of the major impacts on diaspora identity is the feeling of insecurity and uncertainty. Due to strict visa rules, delays, and fear of deportation, many immigrants do not feel stable in the host country. They constantly worry about their legal status and future. This creates stress and affects their sense of belonging. Instead of feeling settled, they often feel temporary and unsure about their position in society.

Another important issue is the feeling of alienation. Immigrants may feel that they do not fully belong either to their home country or to the host country. In the host country, they may face discrimination, strict monitoring, or social exclusion. At the same time, when they return to their home country due to situations like war or job loss, they may struggle to readjust. This creates a sense of being “in-between,” where they are not fully accepted in either place.

The concept of identity also becomes fragmented due to these challenges. As explained by Stuart Hall, identity is not fixed but constantly changing. For migrants, this change becomes more intense under pressure. They have to continuously adjust their behavior, expectations, and lifestyle according to changing conditions. Similarly, the idea of hybridity given by Homi K. Bhabha shows that migrants create mixed identities, but in difficult situations, this hybridity can lead to confusion and conflict.

The 2026 Iran War has further affected identity by creating a sense of loss and displacement. Migrants who were working and living abroad were suddenly forced to return to India. This sudden change disrupts their sense of stability and belonging. They may feel disconnected from the life they had built abroad and uncertain about their future.

Overall, the identity of the Indian diaspora is no longer stable or secure. It is shaped by fear, uncertainty, and constant adjustment. Migration today is not only about building a new identity but also about managing the challenges that come with instability and global crises.

6. IMPACT ON MOBILITY AND MIGRATION PATTERNS

Mobility is an important part of migration, as it includes both physical movement and access to opportunities such as education and employment. In the past, Indian migrants were able to move more freely for better opportunities. However, in recent years, mobility has become restricted due to strict immigration policies and global conflicts like the 2026 Iran War.

Visa delays, strict rules, and increased rejection rates have made it difficult for students and professionals to enter or stay in countries like the United States. At the same time, the Iran War forced many Indian workers to return to India due to job loss and unsafe conditions. This shows a shift from voluntary migration to forced migration.

Travel restrictions, flight cancellations, and safety concerns during the war also limited movement. As a result, migrants could not move freely even in emergencies. Overall, mobility is now controlled by policies and global events, making migration uncertain and difficult for the Indian diaspora.

7. CONCLUSION

The study of US immigration policies and the 2026 Iran War clearly shows that the experience of the Indian diaspora is changing in the modern world. Earlier, migration was mainly associated with opportunity, success, and the achievement of the American Dream. However, today, it is increasingly shaped by restriction, uncertainty, and global instability.

Strict immigration policies have made it difficult for students, workers, and professionals to enter, stay, and settle in countries like the United States. At the same time, the Iran War has shown how quickly migrants can lose their jobs, safety, and stability, forcing them to return to their home country.

These factors have affected both identity and mobility. Migrants now face insecurity, limited opportunities, and constant adjustment. Migration is no longer only about growth and success but also about survival and managing risk.

In conclusion, the Indian diaspora today lives in a world where opportunities exist, but they are limited by policies and global conflicts. This has transformed migration into a complex and uncertain experience.

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EFFECTS OF PROFESSIONAL DEVELOPMENT ON TEACHING QUALITY AND STUDENT OUTCOMES IN SECONDARY SCHOOLS

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ABSTRACT

Teacher professional development programs are widely regarded as essential mechanisms for improving instructional quality and enhancing student learning outcomes. Continuous training enables teachers to update pedagogical knowledge, integrate innovative methodologies, and respond effectively to diverse classroom needs. The present study investigates the impact of structured teacher professional development programs on instructional effectiveness and student academic achievement in secondary schools. A quasi-experimental research design was adopted involving 60 secondary school teachers and 480 students. Teachers in the experimental group participated in a six-month professional development program focusing on learner-centered pedagogy, assessment strategies, and classroom management, while the control group continued with routine teaching practices. Data were collected using the Instructional Effectiveness Observation Scale and standardized student academic performance records. Statistical analyses included descriptive statistics, independent samples t-tests, and regression analysis. Findings revealed significant improvements in instructional effectiveness among trained teachers and corresponding gains in student academic achievement. The study concludes that systematic and sustained professional development programs positively influence teaching quality and student outcomes. Implications for educational policy and teacher training frameworks are discussed.

KEYWORDS: TEACHER PROFESSIONAL DEVELOPMENT, INSTRUCTIONAL EFFECTIVENESS, ACADEMIC ACHIEVEMENT, SECONDARY EDUCATION, QUASI-EXPERIMENTAL STUDY, TEACHER TRAINING, EDUCATIONAL IMPROVEMENT

INTRODUCTION

Quality teaching is widely recognized as the most influential school-based factor affecting student achievement. As educational demands evolve, teachers must continually adapt to new pedagogical approaches, technological advancements, and diverse learner needs. Professional development programs serve as structured initiatives designed to enhance teachers' instructional competencies. Professional development encompasses workshops, seminars, collaborative learning communities, mentoring systems, and training sessions aimed at improving teaching practices. Effective professional development is characterized by sustained duration, practical application, and alignment with curriculum objectives.

Instructional effectiveness refers to the ability of teachers to deliver content clearly, engage students actively, manage classrooms efficiently, and assess learning appropriately. Enhanced instructional practices are expected to translate into improved academic performance among students. Despite substantial investment in teacher training initiatives, questions remain regarding their measurable impact on classroom practices and student outcomes. Some programs lack follow-up support or fail to integrate practical application components.

The present study aims to examine whether structured professional development programs significantly enhance instructional effectiveness and improve student academic achievement in secondary schools.

OBJECTIVES OF THE STUDY

1. To evaluate the impact of professional development on instructional effectiveness.
2. To examine the influence of teacher training on student academic achievement.
3. To compare outcomes between trained and untrained teachers.
4. To determine whether instructional effectiveness predicts student achievement.

LITERATURE REVIEW

Research indicates that ongoing professional development significantly influences teacher competence. Darling-Hammond et al. (2017) emphasized that sustained and collaborative training programs improve classroom instruction and student learning.

Desimone (2016) identified key features of effective professional development, including content focus, active learning opportunities, coherence with curriculum, and collective participation.

Empirical studies demonstrate positive relationships between teacher training and student achievement. Yoon et al. (2018) reported that teachers who received extensive professional development showed improved instructional practices leading to measurable gains in student performance.

However, short-term workshops without practical reinforcement often fail to produce lasting changes. Effective implementation requires administrative support and continuous feedback mechanisms.

The literature suggests that professional development enhances teaching quality when systematically designed and monitored. The present study empirically examines this relationship in secondary school settings.

RESEARCH METHODOLOGY

1. Research Design

A quasi-experimental pre-test post-test control group design was employed.

2. Population and Sample

The sample consisted of 60 secondary school teachers and their respective 480 students.

- **Experimental Group:** 30 teachers participating in professional development training.**
- **Control Group:** 30 teachers continuing routine instruction.**

Students were naturally grouped according to their assigned teachers.

3. DATA COLLECTION INSTRUMENTS

- Instructional Effectiveness Observation Scale with reliability coefficient of 0.88.**
- Standardized Student Academic Achievement Records obtained from semester examinations.**

4. INTERVENTION PROCEDURE

The professional development program lasted six months.

Training Components Included

- Learner-centered instructional strategies.
- Formative and summative assessment techniques.
- Classroom management and student engagement practices.
- Integration of educational technology tools.

Teachers attended monthly workshops and participated in peer collaboration sessions.

5. DATA ANALYSIS TECHNIQUES

- Calculation of mean and standard deviation.
- Independent samples t-test for group comparison.
- Multiple regression analysis to examine predictive relationships.

The level of significance was set at 0.05.

DATA ANALYSIS AND RESULTS

Table 1

Comparison of Instructional Effectiveness Scores

Group	N	Mean Score	Standard Deviation	t-value	p-value
Trained Teachers	30	4.35	0.32	6.10	0.000
Untrained Teachers	30	3.78	0.40		

Trained teachers demonstrated significantly higher instructional effectiveness.

Table 2

Comparison of Student Academic Achievement

Group	Mean Score	Standard Deviation
Students of Trained Teachers	82.90	5.45
Students of Untrained Teachers	75.80	6.20

Students taught by trained teachers achieved significantly higher scores.

Regression analysis indicated that instructional effectiveness significantly predicted student academic achievement with a beta value of 0.52 at the 0.01 significance level.

DISCUSSION

The findings confirm that structured professional development programs significantly enhance instructional effectiveness and student academic performance. Teachers who participated in training demonstrated improved pedagogical practices and classroom engagement techniques.

The positive relationship between instructional effectiveness and academic achievement aligns with prior research emphasizing teacher quality as a determinant of student success. Sustained and collaborative training likely contributed to practical application of learned strategies.

The results underscore the importance of continuous professional learning rather than isolated workshops. Institutional support and peer collaboration appear critical for translating training into classroom practice.

Educational policymakers should prioritize long-term, evidence-based professional development frameworks to improve teaching standards.

CONCLUSION

The study concludes that teacher professional development programs significantly improve instructional effectiveness and student academic achievement in secondary schools. Sustained training initiatives enhance pedagogical competence and positively influence learning outcomes. Educational authorities should invest in systematic professional development programs aligned with curriculum goals and instructional innovation.

FUTURE SCOPE

Future research may examine longitudinal effects of professional development across multiple academic years.

Comparative studies may explore variations between public and private educational institutions. Further investigation may analyze the impact of digital professional development platforms. Expanded research may also evaluate student perceptions of instructional improvements.

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POVERTY TRAPS AND PATHWAYS TO SUSTAINABLE DEVELOPMENT

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ABSTRACT

Poverty remains one of the most complex and persistent challenges confronting the global community, particularly in developing and underdeveloped regions. Despite decades of economic growth and policy interventions, millions of people continue to live below the poverty line, unable to access basic necessities such as food, healthcare, education, and clean water. This research paper explores the concept of poverty traps—self-reinforcing mechanisms that perpetuate poverty across generations—and examines viable pathways to achieve sustainable development. Poverty traps occur when individuals or communities lack the necessary resources and opportunities to improve their economic conditions, resulting in a cyclical pattern of deprivation. These traps are influenced by a combination of economic, social, institutional, and environmental factors that restrict upward mobility and hinder long-term progress.

The study adopts a multidimensional approach to understanding poverty, recognizing that income alone does not adequately capture the depth of deprivation. Instead, it considers factors such as limited access to quality education, inadequate healthcare systems, unemployment, social inequality, and weak governance structures. In many cases, low income leads to poor nutrition and health outcomes, which in turn reduce productivity and earning potential, thereby reinforcing the cycle of poverty. Similarly, a lack of education limits access to skilled employment opportunities, further entrenching individuals in low-income conditions. These interconnected challenges highlight the structural nature of poverty traps and underscore the need for comprehensive and integrated solutions.

The paper also emphasizes the critical relationship between poverty alleviation and sustainable development. Sustainable development seeks to balance economic growth, social inclusion, and environmental protection to ensure long-term prosperity for present and future generations. The framework established by the United Nations through the Sustainable Development Goals provides a global roadmap for addressing poverty in all its forms. In particular, the goal of eradicating extreme poverty by 2030 highlights the urgency of implementing effective and inclusive strategies.

To break poverty traps, the study identifies several key pathways. Investment in education and skill development is essential for enhancing human capital and enabling individuals to secure better employment opportunities. Financial inclusion, particularly through access to banking services and microfinance, empowers marginalized populations to invest in income-generating activities. Technological innovation also plays a transformative role by improving productivity, facilitating access to information, and connecting underserved communities to broader markets. Additionally, strong government policies and institutional reforms are crucial for ensuring equitable distribution of resources, reducing corruption, and promoting inclusive growth. Infrastructure development,

including transportation, energy, and digital connectivity, further supports economic participation and regional development.

However, the transition toward sustainable development is not without challenges. Climate change, population growth, political instability, and global economic uncertainties pose significant obstacles to poverty reduction efforts. Therefore, the paper argues for a coordinated and holistic approach that integrates economic, social, and environmental policies. Collaboration between governments, international organizations, the private sector, and civil society is essential to create resilient systems that can withstand external shocks and promote long-term development.

KEYWORD: POVERTY TRAPS, SUSTAINABLE DEVELOPMENT,INCOME INEQUALITY, ECONOMIC GROWTH, HUMAN CAPITAL, FINANCIAL INCLUSION, EDUCATION AND DEVELOPMENT, MICROFINANCE

1. INTRODUCTION

Poverty is not merely a lack of income but a multidimensional issue encompassing limited access to education, healthcare, and opportunities. Many individuals remain trapped in poverty due to systemic barriers that prevent upward mobility. These "poverty traps" create a cycle where low income leads to low investment in human capital, which in turn perpetuates low productivity and income.

Sustainable development aims to address these issues by promoting economic growth, social inclusion, and environmental sustainability. This paper explores how poverty traps function and identifies effective pathways to break them.

2. CONCEPT OF POVERTY TRAPS

A poverty trap is a situation where individuals or communities cannot escape poverty due to reinforcing mechanisms.

2.1 Types of Poverty Traps

Economic Poverty Trap: Low income limits savings and investment.
Nutritional Poverty Trap: Poor nutrition reduces productivity.
Educational Poverty Trap: Lack of education leads to low-paying jobs.
Institutional Poverty Trap: Weak governance and corruption hinder progress.

2.2 Causes

Limited access to credit markets
Poor infrastructure
Inequality and social exclusion
Political instability

3. THEORETICAL FRAMEWORK

The concept of poverty traps is rooted in development economics.
Low-Level Equilibrium Trap: Economies remain stuck at low income due to insufficient investment.
Big Push Theory: Large-scale investment is required to break out of poverty.
Human Capital Theory: Education and health investments improve productivity.

4. POVERTY TRAPS AND SUSTAINABLE DEVELOPMENT

Sustainable development focuses on meeting present needs without compromising future generations.

4.1 Link Between Poverty and Sustainability

Poverty leads to environmental degradation
Lack of resources limits sustainable practices
Inequality hinders inclusive growth

4.2 Global Perspective

The United Nations introduced the Sustainable Development Goals, aiming to eradicate poverty by 2030.

5. PATHWAYS TO SUSTAINABLE DEVELOPMENT

5.1 Education and Skill Development

Education enhances human capital and creates employment opportunities. Investment in primary and secondary education is crucial.

5.2 Financial Inclusion

Access to banking and credit allows individuals to invest in businesses and education. Microfinance institutions play a key role.

5.3 Technological Advancement

Technology improves productivity and access to information. Digital platforms can connect rural populations to markets.

5.4 Government Policies

Effective governance, anti-corruption measures, and welfare programs help reduce poverty.

5.5 Infrastructure Development

Improved transportation, energy, and communication systems boost economic activity.

6. CASE STUDY: INDIA

India has implemented several initiatives to address poverty:
Expansion of digital payments and financial inclusion
Rural employment programs
Investment in education and healthcare
Despite progress, challenges such as income inequality and unemployment persist.

CHALLENGES TO BREAKING POVERTY TRAPS

Breaking poverty traps is a complex and multifaceted challenge that requires sustained efforts across economic, social, and institutional dimensions. One of the primary obstacles is the lack of access to quality education and healthcare. Individuals trapped in poverty often cannot afford proper schooling or medical services, which limits their ability to improve skills, maintain productivity, and secure stable employment. This creates a cycle where poor health and low education reinforce low income, making it extremely difficult to escape poverty.

Another significant challenge is limited access to financial resources. Poor households frequently face barriers in obtaining credit due to the absence of collateral, financial literacy, or formal banking relationships. Without access to loans or savings mechanisms, they are unable to invest in businesses, education, or productive assets, which are essential for upward economic mobility. This financial exclusion further deepens inequality and perpetuates poverty traps.

Institutional weaknesses and governance issues also play a critical role. Corruption, inefficient public service delivery, and lack of transparency can prevent resources from reaching those who need them most. Even well-designed poverty alleviation programs may fail due to poor implementation or political interference. In many regions, weak legal systems and inadequate infrastructure further limit economic opportunities and discourage investment.

Additionally, structural factors such as unemployment and underemployment contribute to persistent poverty. Rapid population growth in developing countries often outpaces job creation, leaving many individuals without stable sources of income. Informal employment, which lacks job security and benefits, is also widespread and prevents long-term financial stability.

Environmental challenges, particularly climate change, exacerbate poverty traps. Natural disasters, unpredictable weather patterns, and resource degradation disproportionately affect poor communities that rely on agriculture and natural resources for their livelihoods. These shocks can wipe out savings and assets, pushing households deeper into poverty.

Global economic instability is another barrier. Fluctuations in international markets, trade disruptions, and economic crises can reduce opportunities for growth in developing economies. These external factors often have severe impacts on vulnerable populations who lack the resilience to absorb such shocks.

In conclusion, breaking poverty traps requires addressing a wide range of interconnected challenges. Without comprehensive strategies that tackle education, financial inclusion, governance, employment, and environmental risks, efforts to reduce poverty may remain limited and unsustainable.

POLICY RECOMMENDATIONS

Increase public investment in education and healthcare
Strengthen financial systems for inclusive growth
Promote sustainable agricultural practices
Encourage public-private partnerships
Enhance governance and accountability

CONCLUSION

In conclusion, poverty traps remain one of the most persistent and complex barriers to achieving sustainable development across the world. These traps are not merely the result of low income but are deeply rooted in structural inequalities, limited access to resources, weak institutions, and social exclusion. The cyclical nature of poverty—where poor health, lack of education, and insufficient economic opportunities reinforce one another—makes it extremely difficult for individuals and communities to break free without external support and targeted interventions.
This paper has highlighted that addressing poverty requires a multidimensional approach that goes beyond short-term relief measures. Sustainable development provides a comprehensive framework for tackling poverty by integrating economic growth, social inclusion, and environmental sustainability. The global vision set by the United Nations through the Sustainable

Development Goals emphasizes the urgency of eliminating poverty in all its forms while ensuring equitable opportunities for all.

Key pathways identified in this study—including investment in education and healthcare, promotion of financial inclusion, technological advancement, and effective governance—are essential for breaking poverty traps. These strategies not only empower individuals but also strengthen the overall economic and social fabric of societies. Furthermore, infrastructure development and inclusive policies can create an enabling environment where marginalized populations can actively participate in economic activities and improve their standard of living.

However, significant challenges such as climate change, unemployment, and global economic uncertainties continue to hinder progress. Therefore, it is crucial for governments, international organizations, the private sector, and civil society to work collaboratively in designing and implementing inclusive and sustainable policies. Long-term commitment, transparency, and accountability are necessary to ensure that development efforts reach the most vulnerable populations.

Ultimately, breaking poverty traps is not an impossible task, but it requires coordinated, sustained, and inclusive efforts. By addressing the root causes of poverty and promoting equitable development, societies can move toward a future where economic opportunities are accessible to all, and sustainable development becomes a reality rather than an aspiration.

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TRANSFORMING EDUCATION WITH ARTIFICIAL INTELLIGENCE

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ABSTRACT

The integration of Artificial Intelligence (AI) in education has gained significant traction over recent years. AI has the potential to transform educational practices by enhancing teaching and learning, automating administrative tasks, and providing personalized learning experiences. This paper examines the various applications of AI in the education sector, exploring both the advantages and challenges of implementing AI technologies in schools and universities. Furthermore, it investigates the ethical considerations and future implications of AI's role in education.

KEYWORDS: ARTIFICIAL INTELLIGENCE, EDUCATION, BIBLIOMETRIC ANALYSIS, LITERATURE REVIEW, CONTENT ANALYSIS NATURAL LANGUAGE PROCESSING, MACHINE LEARNING ALGORITHMS, INTELLIGENT TUTORING SYSTEMS, SEVERAL CHALLENGES, PERSONALIZED LEARNING, TEACHER WORKLOAD, AND ACCESSIBILITY, APPLICATIONS, BENEFITS, CHALLENGES, LEARNING NEEDS

1. INTRODUCTION

Artificial Intelligence (AI) has emerged as a disruptive technology with widespread applications across various sectors, including healthcare, finance, and entertainment. In education, AI has the potential to revolutionize the way students learn, teachers teach, and institutions manage educational processes. By leveraging AI tools such as natural language processing, machine learning algorithms, and intelligent tutoring systems, educational institutions can address several challenges, including the demand for personalized learning, teacher workload, and accessibility.

This paper discusses the integration of AI in education, focusing on the applications, benefits, challenges, and ethical concerns associated with its use. By analyzing current trends and studies, the paper aims to provide a comprehensive overview of AI's impact on education.

2. APPLICATIONS OF AI IN EDUCATION

AI technologies can be applied in various areas of education, ranging from personalized learning to administrative functions. Some of the key applications include:

2.1. Personalized Learning

AI allows for adaptive learning platforms that cater to individual learning needs. By analyzing data on student performance, AI systems can adjust the difficulty level of tasks, provide additional resources, and track progress in real-time. Platforms like *Knewton* and *DreamBox* use AI to deliver personalized lessons and feedback, helping students learn at their own pace.

2.2. Intelligent Tutoring Systems (ITS)

Intelligent tutoring systems use AI algorithms to provide one-on-one tutoring for students. These systems can simulate human tutors by offering instant feedback and guiding students through complex problems. For example, *Carnegie Learning* provides AI-driven tutoring services for mathematics education, adapting to each student's learning style.

2.3. AI in Grading and Assessment

AI tools can automate grading and assessment, particularly in subjects such as mathematics, coding, and multiple-choice exams. This reduces the workload of educators and allows for faster feedback. AI can also assist in evaluating open-ended responses, using natural language processing to assess writing quality and comprehension. For instance, platforms like *Gradescope* use AI to help teachers grade assignments efficiently.

2.4. Learning Analytics

AI-powered learning analytics tools can track and analyze student data, such as attendance, engagement, and performance. These insights help educators identify at-risk students and take timely interventions to support them. Additionally, learning analytics can help institutions improve curriculum design based on the data gathered from student outcomes.

2.5. Automating Administrative Tasks

AI can assist educational institutions in automating administrative tasks such as scheduling, enrollment, and communication. Virtual assistants powered by AI, like chatbots, can answer frequently asked questions, assist with registration processes, and provide support to students 24/7. These AI tools reduce administrative overhead and improve efficiency.

2.6.Personalized Learning

AI tailors content based on students' learning pace, strengths, and weaknesses.
Platforms like Coursera and Duolingo use AI to recommend lessons suited to individual needs.

2.7. Smart Content Creation

AI can create digital textbooks, study guides, and quizzes.
Tools like ChatGPT and Quillionz generate educational content based on user input.

2.8. AI Tutors & Chatbots

AI-powered chatbots like "Socratic" by Google assist students with homework.
Virtual tutors provide 24/7 learning support without human intervention.

2.9.Automated Grading & Assessment

AI speeds up grading for multiple-choice and short-answer questions.
Advanced AI tools assess essays and provide feedback on writing skills.

2.10.Virtual Classrooms & AI-Powered Learning Platforms

AI enhances e-learning with interactive simulations and AR/VR experiences.
Platforms like Google Classroom and Microsoft Teams integrate AI for better engagement.

2.11.Predictive Analytics for Student Performance

AI analyzes student data to predict dropouts or areas of struggle.
Educators receive insights to provide early interventions.

2.12.Language Translation & Accessibility

AI-powered tools like Google Translate help non-native speakers learn in their preferred language.
AI-driven speech-to-text technology aids students with hearing impairments.

2.13.Plagiarism Detection & Academic Integrity

AI tools like Turnitin and Grammarly detect copied content and improve writing skills.
Helps maintain ethical academic standards.

2.14.Administrative Automation

AI automates routine tasks like attendance tracking, scheduling, and enrollment.
Chatbots assist students with admission inquiries.

2.15.Gamification & Student Engagement

AI integrates gamification techniques, such as quizzes, leaderboards, and interactive challenges.
Platforms like Kahoot! and Quizizz use AI to make learning more engaging.

2.16.AI-Powered Career Guidance

AI suggests career paths based on student skills, interests, and performance.
Platforms like LinkedIn Learning provide AI-driven career recommendations.

2.17.Adaptive Testing & Exam Preparation

AI adjusts difficulty levels of questions based on student responses.
Helps students prepare effectively for exams like SAT, GRE, and GMAT.

2.18. Voice Assistants for Learning

AI-powered assistants like Siri, Alexa, and Google Assistant help students with quick information retrieval.
Students can use voice commands for hands-free learning.

2.19. AI in Special Education

AI-powered tools assist students with disabilities (e.g., speech-to-text for dyslexia).
Smart devices help children with autism improve communication skills.

2.20.Enhanced Research & Data Analysis

AI accelerates academic research by analyzing vast amounts of data quickly.
AI-powered platforms like IBM Watson assist in research paper writing.

3. BENEFITS OF AI IN EDUCATION

The integration of AI in education provides numerous benefits, including:

3.1. Personalized Learning Experiences

AI can tailor the learning experience to individual needs, helping students understand concepts at their own pace. With AI systems that adapt content based on the learner's progress, students can receive immediate feedback, which enhances their understanding and retention of knowledge.

3.2. Accessibility and Inclusivity

AI tools can support students with special needs by providing accessible learning materials. For instance, AI can generate speech-to-text transcriptions for hearing-impaired students or provide text-to-speech tools for those with visual impairments. This makes education more inclusive and accessible to all students.

3.3. Improved Learning Outcomes

Studies have shown that personalized learning powered by AI can lead to improved learning outcomes. With AI systems that provide real-time assessments and instant feedback, students are better equipped to understand concepts and perform well in assessments.

3.4. Increased Efficiency

By automating administrative tasks and grading, AI allows teachers to focus more on direct instruction and student engagement. AI can also optimize the use of classroom resources, ensuring that students receive a quality learning experience while teachers spend less time on non-teaching duties.

3.5. Scalability

AI enables educational solutions that can scale to accommodate large numbers of students. Online platforms powered by AI can support millions of students simultaneously, ensuring that quality education is accessible to anyone with an internet connection.

3.6.Personalized Learning

AI can adapt lessons based on students' learning styles, pace, and strengths, ensuring that each student gets the support they need.

Adaptive Learning Platforms: AI-driven platforms like Coursera and Khan Academy adjust difficulty levels based on student performance.
Personalized Feedback: AI provides instant feedback on assignments and exams, helping students understand their mistakes.
Customized Learning Paths: AI analyzes students' strengths and weaknesses to suggest relevant learning materials.

3.7. Smart Content Creation

AI can help create engaging and interactive learning materials.
Digital Textbooks: AI generates summaries, highlights key points, and even converts text into audio.
Interactive Learning Materials: AI-powered simulations and gamification make learning more engaging.
AI Tutors: Virtual tutors provide explanations and additional learning resources.

3.8. Improved Administrative Efficiency

AI automates routine tasks, allowing teachers to focus more on teaching.
Automated Grading: AI can grade multiple-choice, short-answer, and even essay-based questions.
Attendance Tracking: Facial recognition and AI-based systems track student attendance.
Automated Scheduling: AI helps in timetable creation and classroom allocation.

3.9.. Enhanced Student Support

AI provides real-time assistance to students.
Chatbots & Virtual Assistants: AI-powered bots answer student queries anytime.
Language Translation: AI helps students understand content in their preferred language.
Speech-to-Text & Text-to-Speech: AI assists students with disabilities by converting speech to text and vice versa.

3.10. Data-Driven Insights & Analytics

AI helps educators and institutions make informed decisions.
Early Warning Systems: AI predicts student performance and identifies at-risk students.
Progress Monitoring: AI tracks student progress and provides insights to teachers and parents.
Predictive Analysis: AI helps institutions plan for future trends in education.

3.11.. Virtual & Augmented Reality (VR & AR)

AI enhances the learning experience through immersive technology.
Virtual Labs: Students can conduct experiments in a virtual environment.
3D Learning Models: AI creates interactive 3D models for better understanding.
Historical & Scientific Simulations: AI brings history and science lessons to life.

3.12. AI in Career Guidance & Skill Development

AI helps students choose the right career paths and develop essential skills.
Career Counseling: AI analyzes student interests and suggests suitable careers.
Skill Assessment: AI tests and recommends skill-building courses.
Job Market Insights: AI informs students about job opportunities and required qualifications.

3.13. Inclusive Education

AI makes education more accessible for all learners.
Assistive Technology: AI tools support students with disabilities (e.g., screen readers for visually impaired students).
Special Education Support: AI helps teachers create personalized learning plans for students with special needs.

Remote Learning: AI-powered platforms enable students in remote areas to access quality education.

3.14. Cost Reduction in Education

AI helps reduce the cost of learning materials and administrative expenses.

Automated Content Creation: Reduces the need for expensive textbooks.

AI-Powered Tutors: Decrease dependency on private tutoring.

Efficient Resource Allocation: AI optimizes school operations to save costs.

3.15. Gamification & Engagement

AI makes learning more fun and interactive.

AI-Powered Games: Educational games enhance student engagement.

Progress Tracking & Rewards: AI provides badges and rewards for achievements.

AI-Based Storytelling: Enhances creativity and understanding through interactive narratives.

4. CHALLENGES AND LIMITATIONS

Despite its potential, the use of AI in education faces several challenges:

4.1. Equity and Access

Not all students have equal access to AI-powered educational tools. Disparities in technology access, especially in low-income regions, can exacerbate educational inequalities. Ensuring that AI tools are accessible to all students is crucial for equitable educational outcomes.

4.2. Data Privacy and Security

The use of AI in education involves the collection of vast amounts of student data. There are concerns about how this data is stored, who has access to it, and how it is used. Educational institutions must ensure that data privacy is maintained, and ethical guidelines are followed to protect student information.

4.3. Teacher Resistance and Training

Some educators may be resistant to the implementation of AI in the classroom, fearing that it could replace their role or that they lack the skills to use these technologies effectively. Professional development programs are essential to help educators integrate AI into their teaching practices.

4.4. Reliability of AI Systems

AI systems are only as effective as the data they are trained on. Bias in the data or flaws in the algorithms can lead to inaccurate results or unfair treatment of students. Ensuring that AI systems are transparent, unbiased, and regularly tested is necessary to maintain their reliability.

5. ETHICAL CONSIDERATIONS

The use of AI in education raises several ethical questions:

5.1. Bias in Algorithms

AI systems can unintentionally perpetuate biases based on the data they are trained on. For example, an AI system might favor students from certain demographic backgrounds or schools, leading to inequality in educational opportunities. It is important to develop algorithms that are fair, transparent, and unbiased.

5.2. Impact on Employment

As AI systems take on administrative tasks and even some teaching roles, concerns arise about the potential displacement of educational workers. It is crucial to consider how AI will affect the job market in education and ensure that human educators remain an integral part of the learning experience.

5.3. Informed Consent

The collection of personal data for AI-driven educational tools requires clear consent from students and their guardians. Educational institutions must ensure that they are transparent about data collection practices and that students' privacy rights are respected.

5.4. Bias and Fairness

AI systems may inherit biases from training data, leading to unfair advantages or disadvantages for certain students.

Ensuring diverse and unbiased datasets can help mitigate this issue.

5.5. Privacy and Data Security

AI systems often collect large amounts of student data, raising concerns about data privacy.

Schools and developers must ensure strong security measures and comply with data protection regulations (e.g., GDPR, FERPA).

5.6. Transparency and Accountability

AI decision-making processes should be transparent so educators, students, and parents understand how conclusions are reached.

Institutions must be accountable for AI-driven decisions, especially those impacting student learning outcomes.

5.7. Equity and Accessibility

AI should enhance education for all students, including those with disabilities and those from underprivileged backgrounds.

Ensuring AI tools are inclusive and accessible is essential.

5.8. Human Oversight

AI should assist, not replace, human educators.

Teachers must be involved in reviewing AI-generated recommendations to ensure they align with ethical and educational goals.

5.9. Psychological and Social Impact

Over-reliance on AI may impact students' critical thinking and social skills.

AI should be used to complement traditional learning rather than completely automate it.

5.10. Misuse of AI in Education

AI tools like ChatGPT can be misused for plagiarism or cheating.

Schools should develop policies to encourage responsible AI use.

6. FUTURE OF AI IN EDUCATION

The future of AI in education is promising, with potential applications expanding across various fields. As AI technology continues to evolve, we can expect to see more sophisticated systems that enhance personalization, improve learning outcomes, and foster lifelong learning.

In the near future, we may see AI systems that can provide real-time translation, enabling students from different linguistic backgrounds to learn together in a multicultural environment. Furthermore, AI may play a key role in predicting and preventing student dropout by analyzing trends and providing timely interventions. However, it is essential that AI in education is implemented responsibly, with careful attention to the ethical, social, and cultural implications. The collaboration between policymakers, educators, technologists, and students will be critical in shaping the future of AI in education.

7. CONCLUSION

AI has the potential to revolutionize education by providing personalized learning experiences, improving efficiency, and enhancing accessibility. However, the adoption of AI must be approached with caution, considering the challenges and ethical concerns associated with its use. By addressing issues such as equity, data privacy, and teacher readiness, AI can be harnessed to create more inclusive and effective educational environments. As AI continues to develop, its role in education will only become more significant, offering new opportunities for students, teachers, and institutions alike.

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LIBRARY MANAGEMENT PRACTICES IN THE 21ST CENTURY: AN EMPIRICAL STUDY

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ABSTRACT

The 21st century has witnessed a profound transformation in library management practices, driven by rapid advancements in information and communication technology (ICT), evolving user expectations, and the growing demand for instant and remote access to information. This empirical study examines the changing landscape of library management in academic institutions, with a particular focus on how modern practices influence service efficiency, resource utilization, and user satisfaction. Libraries, traditionally perceived as repositories of printed materials, have now evolved into dynamic knowledge hubs that integrate both physical and digital resources, requiring innovative management approaches to remain relevant and effective.

The primary objective of this study is to analyze contemporary library management practices and evaluate their effectiveness in meeting the information needs of users in the digital age. The study also aims to identify the challenges faced by library professionals in implementing these practices and to suggest strategies for improving overall management efficiency. A quantitative research design was adopted for this study, supported by empirical data collected through a structured questionnaire distributed among 140 respondents, including students, faculty members, and library staff from selected academic institutions. The sampling method ensured representation from diverse user groups to capture a comprehensive perspective on library services.

The collected data were analyzed using statistical tools such as percentage analysis, mean score analysis, and correlation techniques to establish relationships between management practices and user satisfaction. The findings reveal that a significant proportion of users are aware of modern library services and actively engage with digital resources such as e-books, online journals, institutional repositories, and automated catalog systems (OPAC). The study highlights that digital resource access and library automation are among the most influential factors contributing to improved service delivery and user experience.

KEYWORDS: LIBRARY MANAGEMENT, DIGITAL LIBRARIES, USER SATISFACTION, INFORMATION SERVICES, LIBRARY AUTOMATION

1. INTRODUCTION

The 21st century has brought rapid changes in the field of library and information science. Traditional library management practices have evolved to include digital tools, automated systems, and user-centric approaches. Libraries are no longer just repositories of books but dynamic information centers that provide access to both physical and digital resources. Effective management practices are essential to ensure quality service delivery and user satisfaction. Furthermore, the results indicate a strong positive correlation between effective library management practices and user satisfaction. Libraries that have adopted user-centered approaches, integrated advanced technologies, and streamlined their operational processes tend

to exhibit higher levels of user engagement and satisfaction. Services such as online access to resources, remote login facilities, digital reference services, and automated circulation systems have significantly enhanced the accessibility and convenience of library services. These developments have also reduced the time and effort required by users to locate and retrieve information, thereby improving overall efficiency.

Despite these advancements, the study also identifies several challenges that hinder the effective implementation of modern library management practices. One of the major issues is the lack of adequate funding, which limits the ability of libraries to invest in advanced technologies and infrastructure. Additionally, the shortage of skilled and trained library professionals poses a significant barrier to the successful adoption of digital tools and systems. The digital divide among users, particularly in terms of technological literacy and access to reliable internet connectivity, further complicates the situation. Resistance to change among staff and users is another factor that affects the smooth transition from traditional to modern management practices.

The study emphasizes the importance of continuous professional development and training programs for library staff to enhance their technical competencies and adapt to emerging trends. It also underscores the need for libraries to adopt strategic planning and innovative management models that prioritize user needs and leverage technology effectively. Collaborative initiatives, resource sharing, and partnerships with other institutions can further strengthen library services and optimize resource utilization.

2. REVIEW OF LITERATURE

The concept of library management has evolved significantly in the 21st century, influenced by technological advancements, changing user expectations, and the shift toward digital information systems. Various scholars have contributed to understanding modern library management practices, highlighting the integration of technology, user-centered services, and strategic planning. Kumar (2020), in his book *Modern Library Management*, emphasizes the importance of adopting innovative management techniques to enhance library efficiency. He discusses how automation, digital cataloging, and electronic resource management systems have transformed traditional library operations. According to Kumar, effective management practices are essential for improving service quality and ensuring user satisfaction in academic libraries.

Ranganathan (1963), in his classic work *The Five Laws of Library Science*, provides a foundational framework that continues to guide modern library management. His principles, particularly "Books are for use" and "Save the time of the reader," remain highly relevant in the digital age, influencing the development of user-centered services and efficient information retrieval systems.

Evans and Saponaro (2012), in *Management Basics for Information Professionals*, highlight the role of strategic planning, leadership, and organizational behavior in library management. They argue that modern libraries require flexible management approaches that can adapt to rapid technological changes and evolving user needs. Their work underscores the importance of decision-making and performance evaluation in library settings.

Stueart and Moran (2013), in *Library and Information Center Management*, discuss contemporary management practices, including human resource management, budgeting, and policy formulation. They emphasize that effective leadership and staff development are critical for implementing technological innovations in libraries.

Gorman (2015), in *Our Enduring Values Revisited: Librarianship in an Ever-Changing World*, explores the balance between traditional library values and modern technological trends. He argues that while technology is essential, core values such as access, service, and intellectual freedom must remain central to library management practices.

Rowley (2011), in *The Electronic Library*, examines the impact of digital technologies on library services and management. She highlights the importance of electronic resources, digital repositories, and online user services in transforming library operations. Rowley also stresses the need for continuous adaptation to technological advancements.

3. OBJECTIVES OF THE STUDY

To examine modern library management practices
To evaluate the effectiveness of these practices
To analyze user satisfaction with library services
To identify challenges in library management

RESEARCH METHODOLOGY

This study adopts a systematic approach to examine library management practices in the 21st century, focusing on the effectiveness of modern techniques and their impact on user satisfaction.

1. Research Design

The study is based on a **descriptive and analytical research design**. The descriptive approach helps in understanding existing library management practices, while the analytical approach evaluates their effectiveness and relationship with user satisfaction.

2. Nature of the Study

The research is **empirical in nature**, as it is based on primary data collected directly from respondents. It aims to provide real-world insights into the functioning of modern libraries.

3. Data Collection Methods

a) Primary Data

Primary data were collected using a **structured questionnaire** designed to gather information on:
Awareness of library services
Usage of digital and traditional resources
Satisfaction level of users
Effectiveness of management practices
The questionnaire included both **closed-ended and Likert scale questions** to ensure quantitative analysis.

b) Secondary Data

Secondary data were collected from:
Books and academic journals
Research articles and reports
Library websites and official publications

These sources helped in building the theoretical framework of the study.

4. SAMPLING DESIGN

Population: Students, faculty members, and library staff of academic institutions
Sampling Technique: Simple random sampling was used to ensure unbiased selection
Sample Size: 140 respondents
100 Students
25 Faculty Members
15 Library Staff

The study was conducted in selected **academic libraries** (colleges/universities), focusing on their management practices and service delivery systems.

6. TOOLS AND TECHNIQUES FOR DATA ANALYSIS

The collected data were analyzed using the following statistical tools:
Percentage Analysis: To understand distribution and general trends
Mean Score Analysis: To measure user satisfaction and effectiveness of services
Correlation Analysis: To examine the relationship between management practices and user satisfaction
Data were presented using **tables and simple statistical measures** for clarity.

7. HYPOTHESIS OF THE STUDY

H_0 (Null Hypothesis): There is no significant relationship between library management practices and user satisfaction.
H_1 (Alternative Hypothesis): There is a significant relationship between library management practices and user satisfaction.

8. LIMITATIONS OF THE STUDY

The study is limited to a **small sample size** and selected institutions
Responses may be subject to **personal bias**
Limited access to advanced statistical tools
Time constraints restricted deeper analysis

9. ETHICAL CONSIDERATIONS

Respondents' information was kept **confidential**
Participation was **voluntary**
Data were used strictly for **academic purposes**

5. DATA ANALYSIS AND INTERPRETATION

Table 1: Awareness of Modern Library Services

Response	Respondents	Percentage
Yes	110	78.6%
No	30	21.4%

Interpretation: A majority of respondents are aware of modern library services.

Table 2: Usage of Library Services

Service Type	Respondents	Percentage
Digital Resources	70	50%
Print Resources	30	21.4%
Both	40	28.6%

Interpretation: Digital resources are the most used services among respondents.

Table 3: Satisfaction Level

Satisfaction Level	Respondents	Percentage
Highly Satisfied	45	32.1%
Satisfied	60	42.9%
Neutral	20	14.3%
Dissatisfied	15	10.7%

Interpretation: Most users are satisfied with current library management practices.

Table 4: Mean Score Analysis

Management Practice	Mean Score
Library Automation	4.3
Digital Resource Access	4.5
User Support Services	4.1
Staff Efficiency	3.9

Interpretation: Digital resource access has the highest satisfaction level.

6. FINDINGS

High awareness of modern library services among users.
Digital resources are more frequently used than print resources.
Strong positive relationship between management practices and satisfaction.
Challenges include limited funding and lack of trained staff.

7. SUGGESTIONS

Invest in staff training and development programs.
Enhance digital infrastructure and services.
Implement user feedback systems for continuous improvement.
Increase funding for technological upgrades.

8. CONCLUSION

The study on *"Library Management Practices in the 21st Century: An Empirical Study"* highlights the significant transformation that libraries have undergone in response to rapid technological advancements and changing user expectations. Modern library management practices have shifted from traditional methods to more dynamic, technology-driven approaches that emphasize efficiency, accessibility, and user satisfaction. The integration of digital tools such as automated library systems, online public access catalogs (OPAC), e-resources, and institutional repositories has greatly enhanced the quality and speed of information services.

The findings of the study reveal that effective management practices play a crucial role in improving library performance and meeting the diverse needs of users. A majority of respondents expressed satisfaction with the availability and accessibility of digital resources, indicating the success of technology adoption in libraries. Furthermore, the positive relationship between management practices and user satisfaction underscores the importance of adopting user-centered approaches and innovative strategies in library administration.

However, the study also identifies several challenges that continue to affect library management in the modern era. Issues such as limited financial resources, inadequate infrastructure, lack of trained personnel, and varying levels of digital literacy among users hinder the full realization of technological benefits. Addressing these challenges requires strategic planning, increased investment, and continuous professional development for library staff.

In conclusion, library management practices in the 21st century must focus on adaptability, innovation, and user engagement to remain relevant in an increasingly digital world. Libraries should strive to balance traditional values with modern technologies while ensuring inclusive and equitable access to information. By embracing change and continuously improving management strategies, libraries can strengthen their role as essential centers of knowledge, learning, and research in the contemporary information society.

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ARTIFICIAL INTELLIGENCE IN INDIAN HIGHER EDUCATION: IMPACTS ON TEACHING-LEARNING OUTCOMES, ACADEMIC PERFORMANCE, AND INSTITUTIONAL EFFICIENCY

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ABSTRACT

Artificial Intelligence (AI) is rapidly transforming higher education systems worldwide, with India emerging as a significant adopter due to its expanding digital infrastructure and policy emphasis on technology-enabled learning. This study investigates the impact of AI integration in Indian higher education institutions on teaching-learning outcomes, student academic performance, and institutional efficiency. Using a mixed-method research design, the study combines secondary data from national education reports and primary survey data collected from 250 students and 80 faculty members across universities in Gujarat and Maharashtra. Statistical tools such as correlation, regression analysis, and ANOVA are employed to examine relationships between AI usage and educational outcomes. The findings reveal that AI significantly enhances personalized learning, improves student engagement, and positively influences academic performance. Additionally, AI contributes to administrative efficiency through automation and data-driven decision-making. However, challenges such as digital divide, lack of faculty training, and ethical concerns persist. The study contributes to the growing discourse on AI in education by providing empirical evidence from the Indian context and offers policy recommendations for effective AI integration in higher education.

KEYWORDS: ARTIFICIAL INTELLIGENCE, HIGHER EDUCATION, INDIA, ACADEMIC PERFORMANCE, DIGITAL LEARNING, EDUCATIONAL TECHNOLOGY, INSTITUTIONAL EFFICIENCY

1. INTRODUCTION

Background

The integration of Artificial Intelligence (AI) into education has revolutionized traditional pedagogical approaches. AI-powered tools such as adaptive learning platforms, intelligent tutoring systems, and automated grading mechanisms are increasingly being adopted in higher education institutions globally. In India, initiatives under the National Education Policy (NEP 2020) emphasize the use of digital technologies, including AI, to enhance educational quality and accessibility. The rise of platforms like AI-based learning management systems and virtual assistants has enabled personalized learning experiences and improved student engagement. Universities are leveraging AI for predictive analytics, curriculum design, and administrative automation.

Problem Statement

Despite the growing adoption of AI in Indian higher education, there is limited empirical evidence on its actual impact on student performance and institutional efficiency. Moreover, disparities in access and preparedness raise concerns about equitable implementation.

Objectives of the Study

To analyze the role of AI in enhancing teaching-learning processes
To evaluate the impact of AI on student academic performance
To assess the contribution of AI to institutional efficiency

To identify challenges in AI adoption in Indian higher education

2. REVIEW OF LITERATURE

The integration of AI in education has been widely studied in recent years, particularly in the context of digital transformation and learning outcomes.

Holmes et al. (2019) explored the potential of AI in education and emphasized its role in personalized learning and intelligent tutoring systems. The study highlighted that AI can significantly improve learning efficiency and student engagement.

Kumar and Sharma (2021) examined AI adoption in Indian universities and found that AI-based tools improved teaching effectiveness and student satisfaction.

Singh et al. (2022) conducted an empirical study on AI-driven learning platforms and reported a positive correlation between AI usage and student academic performance.

UNESCO (2021) emphasized the ethical implications of AI in education, including data privacy and algorithmic bias.

Patel and Mehta (2023) analyzed the use of AI in Gujarat universities and found that AI improved administrative efficiency but required significant faculty training.

Rao and Iyer (2024) studied AI-enabled assessment systems and concluded that automated grading reduced workload and improved evaluation accuracy.

Zawacki-Richter et al. (2019) conducted a systematic review and identified key areas of AI application in education, including adaptive learning, assessment, and administration.

Chaudhary and Gupta (2023) found that AI-based recommendation systems enhanced student retention and reduced dropout rates.

Mishra and Kulkarni (2022) highlighted that AI adoption is influenced by infrastructure and digital literacy.

Overall, literature indicates that AI has significant potential to transform education but requires careful implementation.

3. RESEARCH GAP

Limited India-specific empirical studies on AI's impact on academic performance
Lack of integration between student and faculty perspectives
Insufficient focus on institutional efficiency alongside learning outcomes
Limited post-NEP 2020 analysis

4. RESEARCH OBJECTIVES

To examine the extent of AI adoption in Indian higher education

To analyze its impact on student learning outcomes
To evaluate its role in improving institutional efficiency
To identify barriers to effective AI implementation

5. RESEARCH HYPOTHESES

H1: AI integration positively affects student academic performance
H2: AI enhances teaching effectiveness
H3: AI significantly improves institutional efficiency
H4: Digital literacy influences AI adoption

6. RESEARCH METHODOLOGY

Research Design

Descriptive and analytical research design using mixed methods

Data Sources

Secondary: UGC reports, AISHE data, UNESCO reports
Primary: Survey data from students and faculty

Sampling Method

Stratified random sampling

Sample Size

Students: 250
Faculty: 80

Tools for Data Collection

Structured questionnaire
5-point Likert scale

Statistical Techniques Used

Descriptive statistics
Correlation analysis
Multiple regression
ANOVA

7. DATA ANALYSIS AND INTERPRETATION

Table 1: AI Usage Among Students

AI Tool Usage Level	Percentage (%)
High	42
Moderate	38
Low	20

Interpretation:

A significant proportion of students actively use AI tools, indicating growing adoption in higher education.

Table 2: Correlation Between AI Usage and Academic Performance

Variable	Correlation (r)
AI Usage vs GPA	0.62

Interpretation:

There is a strong positive correlation between AI usage and academic performance.

Table 3: Regression Results

Variable	Coefficient	p-value
AI Usage	0.71	0.000
Faculty Support	0.48	0.009
Digital Literacy	0.53	0.004

Interpretation:

AI usage significantly impacts academic performance, supporting H1.

Table 4: ANOVA Results (Teaching Effectiveness)

Source	F-value	p-value
Between Groups	6.12	0.002

Interpretation:

AI significantly improves teaching effectiveness, supporting H2.

Table 5: Institutional Efficiency Indicators

Indicator	Improvement (%)
Administrative Tasks	35
Evaluation Speed	40
Student Support Services	30

Interpretation:

AI enhances institutional efficiency by automating processes.

8. DISCUSSION OF FINDINGS

The findings indicate that AI plays a transformative role in Indian higher education. Students using AI tools demonstrate better academic performance due to personalized learning and instant feedback. Faculty members benefit from AI through automated grading and improved instructional strategies.

Institutionally, AI contributes to efficiency by reducing administrative workload and enabling data-driven decision-making. However, challenges such as digital divide and lack of training hinder optimal utilization.

9. IMPLICATIONS OF THE STUDY

Academic Implications

Expands literature on AI in education
Provides empirical evidence from India
Encourages interdisciplinary research

Practical Implications

Need for faculty training programs
Investment in digital infrastructure
Development of ethical AI policies

10. LIMITATIONS OF THE STUDY

Limited geographical scope
Moderate sample size
Self-reported data bias
Rapid technological changes

11. SUGGESTIONS FOR FUTURE RESEARCH

Longitudinal studies on AI impact
Comparative studies across countries
Subject-specific AI applications
Role of generative AI tools

12. CONCLUSION

Artificial Intelligence has the potential to revolutionize Indian higher education by enhancing learning outcomes, improving academic performance, and increasing institutional efficiency. However, its success depends on equitable access, proper training, and ethical implementation. Policymakers and educational institutions must adopt a balanced approach to maximize benefits while addressing challenges.

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URBAN YOUTH UNEMPLOYMENT AND ASPIRATIONS

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ABSTRACT

Youth unemployment represents one of the most critical social challenges facing contemporary urban societies. Young people confronted with unstable labor markets, delayed entry into employment, and uncertain career prospects experience deep effects on identity, aspirations, and everyday life. This study examines how urban unemployed youth construct meaning around work, negotiate social identity, and manage aspirations in contexts marked by economic precarity and competitive opportunity structures. Grounded in sociological perspectives on labor, youth transitions, social inequality, and identity, the research explores how unemployment influences emotional experience, self-worth, social participation, and future orientation among young people. A mixed-methods research design was adopted, consisting of a survey of 640 unemployed and underemployed urban youth and in-depth interviews with 34 participants representing diverse educational, class, and occupational backgrounds. Quantitative findings indicate strong associations between prolonged unemployment, declining self-confidence, social withdrawal, and increased uncertainty regarding future goals. However, outcomes vary by social support, household security, and access to informal work networks. Qualitative narratives reveal experiences of stagnation, resilience, family expectations, self-blame, improvisation, and negotiation between hope and frustration. Young people describe unemployment not merely as economic absence but as a social condition shaping identity, time, and emotional life.

The study argues that youth unemployment should be understood as a socially embedded process rather than an individual failure. It reshapes moral expectations, family relations, social roles, and aspirations within unequal opportunity structures. The findings contribute to sociological debates on work, precarity, and youth transitions by highlighting lived experiences of uncertainty, adaptation, and symbolic struggle. Implications for employment policy, counseling, skill-oriented programs, and community support interventions are discussed, along with areas for future research.

KEYWORDS: YOUTH UNEMPLOYMENT; SOCIAL IDENTITY; LIFE ASPIRATIONS; URBAN YOUTH; PRECARITY; WORK AND SOCIETY; SOCIOLOGY OF LABOR

1. INTRODUCTION

Youth is widely represented as a period of aspiration, mobility, and transition toward adulthood. However, in many urban contexts, the pathway from education to employment has become uncertain and fragmented. Rapid economic transformation, competition, technological change, and unstable labor markets produce conditions in which young people encounter repeated job search cycles, short-term contracts, or prolonged unemployment. Unemployment is not only the absence of work but a disruption of social identity, routine, and recognition. Work provides status, meaning, and legitimacy in society. When employment is delayed or denied, young people experience

challenges to dignity, self-worth, and belonging. Family expectations, peer comparison, and social judgment intensify emotional pressure, particularly in middle-class and aspirational urban environments.

This study examines how unemployed urban youth interpret their situation, construct identity, maintain or revise aspirations, and negotiate everyday survival in contexts of uncertainty.

RESEARCH QUESTION

How does unemployment influence social identity, emotional experience, and life aspirations among urban youth, and how do young people negotiate everyday survival and meaning in conditions of labor uncertainty?

HYPOTHESIS

Prolonged unemployment is associated with increased emotional strain, identity insecurity, and aspiration reevaluation; however, supportive networks and informal opportunities mitigate negative outcomes and sustain resilience.

The study positions youth unemployment as a relational and structural experience rather than an individual deficit.

2. LITERATURE REVIEW

2.1 Work, Identity, and Social Meaning

Work structures everyday time, social roles, and identity recognition. Employment provides economic stability and symbolic legitimacy, while unemployment disrupts self-definition and social participation.

2.2 Youth Transitions and Precarity

Contemporary youth transitions are increasingly nonlinear. Delayed employment, contract work, and informal labor reflect growing precarity and uncertainty in the life course.

2.3 Class, Inequality, and Opportunity Structures

Access to employment opportunities is shaped by class resources, education quality, social networks, and institutional advantage. Inequality produces uneven exposure to unemployment and varying strategies of adaptation.

2.4 Emotional Life and Social Pressure

Unemployment influences self-esteem, anxiety, and social withdrawal. Family and community expectations intensify pressure, shaping emotional and moral responses to joblessness.

2.5 Gaps in Research

Many studies emphasize economic indicators or policy outcomes, overlooking lived meanings, identity processes, and everyday survival practices of unemployed youth. This study integrates quantitative patterns with narrative experiences.

3. RESEARCH METHODOLOGY

3.1 Research Design

A mixed-methods design combined survey data with interpretive interviews to capture both measurable trends and experiential meaning.

3.2 Population and Sampling

The study focused on unemployed and underemployed youth aged 18–32 living in urban areas. A survey was administered to 640 respondents using stratified sampling by education level and neighborhood type. Thirty-four participants were purposively selected for interviews based on unemployment duration and family background.

3.3 Data Collection

The survey measured unemployment duration, job search activity, emotional well-being, self-confidence, social participation, aspirations, and support networks. Interviews explored identity negotiation, family relationships, everyday routines, informal work strategies, and future expectations.

3.4 Data Analysis

Quantitative data were analyzed using descriptive and correlation analysis to identify associations between unemployment and psychosocial outcomes. Qualitative transcripts were thematically coded to interpret symbolic meanings, tensions, and coping processes.

3.5 Ethical Considerations

Participation was voluntary, confidentiality was maintained, and respondents provided informed consent.

4. DATA ANALYSIS AND FINDINGS

EDUCATIONAL ATTAINMENT IN THE UNITED STATES, AGE 25 AND OVER (2009)

EDUCATIONAL ATTAINMENT	PERCENTAGE ATTAINED
ASSOCIATES AND/OR BACHELOR'S DEGREE	38.54%
DOCTORATE OR PROFESSIONAL DEGREE	2.94%
HIGH SCHOOL GRADUATE	86.68%
MASTER'S DEGREE	7.62%
SOME COLLEGE	55.60%

4.1 Quantitative Findings

Longer unemployment duration correlated with declining confidence, increased stress, and reduced social participation. Respondents with strong family or peer support reported higher resilience and more stable aspirations than those lacking support structures. Access to informal or temporary work partially buffered emotional effects.

4.2 Qualitative Findings

Three extended themes emerged.

1. Waiting, Time, and Emotional Strain

Participants described unemployment as an experience of suspended time, filled with uncertainty, guilt, and comparison with successful peers.

2. Identity, Respect, and Social Judgment

Youth expressed fear of being seen as unproductive or unsuccessful, negotiating dignity through silence, justification, or selective visibility.

3. Hope, Resilience, and Improvised Pathways

Some respondents developed alternative aspirations, skill-seeking strategies, or informal economic activities, demonstrating resilience despite constraint.

5. DISCUSSION

The findings show that youth unemployment reshapes identity, aspiration, and emotional life. It reflects structural inequalities rather than individual inadequacy. Social meaning of unemployment is mediated through family expectations, class narratives of success, and symbolic value of work. Youth respond through adaptation, reinterpretation, and selective participation, revealing agency within constraint. Unemployment emerges as a moral, emotional, and relational condition embedded in broader social structures.

6. IMPLICATIONS

Interventions should integrate employment programs with psychological support, mentoring networks, community engagement, and inclusive labor market pathways. Policy must address inequality in opportunity, not only skills training.

7. LIMITATIONS AND FUTURE RESEARCH

The study focuses on urban youth and does not examine rural or migrant unemployed populations. Future research should explore gendered unemployment experiences and longitudinal impact on life trajectories.

8. CONCLUSION

Urban youth unemployment transforms social identity, aspirations, and emotional experience. Young people navigate uncertainty through resilience, negotiation, and symbolic struggle for dignity. Understanding unemployment as a socially embedded process deepens insight into inequality, youth transitions, and the changing meaning of work in contemporary societies.

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THE ROLE OF COMPUTER SCIENCE IN DIGITAL TRANSFORMATION

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ABSTRACT

Digital transformation has become a critical driver of growth, innovation, and competitiveness in the modern world. At the core of this transformation lies computer science, which provides the theoretical foundations, tools, and technologies that enable organizations to transition from traditional processes to digital ecosystems. This research paper explores the role of computer science in digital transformation, focusing on its impact across industries, key technologies involved, benefits, challenges, and future prospects. The study adopts a descriptive and analytical approach using secondary data sources such as academic journals, industry reports, and scholarly publications. The findings indicate that computer science plays a central role in enabling automation, data-driven decision-making, enhanced customer experiences, and operational efficiency. However, challenges such as cybersecurity risks, skill gaps, and high implementation costs must be addressed to achieve sustainable digital transformation.

INTRODUCTION

In the 21st century, digital transformation has emerged as a fundamental shift in how organizations operate and deliver value to customers. It involves the integration of digital technologies into all areas of business and society, fundamentally changing processes, culture, and customer experiences. Computer science serves as the backbone of this transformation by providing the necessary frameworks, algorithms, and systems that support digital innovation.

From cloud computing and artificial intelligence to big data analytics and cybersecurity, computer science drives the development and implementation of technologies that enable digital transformation. Organizations across sectors such as healthcare, education, finance, manufacturing, and retail are increasingly relying on computer science to enhance efficiency, improve decision-making, and remain competitive in a rapidly evolving environment.

This paper aims to examine the role of computer science in digital transformation, highlighting its applications, benefits, and challenges, while also exploring future trends.

OBJECTIVES OF THE STUDY

To understand the concept of digital transformation
To analyze the role of computer science in enabling digital transformation
To identify key technologies driving digital transformation
To examine the benefits and challenges of digital transformation
To explore future prospects in the field

RESEARCH METHODOLOGY

This research is based on secondary data collected from books, research journals, conference papers, and credible online sources. A descriptive and analytical methodology is used to interpret the data and provide insights into the role of computer science in digital transformation.

CONCEPT OF DIGITAL TRANSFORMATION

Digital transformation refers to the comprehensive integration of digital technologies into all aspects of an organization, fundamentally changing how it operates, delivers value to customers, and competes in the marketplace. It goes beyond simply adopting new technologies; it involves rethinking business models, redesigning processes, and fostering a culture of continuous innovation. In essence, digital transformation is both a technological and organizational shift that aligns people, processes, and technology toward improved performance and customer-centric outcomes.

At its core, digital transformation is driven by advances in computer science and information technology. Technologies such as cloud computing, artificial intelligence (AI), machine learning (ML), big data analytics, the Internet of Things (IoT), and blockchain enable organizations to digitize operations, automate workflows, and make data-driven decisions. These technologies allow businesses to collect vast amounts of data, analyze patterns, and generate actionable insights in real time, thereby improving efficiency and responsiveness.

A useful way to understand digital transformation is through its three stages: digitization, digitalization, and transformation. Digitization involves converting analog information into digital formats, such as scanning paper documents into electronic files. Digitalization refers to using digital technologies to improve existing processes, for example, implementing online banking systems or e-commerce platforms. Digital transformation, the final stage, involves a complete reimagining of business strategies and models, such as platform-based services (e.g., Uber, Amazon) or fully digital enterprises.

Another important dimension of digital transformation is customer experience. Modern consumers expect personalized, fast, and seamless interactions across digital channels. Organizations leverage technologies like AI-powered chatbots, recommendation systems, and mobile applications to enhance customer engagement and satisfaction. As a result, businesses are shifting from product-centric approaches to customer-centric models.

Organizational culture also plays a critical role in digital transformation. Successful transformation requires a mindset that embraces change, experimentation, and innovation. Companies must invest in upskilling their workforce, adopting agile methodologies, and encouraging cross-functional collaboration. Leadership commitment is essential to drive digital initiatives and manage resistance to change.

Digital transformation has widespread implications across industries. In healthcare, it enables telemedicine and electronic health records; in education, it supports online learning platforms; in finance, it powers digital payments and fintech innovations; and in manufacturing, it drives automation and smart factories. Governments are also adopting digital transformation through e-governance initiatives to improve public service delivery and transparency.

Despite its advantages, digital transformation presents challenges such as high implementation costs, cybersecurity risks, data privacy concerns, and integration issues with legacy systems. Additionally, the digital divide and lack of technical skills can hinder adoption, particularly in developing regions.

In conclusion, digital transformation is a strategic imperative in the modern digital economy. It enables organizations to remain competitive, innovative, and responsive to changing market demands. By effectively leveraging computer science and digital technologies, organizations can achieve sustainable growth and long-term success.

ROLE OF COMPUTER SCIENCE IN DIGITAL TRANSFORMATION

Computer science plays a pivotal role in enabling digital transformation by providing the theoretical and practical foundations for modern technologies.

1. Data Management and Analytics

Computer science enables the collection, storage, and analysis of large volumes of data. Big data analytics helps organizations make informed decisions, predict trends, and improve performance.

2. Artificial Intelligence and Machine Learning

AI and ML, key areas of computer science, allow systems to learn from data and make intelligent decisions. These technologies are widely used in automation, recommendation systems, fraud detection, and customer service.

3. Cloud Computing

Cloud computing provides scalable and cost-effective solutions for storing and processing data. It allows organizations to access resources on-demand and supports remote work and collaboration.

4. Cybersecurity

As digital transformation increases reliance on digital systems, cybersecurity becomes essential. Computer science provides techniques to protect data, systems, and networks from cyber threats.

5. Software Development

Computer science enables the design and development of software applications that support digital transformation. Agile and DevOps practices improve software quality and delivery speed.

6. Internet of Things (IoT)

IoT connects devices and systems, enabling real-time data collection and automation. Computer science supports IoT through embedded systems, networking, and data processing.

APPLICATIONS ACROSS INDUSTRIES

Digital transformation driven by computer science has impacted various sectors:
Healthcare: Telemedicine, electronic health records, and AI-based diagnostics
Education: Online learning platforms and virtual classrooms
Finance: Digital banking, fintech, and blockchain technology
Retail: E-commerce, personalized marketing, and supply chain optimization
Manufacturing: Automation, robotics, and smart factories

BENEFITS OF DIGITAL TRANSFORMATION

Improved efficiency and productivity
Enhanced customer experience
Data-driven decision-making

Cost reduction
Increased innovation and competitiveness

CHALLENGES OF DIGITAL TRANSFORMATION

High implementation costs
Cybersecurity risks
Resistance to change
Skill gaps in workforce
Data privacy concerns

FUTURE PROSPECTS

The future of digital transformation is closely tied to advancements in computer science. Emerging technologies such as quantum computing, advanced AI, and 5G networks are expected to further accelerate digital transformation. Organizations will increasingly rely on automation, intelligent systems, and real-time analytics.

Moreover, the integration of technologies will lead to the development of smart cities, autonomous vehicles, and advanced healthcare systems. Governments and businesses must invest in education and infrastructure to fully leverage the potential of computer science.

CONCLUSION

Computer science plays a crucial role in driving digital transformation by enabling the development and implementation of advanced technologies. It has transformed industries, improved efficiency, and created new opportunities for innovation. Despite challenges, the continued evolution of computer science will further enhance digital transformation, shaping the future of society and business.

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ROLE OF MOTIVATION IN COGNITIVE DEVELOPMENT OF SECONDARY SCHOOL STUDENTS

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ABSTRACT

Motivation is a key psychological factor that significantly influences students' learning behavior and cognitive growth, especially at the secondary school level. This stage represents a crucial period of intellectual development, where learners acquire higher-order thinking skills such as reasoning, analysis, and problem-solving. The present study explores the role of motivation in enhancing cognitive development among secondary school students by examining both intrinsic and extrinsic motivational factors.

The study follows a conceptual and analytical approach based on established psychological theories and previous research findings. It highlights that intrinsic motivation, which is driven by internal interest and satisfaction, has a stronger and more lasting impact on cognitive engagement compared to extrinsic motivation, which depends on external rewards or pressures. However, both forms of motivation are important and work together to influence academic performance and learning outcomes.

The paper also emphasizes the role of teachers, classroom environment, peer interaction, and technology in promoting motivation. A supportive and engaging learning environment helps students feel confident, autonomous, and motivated, which in turn enhances their cognitive abilities such as memory, attention, and critical thinking.

The findings suggest that motivation is a central factor in cognitive development rather than just a supportive element. Educational strategies that focus on increasing student motivation can lead to improved academic achievement and stronger intellectual growth. Therefore, it is essential for educators and institutions to adopt effective motivational practices to ensure holistic development of learners.

KEYWORDS: MOTIVATION, COGNITIVE DEVELOPMENT, SECONDARY SCHOOL STUDENTS, INTRINSIC MOTIVATION, EXTRINSIC MOTIVATION, EDUCATIONAL PSYCHOLOGY

1. INTRODUCTION

Education is not limited to acquiring knowledge; it also involves developing cognitive abilities such as thinking, reasoning, and problem-solving. Cognitive development refers to the improvement of these mental processes. Among the many factors influencing cognitive growth, motivation plays a vital role.

Motivation determines how much effort students put into learning tasks, how persistent they are, and how actively they participate in classroom activities. Secondary school students, typically in adolescence, experience rapid cognitive and emotional development. At this stage, motivation becomes crucial in shaping their learning experiences and intellectual growth.

This paper aims to examine the relationship between motivation and cognitive development in secondary school students. It also explores how different types of motivation influence cognitive processes and learning outcomes.

2. CONCEPTUAL FRAMEWORK

2.1 Motivation

Motivation refers to the internal and external forces that drive individuals to act towards achieving goals.

Intrinsic Motivation: Learning driven by personal interest, curiosity, and enjoyment.

Extrinsic Motivation: Learning influenced by external rewards such as grades, praise, or recognition.

Intrinsic motivation is generally more effective in promoting deep learning and long-term cognitive development.

2.2 Cognitive Development

Cognitive development includes the growth of mental abilities such as attention, memory, reasoning, language, and problem-solving. During secondary education, students develop the ability to think abstractly and critically.

3. THEORETICAL BACKGROUND

3.1 Piaget's Cognitive Development Theory

According to Piaget, adolescents reach the formal operational stage, where they develop abstract and logical thinking abilities. Motivation helps students effectively use these cognitive skills.

3.2 Self-Determination Theory

This theory states that motivation increases when students experience autonomy, competence, and social connection. These factors enhance engagement and cognitive development.

3.3 Social Cognitive Theory

This theory emphasizes self-efficacy, or belief in one's ability. Students with higher self-confidence are more motivated and perform better cognitively.

4. ROLE OF MOTIVATION IN COGNITIVE DEVELOPMENT

4.1 Attention and Concentration

Motivated students are more focused, which improves understanding and learning.

4.2 Memory Improvement

Motivation enhances the ability to store and recall information.

4.3 Critical Thinking

Motivated learners analyze and evaluate information instead of memorizing it.

4.4 Problem-Solving Skills

Students with strong motivation show persistence in solving difficult problems.

5. FACTORS AFFECTING MOTIVATION

5.1 Teacher Influence

Teachers motivate students through encouragement, feedback, and teaching methods.

5.2 Classroom Environment

A positive and interactive classroom supports motivation and engagement.

5.3 Family Support
Parental encouragement influences students' attitudes towards learning.

5.4 Peer Influence
Peers can positively or negatively impact motivation.

5.5 Technology Use
Digital tools make learning more engaging and interactive.

6. STRATEGIES TO ENHANCE MOTIVATION

6.1 Goal Setting
Setting clear and achievable goals helps maintain focus.

6.2 Active Learning
Group discussions, projects, and activities increase engagement.

6.3 Feedback
Constructive feedback improves confidence and performance.

6.4 Rewards and Recognition
Acknowledging achievements boosts motivation.

6.5 Encouraging Autonomy
Giving students choices increases intrinsic motivation.

7. RESEARCH METHODOLOGY
Research Design: Descriptive method
Sample: Secondary school students
Tools: Questionnaires and cognitive tests
Analysis: Statistical methods such as mean and correlation

8. FINDINGS AND DISCUSSION
The study shows that highly motivated students perform better cognitively. Intrinsic motivation is strongly linked to higher-order thinking skills such as analysis and creativity. Extrinsic motivation also helps but mainly for short-term goals. The results also highlight the importance of teacher support and a positive classroom environment in enhancing motivation and cognitive development.

9. EDUCATIONAL IMPLICATIONS
Teachers should focus on developing intrinsic motivation.
Classrooms should use interactive and student-centered methods.
Schools should create supportive learning environments.
Teacher training programs should include motivational techniques.

10. CONCLUSION
Motivation plays a crucial role in the cognitive development of secondary school students. It influences how students learn, think, and perform academically. Intrinsic motivation, in particular, leads to deeper understanding and long-term success.

Educational institutions must prioritize motivation-enhancing strategies to ensure holistic development of students and prepare them for lifelong learning.

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RECENT ADVANCES IN THE SYNTHESIS AND APPLICATIONS OF COUMARIN DERIVATIVES: A REVIEW

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ABSTRACT

Coumarins are an important class of benzopyrone derivatives widely distributed in nature and known for their diverse biological and industrial applications. Structurally, they consist of a fused benzene and α-pyrone ring system, enabling various chemical modifications. Coumarin derivatives exhibit significant pharmacological activities such as anticoagulant, antimicrobial, anti-inflammatory, and anticancer effects. In addition, they are widely used in perfumes, dyes, and fluorescent materials due to their excellent photo physical properties. This review summarizes key synthetic methods, including classical and modern approaches, along with important chemical reaction. The spectral characteristics including UV, IR, NMR, and mass spectrometry, are examined for structural characterization. The review also emphasizes recent advancements and applications of coumarin derivatives in pharmaceuticals, materials science, and chemical biology, underscoring their continuing importance in both academic research and industrial applications.

KEYWORDS: COUMARIN; PECHMANN REACTION; BENZOPYRONE; ANTICOAGULANT; SPECTROSCOPY.

1. INTRODUCTION

Coumarins are well-known oxygen-containing heterocyclic compounds[1] that belong to the family of benzo-α-pyrones, consisting of a benzene ring fused with a pyrone ring. The IUPAC name of coumarin is ***2H-1-benzopyran-2-one***. Coumarin was first isolated in 1820 by August Vogel from tonka beans and sweet clover in Munich[2]. He associated the pleasant odor of tonka beans from Guiana with that of clover (*Melilotus officinalis*), which is responsible for the characteristic aroma of newly mown hay. The term "coumarin" is derived from the French word *coumarou*, referring to the tonka bean[4].

Coumarins are generally colorless, crystalline phytochemical compounds that occur either in free form or as glycosides (combined with glucose)[3]. They are widely distributed in nature and are found in both plants and microorganisms. High concentrations of coumarin have been reported in tonka beans, vanilla grass, sweet woodruff, mullein, sweet grass, cassia cinnamon, sweet clover, cassia oil, cinnamon bark oil, and lavender oil. The first successful synthesis of coumarin was reported in 1868 by William Henry Perkin[5].

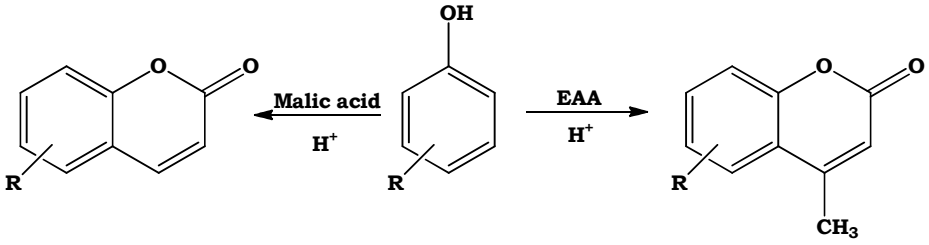
The coumarin nucleus exhibits remarkable adaptability within biological systems compared to its isomeric counterparts such as chromones and flavones, which contributes to its wide natural distribution and diverse biological activity[6]–[9]. A comprehensive account of naturally occurring coumarins has been extensively documented by R. D. H. Murray and S. A. Brown[10]

2. GENERAL METHODS FOR THE SYNTHESIS OF COUMARINS.

There are several methods for building up the coumarin ring system. The key step in many cases has been the formation of the pyrone ring. Phenols, o-hydroxy benzaldehydes and o-hydroxy acetophenones are required precursors for preparing coumarin ring. Some of these important methods are outlined below.

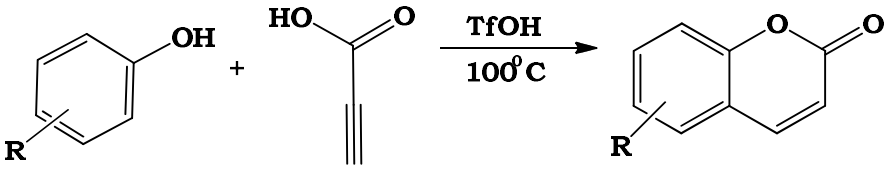
Synthesis of coumarins based on phenols:

(1) The *Pechmann* reaction[11,12] is the most well known and an important method with extensive applications. It involves reaction of phenols with β-ketoesters (ethyl acetoacetate[11] or malic acid[12]) to give variety of coumarin derivatives.

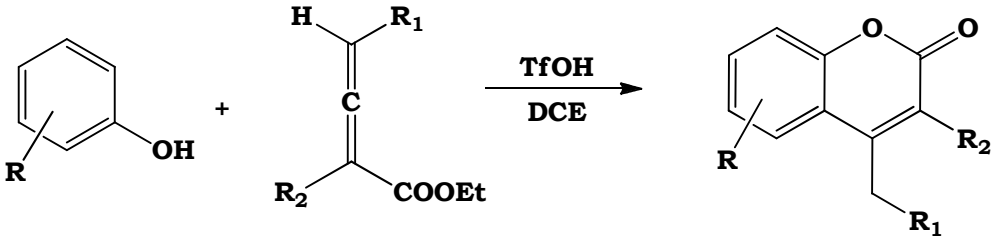


Variety of reagents have been used for this condensation and the reaction has been studied thoroughly using Lewis acid[13], ionic liquids[14], CAN[15], $HClO_4.SiO2$[16], sulfated zirconia[17], $Bi(NO_3)_3.5H_2O$[18], $FeCl_3$[19], sulfonic acid nanoreactor[20], oxalic acid[21], $ClSO_3H$[22], $TiCl_4$[23], $SnCl_2.2H_2O$[24], etc.

(2) *H. Choi et al*[25] have synthesized coumarin derivatives by condensation of substituted phenols with propiolic acid in the presence of Bronsted acid (TfOH).



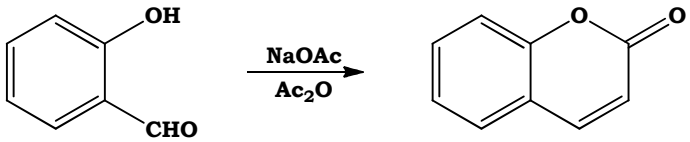
(3) *Lee et al*[26] have prepared substituted coumarins by reacting phenols with allenes in the presence of TfOH in good yield. Depending upon the substitution pattern of allenes employed, various 3,4-disubstituted coumarins have been synthesized by this versatile method.



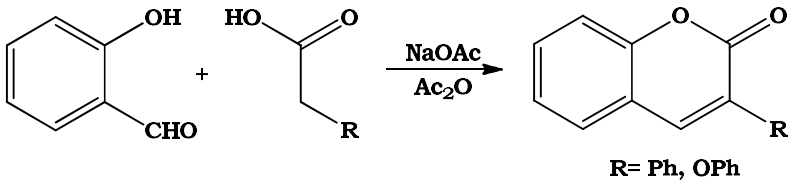
R_1, R_2 = H, Alkyl, Aryl

2.2 Synthesis of coumarins based on o-hydroxy benzaldehydes or o-hydroxy acetophenones:

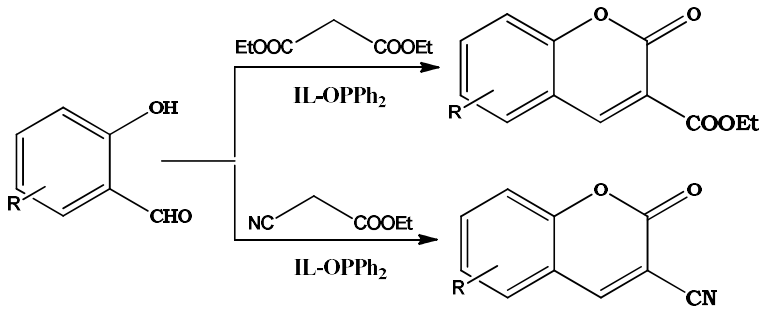
(1) The first and the foremost example of this method is the famous *Perkin reaction*[27]. In the classical reaction, salicylaldehyde is heated with acetic anhydride in the presence of sodium acetate to give coumarin.



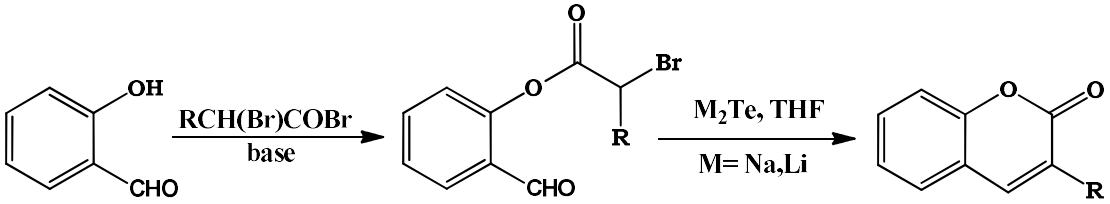
The reaction has been further extended to synthesize 3-phenyl coumarins[28] and 3-phenoxy coumarins[29].



(2) Valizadeh et al.[30] have prepared 3-carbethoxy and 3-cyno substituted coumarins by reacting salicylaldehydes with diethyl malonate or cyno ethylacetate using a task specific ionic liquid (IL, $OPPh_2$) under Knoevenagel reaction condition.

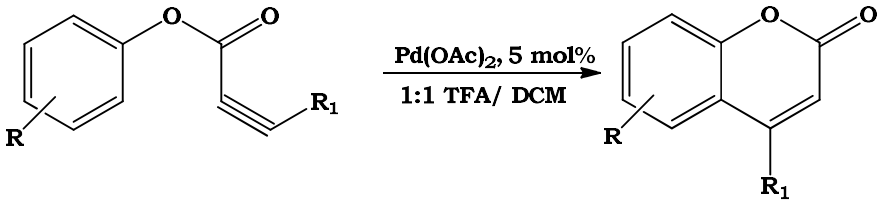


(3) Dittmer et al.[31] have achieved the sodium/lithium telluride-triggered cyclization of the bromoacetate of salicylaldehyde to coumarin via modified Reformatsky reaction.

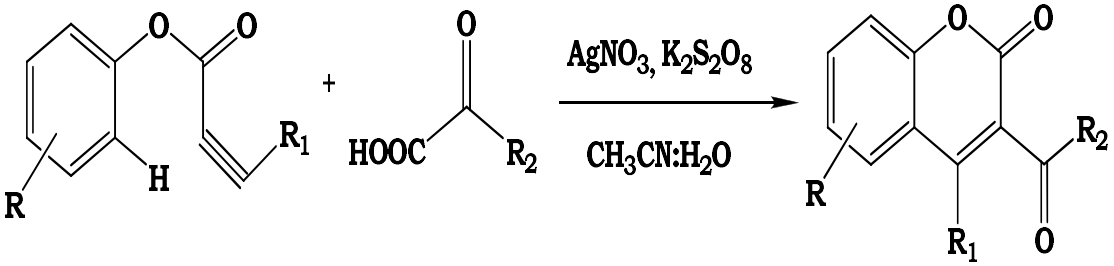


2.3 Miscellaneous preparations of coumarins

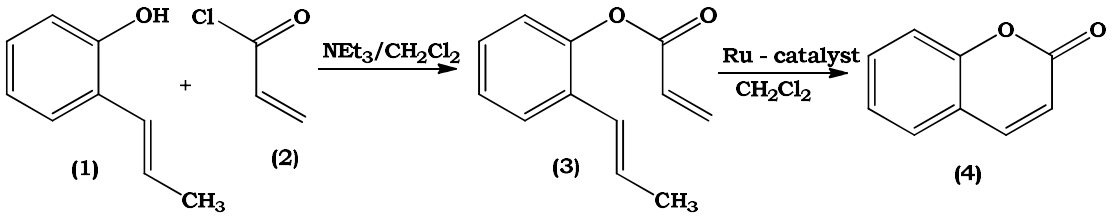
(1) A new method of synthesizing coumarins using arenes and palladium catalyst in 1:1 triflouoroacetic acid and dichloromethane is reported by *J Chengguo et al*[32] and *Kelin Li et al*[33]



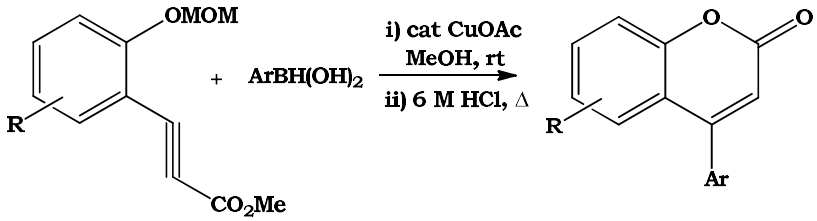
(3) A silver mediated radical cyclization method for the synthesis of coumarin derivatives via the direct difuctionalization of alkynoates with α-ketoacids through C-C double bond formation under mild condition has been developed by *Yan et al*[34].



(4) A K Chatterjee et al[35] have reported the synthesis of coumarins (4) by ring closing metathesis of (3) in the presence of second-generation ruthenium catalyst.



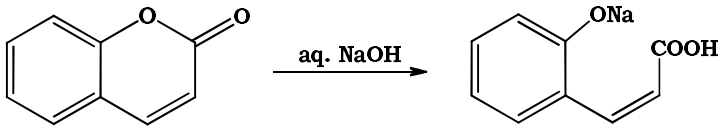
(5) Yamamoto et al[36] have documented CuOAc catalysed reaction of methyl phenyl propiolates having a MOM-protected hydroxy group at the ortho position with various arylboronic acids in MeOH at ambient temperature, resulting in the formation of 4-arylcoumarins in high yields after the acidic workup.



3. REACTIONS OF COUMARINS

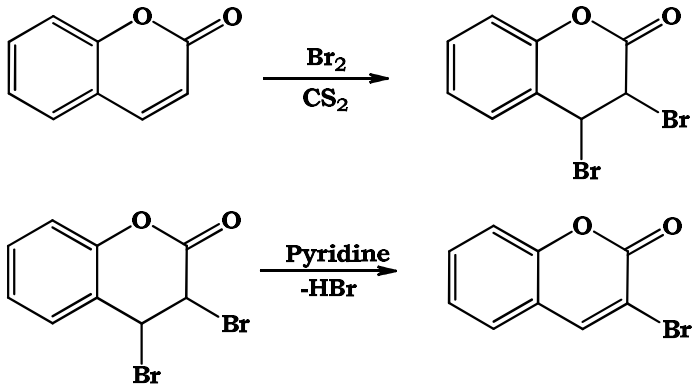
3.1 Action of alkali

All coumarins, being lactones, react with alkalies. Their reactivity towards base and the nature of products formed depends on the structure of the particular coumarin and the consistency of reaction conditions. 7-Methoxy coumarin is much harder to hydrolyze than coumarin; 7-hydroxy coumarin is still harder than 7-methoxy coumarin as it at once forms the negatively charged phenolic ion[37,38].



3.2 Halogenation

Addition of bromine to the 3,4-double bond of coumarin, followed by facile loss of hydrogen bromide gives 3-bromo coumarin[39]. The latter product can also be obtained using N-bromo succinimide.



The presence of 4-alkyl group decreases the stability of dibromide[40]. When coumarin is treated with bromine in carbon disulfide at 140°C or in the presence of iodine at 170°C it gives 3,6-dibromo coumarin and 3,6,8-tribromo coumarin respectively[41]. 4-Halogeno coumarins are made by treating 4-hydroxy coumarin with phosphorus pentahalide and this becomes the only method for introducing halogen at 4-position unless negative groups are present in the benzene ring[42].

3.3 Nitration

Coumarin on nitration gives mainly 6-nitro coumarin along with formation of 8-nitro coumarin[43]. On further nitration at 100°C, 6-nitro coumarin gives 3,6-dinitro coumarin and 8-nitro coumarin gives 6,8-

dinitro coumarin. The ease of nitration increases with introduction of alkyl groups, especially, in 4-position.

3.4 Sulphonation

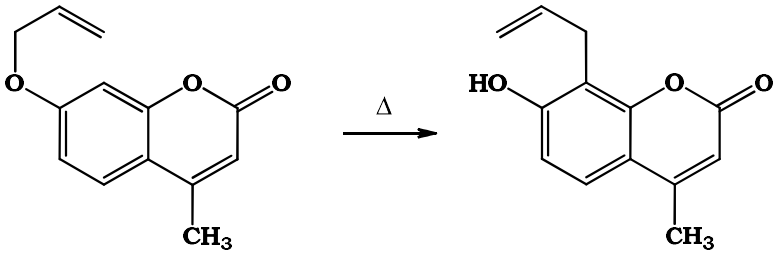
Coumarin when treated with fuming sulfuric acid at 100°C gives coumarin-6-sulphonic acid. Further reaction with fuming sulfuric acid for 1-2 hours at 150-160°C gives coumarin-3,6-disulphonic acid[44].

3.5 Fries rearrangement and Friedel-Crafts reaction

Coumarin with ketone group in the aromatic ring may be prepared directly by *Friedel-Crafts* reaction on hydroxy coumarin, or better by the *Fries* rearrangement[45]. In the 5-hydroxy coumarin series, 5-hydroxy-6-acetyl coumarins are produced, whereas 7-hydroxy coumarin gives 7-hydroxy-8-acetyl coumarin together with a little amount of 6-acetyl derivative[46-48]. If 8-position is substituted, the 6-acetyl derivative is the main product[49].

3.6 Claisen rearrangement

Coumarin with hydroxyl group in the benzene ring behaves as phenol and undergoes all the typical reactions of phenols, including *Claisen* rearrangement. 4-Methyl-7-allyloxy coumarin rearranges to 8-position[50].



4. SPECTRAL PROPERTIES OF COUMARINS

Coumarins exhibit characteristic spectral features due to their conjugated benzopyrone system, making spectroscopic techniques essential for their structural elucidation.

4.1 UV–Visible Spectroscopy

Coumarins can be distinguished from chromones by UV spectra. Chromones show absorption at 240–250 nm (log ε ≈ 3.8), while coumarins exhibit two bands at ~274 nm and ~311 nm due to benzene and pyrone rings, respectively[51]. Substituents affect these bands: methyl groups cause slight shifts, whereas hydroxyl groups produce significant bathochromic shifts depending on conjugation. For example, 7-hydroxycoumarin shows λmax at 300–325 nm, while 5,7-dihydroxycoumarin shows absorption up to ~372 nm[83].

4.2 Infrared Spectroscopy

Coumarins show a characteristic δ-lactone C=O stretching at 1720–1750 cm^{-1}[52,53], which may shift below 1700 cm^{-1} due to intramolecular hydrogen bonding (e.g., dicoumarol ~1660 cm^{-1}). Bands at 1600–1660 cm^{-1} correspond to C=C vibrations and help differentiate coumarins from chromones[54]. Methoxy groups show absorption at 1237–1272 cm^{-1}.

4.3 ^{1}H NMR Spectroscopy

The lactone ring protons C3–H and C4–H appear as doublets (J ≈ 9.5 Hz) at δ 6.1–6.4 and δ 7.5–8.3, respectively[55–57]. Substitution affects chemical shifts: electron-donating groups (e.g., C7–OH) shift C3–H upfield, while C5 substitution shifts C4–H downfield (peri effect)[58,59]. Aromatic proton patterns aid substitution assignment. Furocoumarins show characteristic doublets (J ≈ 2.5 Hz), while pyranocoumarins exhibit methyl singlets (~1.45 δ) and olefinic doublets[60–68].

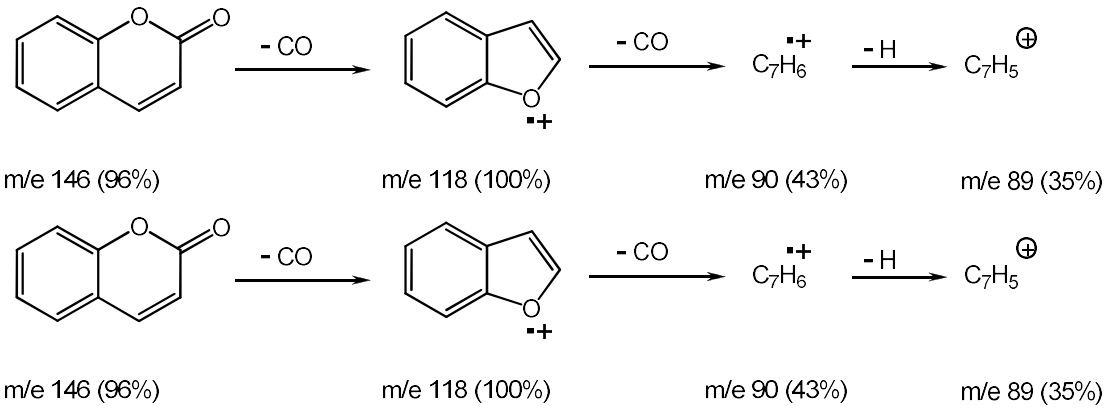
4.4 ^{13}C NMR Spectroscopy

^{13}C NMR provides detailed structural information. In coumarin, signals appear at δ ~159 (C2), 115 (C3), and 142 (C4)[69]. Substituents such as –OH and $–OCH_3$ cause characteristic shifts: quaternary

carbons move ~30 ppm downfield, while ortho and para carbons shift upfield[70–74]. Shift reagents like $TiCl_4$ further assist in assignments.

4.5 Mass Spectrometry

Coumarins show characteristic fragmentation involving loss of CO from the lactone carbonyl group, forming a benzofuran ion, which further fragments by loss of CO and hydrogen[75].



5. Medicinal and industrial applications of coumarins

Coumarin and its derivatives have gained considerable importance due to their diverse therapeutic properties. The presence of coumarins in plant extracts that have been used to treat human ailments is well known[76]. *P K Bose*[77] has reviewed the biochemical properties of natural coumarins. *W Sigmund* [78] noted the effect of both daphnetin and its isomer esculetin on seed germination. Coumarins have interesting cytogenetic properties[79]. *E Quercioli*[80] has studied cytohistological and macroscopical effects of coumarin and its derivatives. Some of the medicinally important coumarins are shown in **Chart 1**.

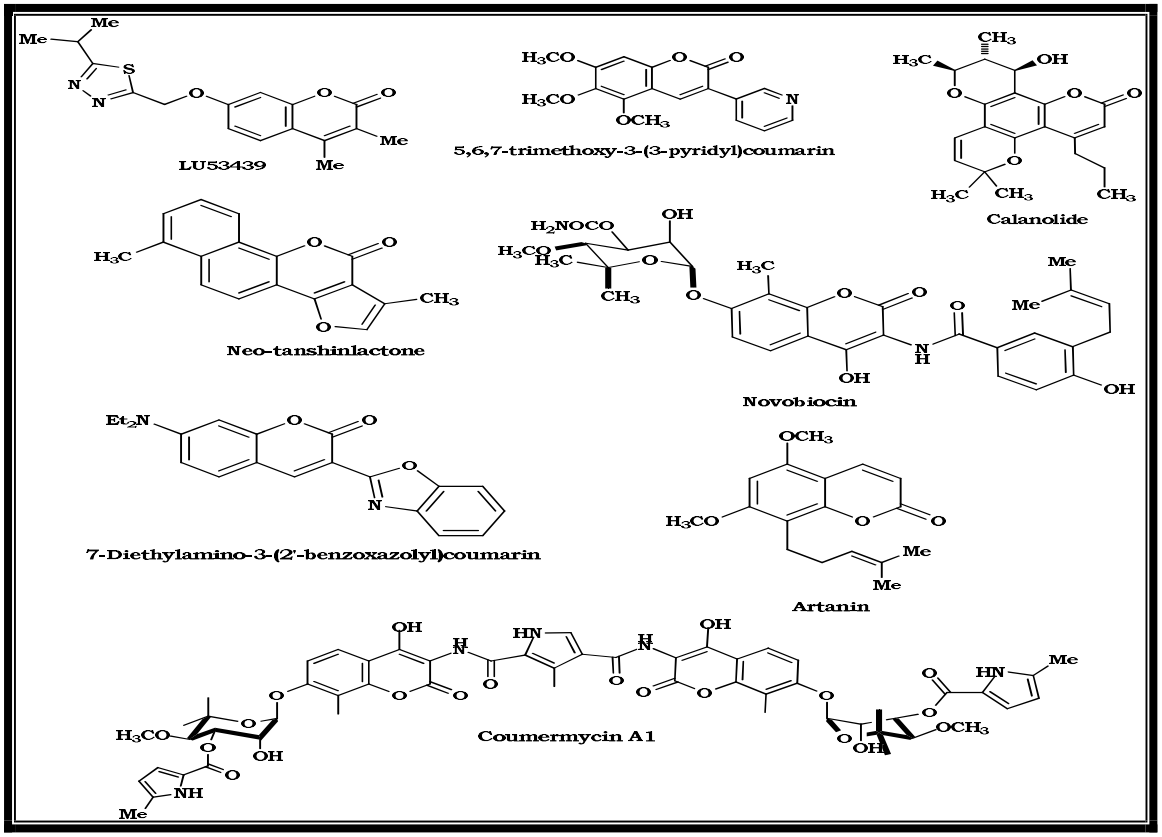


Chart 1

K P Link et al [81] isolated a hemorrhagic agent from the spoiled sweet clover which was found to be 3,3-methylene bis(4-hydroxy coumarin). This led to testing of 4-hydroxycoumarin derivatives as anticoagulant. Number of effective drugs of this 4-hydroxy coumarin group such as dicoumarol[82], warfarin[83], acenocoumarol[84], difenacoum[85], tioclomarol[86], brodifacon[87] and phenprocoumon[88] are in market. Later on *R B Arora* and *C N Mathur*[89] found that weak anticoagulant activity was shown by 3-and 4-phenyl coumarins and marked activity by one of the later namely calophyllolide. Khellactones (coumarin derivatives) are notable because of their bioactivities, including anti-HIV, antitumour[90] and anti-platelet aggregation[91].

Several natural and synthetic drugs containing coumarin scaffold are clinically well-known agents. For example, hymecromone (4-methylumbelliferone) was used as choleretic and Antispasmodic agent[92]. Scopoletin (6-methoxy-7- hydroxycoumarin) has been isolated from several plant species and has antioxidant, hepatoprotective, anti-inflammatory and antifungal properties[93,94].

Carbochromen has beneficial effect in coronary disease[95]. 4-Hydroxycoumarin derivatives acenocoumarol, phenprocoumon , warfarin,difenacoum, and brodifacoum are anticoagulant agents that act as vitamin K antagonists[96].

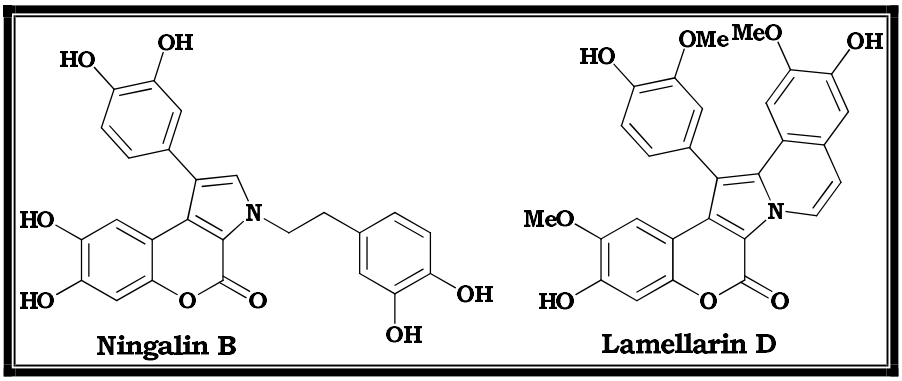
A furanocoumarin, Imperatorin obtained from methanolic extracts of dried roots of *Ferula sumbul* showed an HIV inhibitory activity[97] Imperatorin also induces vasodialation[98] via inhibiting voltage dependant Ca channels and receptors mediated Ca^{+2} influx and release.

K H Lee et al[99] isolated Neo transchinlactone, a furano coumarin derivative from the EtOH extract of S. miltiorrhiza. It was evaluated *in vitro* against several human cancer cell lines. It showed significant inhibition against two ER+ human breast cancer cell lines. Another novel furanocoumarin derivative, 8-benzoyl-4,9-dimethyl angelicin was identified by *H P Hsieh et al*[100] to inhibit influenza A (H1N1) virus induced cytopathic effect in Madin-Darby canine kidney cell culture and act as an anti influenza agent by inhibiting ribonucleoprotein complex associated activity. Osthole from *Ferulago campestris* plant exhibited cytotoxic activity against the lung cancer cell line and breast cancer cells by wound healing and transwell assays[101]. 3''-Demethylchartreusin is a novel antitumor and antibiotic produced by *Streptomyces chartreusis*[102]. Esculetin also exhibited antitumor activities[103]. *Lee et al*[104] reported that neotanshinlactone, a coumarin derivative showed significant inhibition against human breast cancer cell lines and was 10-fold more potent and 20-fold more selective than Tamoxifen. *Paul et al*[105] have developed new series of coumarin-benzimidazole hybrid displaying appreciable anticancer activities against leukemia, colon cancer and breast cancer cell lines. *R C Elderfield* and *J Roy*[106] have synthesized nitrogen mustards from 6-substituted coumarins as potential anticancer agents.

The antibacterial properties of coumarins were first recognized in 1945, when *Goth et al* conducted an investigation with dicoumarol and it was found to inhibit the growth of several strains of bacteria[107]. It has been well known that naturally occurring amino coumarins class of antibiotics novobiocin, clorobiocin and coumermycin A_1 are potential inhibitors of DNA gyrase, an essential enzyme in bacteria[108]. The clinical use of this antibiotic class has been restricted due to the low water solubility, low activity against gram negative bacteria[109] and toxiciy *in vivo* of this class of antibiotics[110]. *Shi et al*[111] developed coumarin–triazole hybrids having antimicrobial activity

against gram-positive, gram-negative bacteria as well as some fungi. Another coumarin derivative, coumarin-trioxane hybrid, active against *Plasmodium falciparum* strains was reported by *Shashidhara et al*[112]. Recently some new pyridyl substituted coumarin derivatives having potential antimicrobial profile have been synthesized from our laboratory[113].

Pyrrolocoumarins occur in a variety of natural products and have considerable pharmacological applications. A chromeno[3,4-b]pyrrol-4(3*H*)-one core structure occurs, for example, in the marine alkaloids Ningalin B and Lamellarin D which exhibit HIV-1 integrase inhibition, immunomodulatory activity and cytotoxicity[114].



Coumarleucasin was isolated from the acetone extracts of the roots of *Leucas inflate* and Calophyllolide was isolated from the alcoholic extracts of the nuts of *Calophyllum inophyllum*. Both are reported to have a potent anti-inflammatory properties[115,116].

The aerial parts of *Heterotheca inuloides* plant is used in folk medicine for the topical treatment of skin wounds and injuries[117]. 7-(3,3-Dimethylallyloxy coumarin was found as one of the components of the extract of the aerial parts of this plant.

Novobiocin is a natural product isolated from soil samples containing Streptomyces spheroids[118] and has clinical use for the treatment of bacterial infection[119,120] and more recently some forms of cancer[121]. *Neckers* and coworkers proposed that novobiocin also possess anti-tumor activity[123]. *S G Tsodikova et al*[124] reported that amino coumarin antibiotics clorobiocin and coumermycin A1, along with novobiocin are highly potent inhibitors of the bacterial type 2 topoisomerase DNA gyrase.

Sohini Sinha et al[125] have introduced a series of coumarin based target specific probes for cancer theranostic application which play a dual role in the field of both diagnosis and therapy. A fluorogenic version of 1,3-dipolar cycloaddition between azides and alkynes (DBCO) has been introduced to develop the triazolylcoumarin based fluorescent scaffolds. These scaffolds were screened for their anticancer activity against breast cancer (MCF7) and human epitheloid cervix carcinoma (HeLa) cell line.

Certain metal complexes of coumarin are also reported to have various medicinal and industrial applications. *I Kostova et al*[126] have reported lanthanide complexes of 4-methyl-7-hydroxycoumarin. These complexes have been reported for their good cytotoxic activity against transformed leukemic cell lines (P3HR1 & THP-1). *I Manolov et al*[127] have reported cytotoxic

screening of new complexes of cerium, lanthanum and neodymium with niffcoumar (4-hydroxy-3-[1-(4-nitro phenyl)-3-oxobutyl]-coumarin) sodium salt. *S-G Roh et al*[128] have reported luminescent lanthanide complexes based on coumarin-3-carboxylic acid for advanced photonic applications such as planar waveguide amplifier and light emitting diodes.

6. CONCLUSION

Coumarins continue to bridge natural and synthetic chemistry with evolving relevance in drug design and advanced material development. Modern synthetic adaptations of classical reactions, driven by sustainable chemistry, have expanded accessibility to functional coumarins with diverse bioactivities and photophysical roles. Their future development lies at the intersection of synthetic innovation, biological insight, and computational chemistry.

Spectroscopic analysis remains an indispensable tool in elucidating coumarin structure and its derivatives. Substituent effects, particularly involving heteroatoms or ring fusion, profoundly influence electronic transitions, vibrational frequencies, and chemical shifts. These features correlate directly with the optical, electronic, and pharmacological properties of coumarin-based compounds, making them vital in designing new therapeutic agents and fluorescent materials.

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CYBER FRAUDS IN THE AGE OF AI: IMPACTS, VULNERABILITIES, AND A SENIOR-CENTRIC PREVENTION FRAMEWORK - A GLOBAL REVIEW WITH SPECIAL REFERENCE TO INDIA

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ABSTRACT

Artificial intelligence (AI) is fundamentally transforming the landscape of cyber fraud by enhancing both defensive capabilities and offensive deception techniques. While AI improves fraud analytics and anomaly detection, it also gives attackers the ability to automate persuasion, assume trusted identities, and carry out highly customized frauds on a large scale. Because AI has two uses, cybercrime has become much more sophisticated, widespread, and successful. Senior citizens, who rely more and more on digital platforms for financial transactions, communication, and basic services, are especially vulnerable to these developments. Digital systems frequently lack age-inclusive security design, sufficient scam awareness tools, and quick reaction support despite this increasing reliance. Because of this, older persons are more susceptible to new types of fraud, such as voice-based deception, phishing, impersonation, deepfakes, and trust exploitation. This study looks at how AI is changing cybercrime that targets older people and makes the case that the lack of human-centered protection frameworks is a bigger problem than technical detection flaws. To identify critical weaknesses, new threats, and research gaps, the study adopts a global approach with reference to India and incorporates ideas from cybersecurity, ageing studies, psychology, human-computer interaction, and public policy. Additionally, it suggests a Senior-Centric AI Fraud Prevention Framework that integrates policy-community cooperation, behavioral analysis, explainable alarms, AI-driven detection, monitoring, and quick mitigation. In the end, the report emphasizes that in addition to cutting-edge technologies, inclusive system design, greater institutional backing, and an understanding of trust as a crucial attack surface are all necessary for effective defence in the AI era.

KEYWORDS: ARTIFICIAL INTELLIGENCE (AI), CYBER FRAUD, SENIOR CITIZENS, PHISHING, DEEPFAKES, VOICE CLONING, INDIA, CYBERSECURITY, EXPLAINABLE AI

1. INTRODUCTION

In the age of artificial intelligence, cyber fraud has reached a new phase, distinguished not only by larger scales, but also by greater realism, speed, and psychological precision. What was formerly associated with crude phishing emails and apparent impersonation attempts is now being driven by systems capable of producing convincing text, cloning familiar voices, fabricating visual proof, and adapting scam scripts in real time. Global risk assessments now address cyber-enabled fraud as a systemic issue rather than a minor inconvenience, highlighting the convergence of data theft, impersonation, organized criminal networks, and AI-assisted social engineering (Europol, 2025; WEF, 2025).

This transition is especially important for senior persons. Older persons are increasingly expected to use digital banking, messaging platforms, telemedicine systems, and online service portals, yet these settings are rarely structured to accommodate the reality of ageing. Slower information

processing, uneven digital literacy, increased dependence on familiar voices or institutional authority, and social isolation can all influence how deception is seen and responded to. In 2024, the FBI claimed that consumers over 60 filed more than 147,000 complaints and lost almost $4.8 billion, the most documented losses of any age group (FBI, 2024). These findings should not be interpreted solely as evidence that seniors are "less careful." Rather, they demonstrate a widening disparity between the sophistication of AI-enabled fraud and the design of systems intended to protect vulnerable consumers.

According to this study, AI's most significant change is relational rather than technical. Fraud is increasingly working via impersonating trust: a bank message that appears authentic, a voice that sounds like family, or an authoritative figure that appears procedurally credible. When trust gets simpler to fake, traditional security advice like "be cautious" or "look for warning signs" becomes less effective. A comprehensive analysis must therefore go beyond simply listing fraud types. It must synthesize how the technological, behavioural, and policy literatures all point to a more human-centered protective framework for older persons.

2. LITERATURE REVIEW: FRAUD, AGEING, AND DIGITAL VULNERABILITY

The literature on fraud among older persons is substantial yet fragmented across various fields. According to research in gerontology and psychology, fraud susceptibility is not solely determined by age. James et al. (2014) and Han et al. (2016) found that vulnerability is influenced by cognitive capacity, financial literacy, social environment, and behavioural factors. This viewpoint changes the emphasis from age-based stereotypes to a more sophisticated understanding of decision-making under ambiguity.

A second stream of research looks at digital fraud broadly, emphasizing impact over frequency. Kemp et al. (2023) claim that, while older persons are not the most common victims, they face more severe repercussions, such as bigger financial losses and slower recovery. This underlines the importance of prioritizing harm minimization beyond attack frequency.

The final stream discusses phishing and online fraud. According to studies by Grilli et al. (2020) and Lin et al. (2019), older people may have a more difficult time discriminating between legal and fraudulent communications, particularly when messages exploit trust, urgency, or familiarity. These findings indicate that standard awareness measures are insufficient, and that simpler, user-centered preventive mechanisms are required. More recent research investigates AI-enabled fraud, such as deepfakes and vocal impersonation. Zhai et al. (2025) show that such technologies undercut traditional indicators of authenticity such as voice and facial recognition. Importantly, older persons frequently rely on family members for verification, implying that trusted-contact systems should be incorporated into fraud protection strategies.

Overall, the literature reveals a lack of integration across domains. While behavioural studies explain vulnerability, cybersecurity research focuses on attack methods, and human-computer interaction research proposes usability solutions, there has been little work combining these insights into a unified framework tailored for older adults, especially in rapidly digitizing contexts such as India. Recent data trends emphasize the urgency of this issue. Cyber fraud has expanded dramatically since 2020, owing to the rapid deployment of digital technology during the COVID-19

timeframe. In India, NCRP and CFCFRMS statistics reveal a significant increase in both complaints and financial losses, with losses expanding at a faster rate than complaint counts. This shows not only increased vulnerability but also a higher severity of fraud instances, particularly among vulnerable populations such as seniors.

3. HOW AI CHANGED THE FRAUD LANDSCAPE

Because artificial intelligence (AI) lowers hurdles for attackers while enabling tailored, realistic, and adaptable frauds, cyber-crime has increased. Fraud has moved from obvious indicators to social interactions dependent on trust. Because convincing impersonation takes use of emotional weaknesses, this is especially dangerous for senior individuals, underscoring the need for system-level protective measures and rendering typical awareness strategies inadequate.

4. WHY THE INDIAN CONTEXT MATTERS

India is a crucial example because of its aging population and quick adoption of digital technology, which makes it more vulnerable to cybercrime. Large-scale effects are indicated by official data, necessitating a coordinated institutional response. Because trust and anxiety are frequently exploited by authority-based scams, it is crucial to put in place quick, easily accessible, and culturally sensitive safeguards for senior individuals.

5. GROWTH TRENDS AND THE ESCALATION OF RISK

Even though not all data points are directly comparable across countries and reporting systems, the overall pattern since 2020 is obvious. The COVID-19 period accelerated digital dependence, increasing exposure to phishing, impersonation, and online financial scams. By 2024, official U.S. elder-fraud reporting showed a significant increase in losses among adults over the age of 60, while global policy and industry evaluations progressively identified internet-enabled fraud as one of the most dangerous types of modern cyber risk. In India, official responses such as fast fund freezing and complaint escalation highlight the scope and gravity of the situation (PIB, 2026). **Figure 1** depicts the growth in cyber fraud affecting elderly adults from 2020 to 2026, using official elder-fraud data and evaluated trend sources (FBI, 2024; PIB, 2026; WEF, 2025).

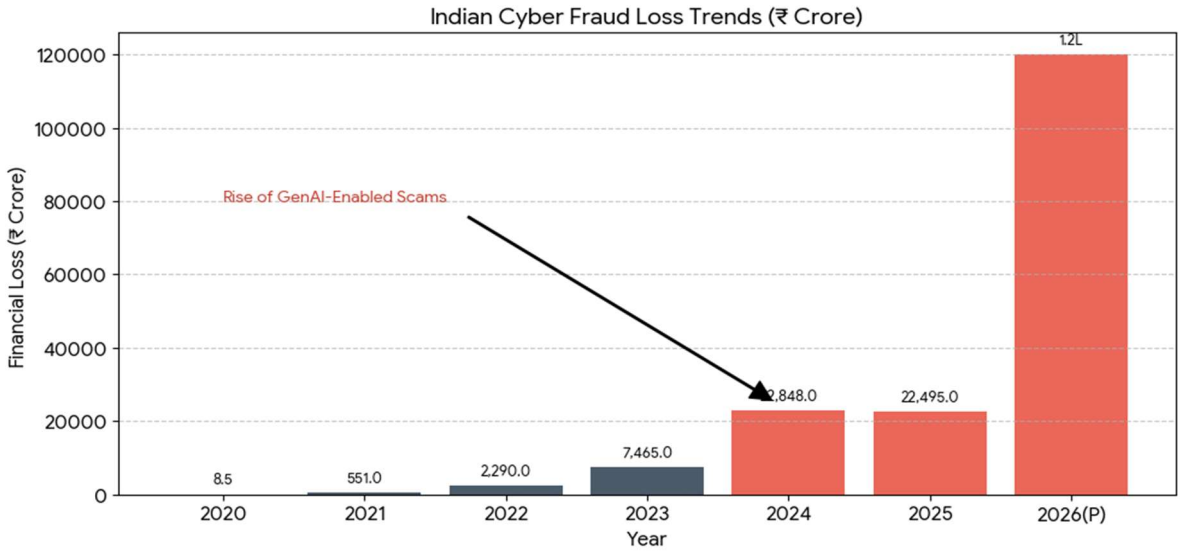


Figure – 1 Growth of Cyber Fraud Targeting Senior Citizens

The statistics are not meant to ensure exact precision across datasets, but to highlight a clear trend—cybercrime targeting seniors is rising in visibility, cost, and AI involvement. The figure complements, rather than replaces, the literature.

FINANCIAL FRAUD AND COMPLAINTS IN INDIA

According to the National Cyber Crime Reporting Portal (NCRP) and Citizen Financial Cyber Fraud Reporting and Management System (CFCFRMS) run by the Indian Cyber Crime Coordination Centre (I4C), the total sum reported by citizens owing to cyber fraud from 2021 to 2025 is depicted in **figure 2**:

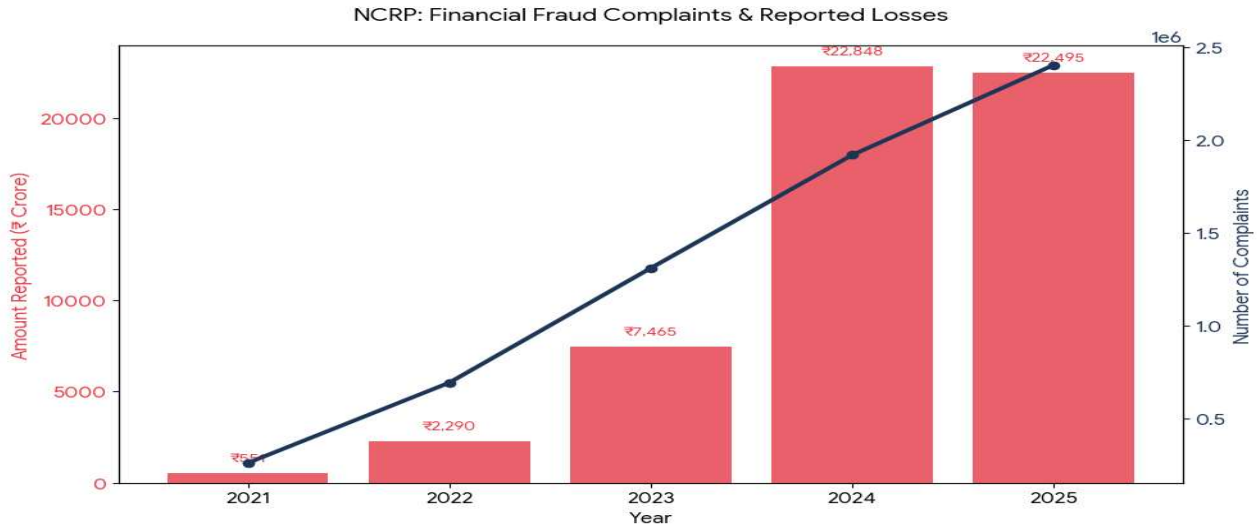


Figure: 2 NCRP: Financial fraud complaints and reported losses

Year	Number of financial frauds complaints on NCRP	Amount Reported (₹ In Crore)
2021	2,62,846	551
2022	6,94,446	2290
2023	13,10,357	7465
2024	19,18,835	22848
2025	24,02,579	22495

FINANCIAL LOSS DUE TO FRAUD IN INDIA

Figure – 3 represents, financial losses reported between 2021 and 2024 surged by 41 times in four years compared to 2021, from 551 crore to 22,848 crore. Complaints increased by ~623%, from 262,846 to over 1.9 million, showing increased victimization and public awareness of reporting options.

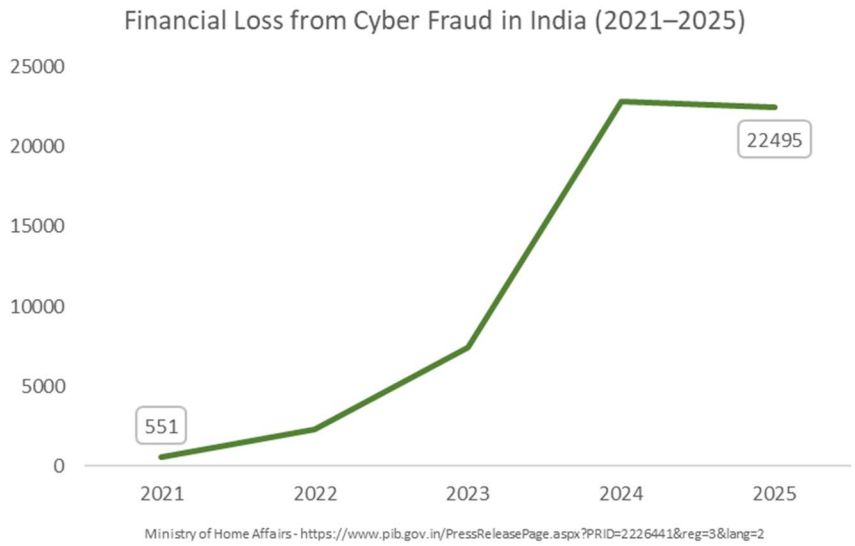


Figure-3 Financial loss due to fraud in India

THE CONTRAST BETWEEN TRENDS OF FRAUD AND COMPLAINT

Despite a significant rise in complaints (7x), financial losses expanded disproportionately, growing nearly six times faster. This trend reflects increasing severity and higher monetary impact per reported fraud case.

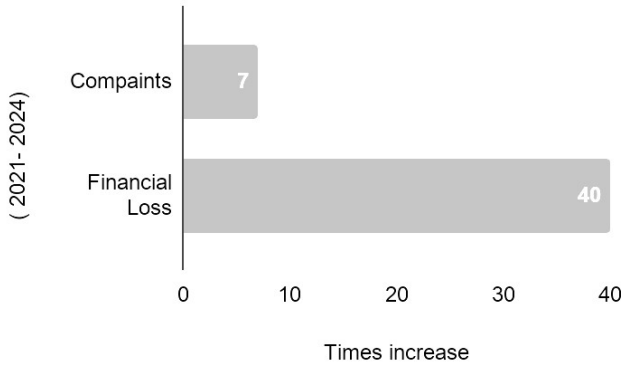


Figure-4 contrast between trends of fraud and complaint

Through figure – 4, the data reveal a significant divergence between complaint volume and financial impact from 2021 to 2024. While complaints increased by approximately seven times (≈600%), financial losses rose much more sharply, by nearly forty times (≈3,900%), indicating a substantial escalation in the severity of cyber fraud incidents.

6. RESEARCH GAP

There are still a lot of unanswered questions regarding fraud that affects senior citizens. Human-computer interaction suggests usability improvements, cybersecurity concentrates on attack methods, and gerontology explains vulnerability. Existing research is dispersed among disciplines. Nevertheless, there is little integration of various viewpoints into a cohesive, useful framework created especially for senior citizens. Furthermore, there is not enough focus on creating straightforward, user-centric protective systems that lessen cognitive burden, despite earlier studies highlighting elements including cognitive decline, financial literacy, and behavioral tendencies. In the context of elder users' real-world coping mechanisms, such relying on trusted

contacts, emerging concerns like AI-enabled fraud (deepfakes and voice impersonation) are similarly understudied.

Furthermore, there is a dearth of context-specific studies in fast digitizing nations like India, where distinct risks are caused by multilingual surroundings, varying levels of digital literacy, and changing financial systems. There is no study connecting these trends to specialized prevention frameworks for elderly adults, despite the fact that current data indicates a dramatic increase in fraud instances and financial losses, particularly after 2020. All things considered, the main gap is the lack of an integrated, flexible, and context-aware framework for preventing fraud that incorporates behavioural insights, technology protections, and social support networks for senior citizens.

7. SENIOR-CENTRIC AI FRAUD PREVENTION FRAMEWORK (SCAFPF) - THE PROPOSED FRAMEWORK

To bridge mentioned gap, this article presents the Senior-Centric AI Fraud Prevention Framework (SCAFPF). The framework is conceptual rather than experimentally tested, although it is based on the studied literature and the practical reality of fraud detection.

Figure 5 depict Senior-Centric AI Fraud Prevention Framework (SCAFPF), a layered conceptual model integrating monitoring, AI detection, behavioural analysis, explainable interfaces, response mechanisms, and policy-community coordination.

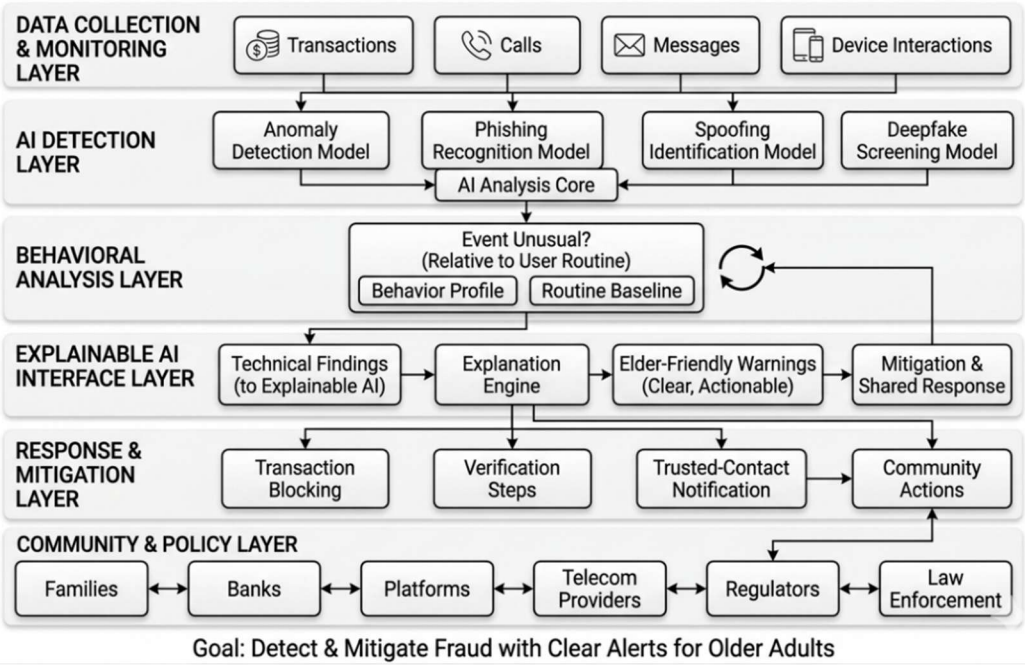


Figure-5 Senior-Centric AI Fraud Prevention Framework (SCAFPF)

The framework has six layers. The data collecting and monitoring layer collects signals from transactions, calls, messages, and device interactions. The AI detection layer uses models to detect anomalies, recognize phishing, identify spoofing, and screen for deepfakes. The behavioural analysis layer determines whether an occurrence is uncommon in comparison to the user's normal routine, which is especially crucial because fraud frequently begins with a change in behaviour. The

explainable AI interface layer transforms technical discoveries into understandable, actionable warnings that older folks can rapidly grasp. The reaction and mitigation layer connects alarms to immediate actions such as transaction blocking, verification steps, and trusted-contact notifications. Finally, the community and policy layers acknowledge that fraud protection for seniors is a shared obligation among families, banks, platforms, telecom providers, regulators, and law enforcement.

The framework's primary contribution is not the assertion that any single layer is innovative in isolation, but rather that senior protection necessitates that various layers collaborate. Technical detection without usability may be overlooked. Clear warnings without escalation channels may be too late. Institutional systems without user-friendly interfaces may stay underutilized. The paradigm thus repositions fraud prevention as a socio-technology design problem rather than a simply technological filtering one.

8. DISCUSSION

This paper contends that the future of elder cyber protection is dependent on a shift in mentality. Much of today's conversation still implies that end users are primarily responsible for safer behaviour. However, when AI can replicate trustworthy identities and create convincing urgency on a large scale, elders cannot bear the entire load. The more pertinent topic is how systems can lessen the amount of judgment necessary in times of crisis. That is why explainability, trust networks, and swift responsiveness are critical. Older folks gain not only from being aware that something is strange, but also from understanding what to do next and who to believe. In India, this might include multilingual notifications, closer interaction with complaint and fund-freezing systems, and more awareness of authority-based scams. More broadly, it entails structuring fraud prevention on actual human vulnerability rather than idealized user logic.

9. IMPLEMENTATION CHALLENGES FOR SCAFPF

To address the staggering 3,900% surge in financial loss despite a smaller rise in complaint volume, implementing the "Six-Layer" framework faces several high-stakes hurdles. The primary challenges revolve around the speed and sophistication of modern fraud compared to the slower pace of traditional elder-friendly systems.

Implementing the Six-Layer Framework to counteract these presents three major challenges: first, the "AI Detection Layer" fails to detect complicated "Deepfakes" in real time before funds leave the account. Second, Elder-Friendly Warnings must be clear enough to work during a crisis without causing "alert fatigue" or accidental lockouts. Third, stopping a 3,900% loss surge requires banks, telecommunications companies, and law enforcement to share data instantly, which is frequently hampered by privacy laws and disagreements over who is legally liable for the stolen funds.

10. CONCLUSION

In the AI era, the rising replication of trust signals has redefined cyber fraud, changing how deceit is created and perceived. Due to cognitive aging, system design constraints, and evolving fraud techniques, older persons are especially vulnerable; these issues are made worse in India's quickly digitizing environment. This study highlights the necessity of combined human-centric and technical defences while introducing the SCAFPF framework based on interdisciplinary ideas.

The main contribution of this study is thus twofold. First, it compiles a diverse set of information into a cohesive narrative about why older persons are disproportionately harmed in AI-enabled fraud situations. Second, it suggests the Senior-Centric AI Fraud Prevention Framework (SCAFPF) as a better conceptual model for senior protection, combining monitoring, detection, behavioural insight, explainability, mitigation, and policy-community cooperation. Simply put, protecting older individuals in the AI era will necessitate both better and more humane solutions.

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IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGY ON MODERN EDUCATION SYSTEMS

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ABSTRACT:

The rapid advancement of **Information and Communication Technology (ICT)** has significantly transformed modern education systems across the globe. This research paper examines the multifaceted impact of ICT on teaching, learning, administration, and educational accessibility. ICT encompasses a wide range of digital tools and technologies, including computers, the internet, mobile devices, and online learning platforms, all of which contribute to enhancing the educational experience.

The integration of ICT in education has led to a shift from traditional teacher-centered approaches to more student-centered, interactive, and collaborative learning environments. Digital tools enable personalized learning, allowing students to access educational content at their own pace and according to their individual needs. Furthermore, ICT facilitates distance education and e-learning, breaking geographical barriers and making education more inclusive and accessible.

However, despite its numerous advantages, the implementation of ICT in education also presents several challenges. These include inadequate infrastructure, lack of technical expertise among educators, high costs of technology adoption, and issues related to cybersecurity and data privacy. Additionally, the digital divide between urban and rural areas continues to limit equal access to ICT-based education.

This paper adopts a descriptive and theoretical approach to analyze the role of ICT in modern education systems. It explores key concepts, benefits, limitations, and future trends associated with ICT integration. The study concludes that while ICT has the potential to revolutionize education, its effective implementation requires proper planning, investment, and policy support.

KEYWORDS: INFORMATION AND COMMUNICATION TECHNOLOGY, E-LEARNING, DIGITAL EDUCATION, SMART CLASSROOMS, ONLINE LEARNING, EDUCATIONAL TECHNOLOGY, DIGITAL DIVIDE

1. INTRODUCTION:

In recent decades, the integration of **Information and Communication Technology (ICT)** into education has brought significant changes to how knowledge is delivered and acquired. Traditional education systems, which relied heavily on textbooks and face-to-face instruction, are increasingly being replaced or supplemented by digital tools and online resources.

Modern education systems aim to prepare students for a rapidly evolving digital world. ICT plays a crucial role in this transformation by providing innovative teaching methods, improving access to information, and enhancing communication between educators and learners. Technologies such as learning management systems, virtual classrooms, and multimedia tools have become essential components of contemporary education.

The COVID-19 pandemic further accelerated the adoption of ICT in education, highlighting its importance in ensuring continuity of learning. Platforms like Zoom and Google Classroom became widely used for remote teaching, demonstrating the effectiveness of digital learning environments. This research paper explores the impact of ICT on modern education systems through a descriptive and theoretical lens. It examines the benefits, challenges, and future prospects of ICT integration in education.

2. CONCEPTUAL FRAMEWORK OF ICT IN EDUCATION:

ICT in education refers to the use of digital technologies to support teaching, learning, and administrative processes. It includes:

Hardware: Computers, tablets, smartboards

Software: Educational applications, LMS platforms

Connectivity: Internet and communication networks

Digital Content: E-books, videos, online courses

Theoretical Foundations

Several learning theories support ICT integration:

Constructivism

Learners actively construct knowledge through interaction with digital tools.

Connectivism

Learning occurs through networks and digital connections.

Behaviorism

ICT tools reinforce learning through feedback and repetition.

These theories highlight the importance of technology in enhancing the learning process.

3. IMPACT OF ICT ON TEACHING AND LEARNING:

3.1 Student-Centered Learning

ICT promotes active learning by shifting focus from teachers to students. Learners engage with multimedia content, simulations, and interactive tools, improving understanding and retention.

3.2 Personalized Learning

Students can learn at their own pace using online platforms. Adaptive learning technologies analyze performance and provide customized content.

3.3 Collaborative Learning

ICT tools enable collaboration through discussion forums, video conferencing, and group projects, even across geographical boundaries.

3.4 Access to Information

The internet provides vast educational resources, including research papers, tutorials, and digital libraries, making learning more comprehensive.

4. ROLE OF ICT IN EDUCATIONAL ADMINISTRATION:

ICT improves efficiency in administrative tasks such as:

Student record management

Online admissions

Attendance tracking

Communication with stakeholders

Educational institutions use management systems to streamline operations and reduce manual workload.

5. ADVANTAGES OF ICT IN EDUCATION:

5.1 Improved Learning Outcomes

Interactive content enhances understanding and retention.

5.2 Accessibility and Flexibility

Students can access learning materials anytime and anywhere.

5.3 Cost Efficiency

Digital resources reduce the need for physical materials.

5.4 Skill Development

ICT helps students develop digital literacy, critical thinking, and problem-solving skills.

6. CHALLENGES OF ICT IN EDUCATION:

Despite the numerous benefits of **Information and Communication Technology (ICT)** in education, its implementation faces several significant challenges that hinder its effectiveness and widespread adoption.

6.1 Digital Divide

Unequal access to technology creates disparities between students, particularly between urban and rural areas. Students from economically weaker backgrounds often lack access to devices such as computers, smartphones, and reliable internet connections. This inequality limits their ability to participate in digital learning and widens the educational gap.

6.2 Lack of Infrastructure

Many educational institutions, especially in developing regions, lack essential infrastructure such as computer labs, high-speed internet, and uninterrupted electricity. Without proper facilities, the integration of ICT into the education system becomes difficult and ineffective.

6.3 Teacher Training

Educators often lack the necessary technical skills and training to effectively use ICT tools in teaching. Many teachers are unfamiliar with digital platforms, software, and modern teaching methodologies, which reduces the potential impact of ICT in classrooms. Continuous professional development is required to address this issue.

6.4 Security and Privacy Issues

The use of ICT exposes educational systems to cybersecurity risks such as data breaches, hacking, and identity theft. Protecting sensitive student and institutional data is a major concern. Additionally, issues related to online privacy and safe internet usage must be addressed.

6.5 Resistance to Change

Some educators and institutions resist adopting ICT due to fear of technology, lack of confidence, or preference for traditional teaching methods. This resistance slows down the digital transformation of education.

6.6 High Implementation Costs

The adoption of ICT requires significant financial investment in hardware, software, maintenance, and training. Many institutions, particularly in developing countries, struggle to afford these costs, limiting ICT adoption.

6.7 Technical Issues and Maintenance

Frequent technical problems such as system failures, software bugs, and network disruptions can interrupt the learning process. Additionally, lack of proper maintenance and technical support further complicates the use of ICT.

6.8 Distraction and Misuse of Technology

Students may misuse digital devices for non-educational purposes such as social media, gaming, or entertainment. This can reduce concentration and negatively impact academic performance.

6.9 Limited Digital Literacy

Not all students and teachers possess the necessary digital skills to effectively use ICT tools. Limited digital literacy can hinder the proper utilization of technology in education.

6.10 Content Quality and Relevance

Not all online educational content is accurate, reliable, or aligned with curriculum standards. Poor-quality content can mislead students and affect learning outcomes.

6.11 Language and Accessibility Barriers

Much of the digital content is available in limited languages, often excluding non-English speakers. Additionally, ICT tools may not always be accessible to students with disabilities, creating further barriers to inclusive education.

6.12 Overdependence on Technology

Excessive reliance on ICT may reduce critical thinking and face-to-face interaction among students. It may also lead to reduced traditional learning skills such as handwriting and direct communication.

7. ICT IN DISTANCE AND ONLINE EDUCATION:

ICT enables remote learning through:
Virtual classrooms
Online assessments
Digital collaboration tools
This has made education accessible to students in remote areas and working professionals.

8. EMERGING TRENDS IN ICT AND EDUCATION:

8.1 Artificial Intelligence

AI enhances personalized learning and automated assessment.

8.2 Virtual Reality (VR)

Provides immersive learning experiences.

8.3 Cloud Computing

Facilitates storage and access to educational resources.

8.4 Mobile Learning

Smartphones enable learning on the go.

9. FUTURE PROSPECTS:

The future of ICT in education includes:
Smart classrooms
Global learning networks
Increased use of AI and automation
Greater emphasis on digital skills
Governments and institutions must invest in infrastructure and training to maximize ICT benefits.

10. CONCLUSION:

The integration of **Information and Communication Technology** has fundamentally transformed modern education systems. It has improved accessibility, enhanced learning experiences, and prepared students for the digital age. However, challenges such as the digital divide, lack of infrastructure, and insufficient training must be addressed.

Effective implementation of ICT requires collaboration between governments, educators, and technology providers. With proper strategies and investments, ICT can revolutionize education and create more inclusive and efficient learning environments.

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DNA PROFILING AND CRIMINAL JUSTICE SYSTEM IN INDIA: A CRITICAL LEGAL ANALYSIS

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PRACTICING ADVOCATE

ABSTRACT

The integration of scientific techniques into the administration of justice has transformed the evidentiary landscape of criminal law. Among such innovations, **DNA profiling** stands as a revolutionary tool that ensures precision, objectivity, and reliability in identifying individuals. In India, the growing reliance on DNA evidence reflects a paradigm shift from traditional testimonial evidence to scientifically verifiable proof.

This research paper critically examines the role of DNA profiling in the Indian criminal justice system, focusing on its legal admissibility, judicial interpretation, and constitutional implications. The study analyzes landmark judicial pronouncements, statutory provisions under the **Bharatiya Sakshya Adhiniyam, 2023**, and procedural laws, while also addressing key concerns such as **privacy, consent, and misuse of genetic data**.

The paper argues that while DNA profiling strengthens the justice delivery mechanism by minimizing wrongful convictions and enhancing investigative efficiency, the absence of a comprehensive regulatory framework poses significant risks. Therefore, a balanced approach that harmonizes scientific advancement with constitutional safeguards is essential for the ethical and effective use of DNA technology in India.

KEYWORDS: DNA PROFILING, FORENSIC SCIENCE, CRIMINAL JUSTICE, EVIDENCE LAW, PRIVACY, BHARATIYA SAKSHYA ADHINIYAM, ARTICLE 21, JUDICIAL APPROACH

I. INTRODUCTION

The modern criminal justice system is witnessing an unprecedented transformation driven by scientific advancements. Among these, **DNA profiling** has emerged as a cornerstone of forensic investigation, offering unparalleled accuracy in identifying individuals. It represents a shift from subjective forms of evidence, such as eyewitness testimony, to **objective, scientific, and verifiable proof**.

In India, where the criminal justice system often grapples with delays, wrongful convictions, and evidentiary inconsistencies, DNA profiling provides a beacon of hope. It not only aids in securing convictions but also plays a crucial role in **exonerating the innocent**, thereby upholding the fundamental principle that "justice must not only be done but must also be seen to be done."

However, the growing reliance on DNA evidence raises critical legal and ethical questions. Can the State compel an individual to provide DNA samples? Does the storage of genetic data violate the **right to privacy under Article 21**? Is the existing legal framework sufficient to regulate such a powerful tool? These questions form the foundation of the present study.

II. CONCEPTUAL FRAMEWORK OF DNA PROFILING

DNA profiling, also known as DNA fingerprinting, is a scientific technique used to identify individuals based on their unique genetic characteristics. The process involves extraction of DNA from biological samples such as blood, saliva, hair, or skin cells, followed by analysis of specific genetic markers.

The uniqueness of DNA lies in its structure—except for identical twins, no two individuals share the same DNA profile. This makes DNA profiling an extremely reliable method for establishing identity.

The techniques commonly used include:
Polymerase Chain Reaction (PCR)
Short Tandem Repeat (STR) Analysis
Restriction Fragment Length Polymorphism (RFLP)
Thus, DNA profiling serves as a **scientific bridge between biology and law**, enabling courts to rely on empirical evidence rather than subjective interpretation.

III. LEGAL FRAMEWORK IN INDIA

The admissibility of DNA evidence in India is governed by a combination of statutory provisions and judicial interpretations.

1. Bharatiya Sakshya Adhiniyam, 2023

This new legislation recognizes **expert opinion** as relevant evidence, thereby providing legal validity to DNA reports submitted by forensic experts.

2. Bharatiya Nagarik Suraksha Sanhita, 2023

It allows for medical examination of accused persons and collection of biological samples, facilitating DNA analysis during investigation.

3. Constitutional Perspective

The use of DNA profiling must comply with **Article 21**, which guarantees the right to life and personal liberty, including the **right to privacy** as recognized in *Justice K.S. Puttaswamy v. Union of India (2017)*.

4. Proposed DNA Technology Regulation Framework

India has proposed legislation to regulate DNA databases, ensure data protection, and prevent misuse. However, its implementation remains a matter of concern.

IV. JUDICIAL APPROACH: LANDMARK CASE LAWS

Indian judiciary has played a pivotal role in shaping the legal landscape of DNA profiling.

1. State of Bombay v. Kathi Kalu Oghad (1961)

The Supreme Court held that collection of physical evidence does not violate the right against self-incrimination under Article 20(3).

2. Selvi v. State of Karnataka (2010)

The Court emphasized the importance of **consent and personal liberty**, holding that involuntary scientific tests violate constitutional rights.

3. Krishna Kumar Malik v. State of Haryana (2011)

The Court recognized DNA evidence as a crucial tool in rape cases and emphasized its importance in securing justice.

4. Justice K.S. Puttaswamy v. Union of India (2017)

Established privacy as a fundamental right, thereby impacting the use and storage of DNA data.
These judgments collectively highlight a **balanced judicial approach**, recognizing both the utility of DNA profiling and the need to protect individual rights.

V. ROLE OF DNA PROFILING IN CRIMINAL JUSTICE

DNA profiling has significantly strengthened the criminal justice system in multiple ways:
Accurate Identification of Accused
Reduction of Wrongful Convictions
Strengthening Prosecution Cases
Scientific Corroboration in Sexual Offences
Speedy Investigation and Trial
It enhances the credibility of the justice system by ensuring that decisions are based on **scientific certainty rather than conjecture**.

VI. CHALLENGES AND CONCERNS

Despite its advantages, DNA profiling raises several concerns:
Privacy Violation: Storage of genetic data may lead to surveillance and misuse.
Lack of Regulation: Absence of a comprehensive legal framework.
Ethical Issues: Consent, dignity, and bodily autonomy.
Technical Limitations: Risk of contamination and human error.
Data Security Risks: Potential misuse of DNA databases.
These challenges necessitate urgent legal reforms.

VII. FINDINGS

DNA profiling is a highly reliable form of scientific evidence.
Indian courts increasingly rely on DNA evidence.
Existing laws provide partial regulation but lack comprehensive coverage.
Privacy concerns remain a major challenge.
Judicial approach emphasizes balance between science and rights.

VIII. SUGGESTIONS

Enact a comprehensive DNA regulation law with strict safeguards.
Ensure data protection and privacy compliance.
Establish standardized forensic procedures.
Train investigation agencies and judicial officers.
Create independent regulatory authorities for DNA databases.
Promote public awareness regarding DNA technology.

IX. CONCLUSION

DNA profiling represents a revolutionary advancement in the field of criminal justice, offering unprecedented accuracy and reliability. It has the potential to transform the justice delivery system by ensuring fairness, efficiency, and scientific objectivity. However, its unregulated use poses serious threats to privacy and fundamental rights. Therefore, the future of DNA profiling in India lies in achieving a delicate balance between **technological progress and constitutional morality**.

As rightly observed, **science must serve justice, but justice must always protect humanity.**

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GARLIC (ALLIUM SATIVUM L.): TRADITIONAL USES, BIOACTIVE COMPOUNDS, AND THERAPEUTIC POTENTIAL

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ABSTRACT

Garlic (*Allium sativum* L.) is a widely recognized medicinal plant with significant therapeutic potential and a long history of traditional use across various cultures. This study reviews the medicinal, chemical, and traditional values of garlic, focusing on its bioactive compounds and their role in disease prevention and treatment. Garlic exhibits strong antimicrobial, antiviral, antifungal, and antidiabetic properties due to sulfur-containing compounds such as allicin, ajoene, and S-allylcysteine. It has been traditionally used to treat infections, respiratory disorders, cardiovascular diseases, and metabolic conditions. Scientific studies further support its ability to inhibit microbial growth, reduce blood glucose levels, improve lipid profiles, and enhance immune responses. Additionally, garlic demonstrates potential in combating fungal pathogens and viral infections. Despite its promising pharmacological properties, further clinical studies are required to confirm its safety and efficacy in humans. Overall, garlic represents a valuable natural remedy with diverse therapeutic applications and potential for future pharmaceutical development.

KEY WORDS: MEDICAL, GARLIC, ANTIFUNGAL, ANTIDIABETIC, ANTIVIRAL

INTRODUCTION

Natural products derived from plants, animals, and microorganisms have been used for thousands of years to treat various diseases. Among these, medicinal plants play a significant role due to their therapeutic properties and availability. Garlic (*Allium sativum* L.) is one of the most widely used medicinal and culinary plants, known for its effectiveness in treating infectious and non-infectious diseases across different cultures.

Historically, garlic has been recognized for its healing properties since ancient times. In Egypt, as early as 1500 BC, garlic was used to treat diarrhea, and its medicinal value was documented on temple walls and papyrus. Ancient Greek physicians such as Hippocrates and Galen used garlic to treat intestinal and other health disorders. In Asian countries like China and Japan, it was traditionally used for headaches, flu, sore throat, and fever. Similarly, in Africa, especially Nigeria, garlic has been used to treat abdominal discomfort, respiratory infections, and ear infections. In Europe and India, it has been commonly used for colds, asthma, and hay fever. Due to its strong antimicrobial properties, garlic is often referred to as “Russian penicillin.”

From a botanical perspective, garlic belongs to the genus *Allium*. Its classification has been debated, but modern systems based on molecular studies place it under class Liliopsida and family Alliaceae. The plant is a herbaceous perennial that grows from a bulb made up of multiple cloves covered in a thin, yellowish skin. These cloves are the most commonly used part and are known for their strong, pungent flavor caused by sulfur-containing compounds. Garlic plants have flat leaves, a cylindrical stem reaching up to 50 cm in height, and may produce lilac or pink flowers.

The name "*Allium*" is derived from a Celtic word meaning "pungent," reflecting its strong taste, while "*sativum*" means cultivated, indicating its long history of domestication. Garlic is believed to have originated in Central Asia and spread across the world through regions such as China, the Mediterranean, and Europe. Today, it is cultivated globally due to its adaptability and high demand. In addition to its traditional uses, garlic is an important source of bioactive compounds used in modern medicine. It exhibits antimicrobial, anti-inflammatory, and antioxidant properties, making it valuable in the prevention and treatment of various diseases. It is also widely used as a spice, enhancing the flavor of food while providing health benefits. Garlic is a highly valuable plant with significant medicinal, nutritional, and cultural importance. Its long history of use, combined with modern scientific validation, highlights its role as both a traditional remedy and a potential source for pharmaceutical development.

TAXONOMICAL POSITION

Kingdom: Plantae
Family: Amaryllidaceae
Subfamily: Allioideae
Genus: *Allium*
Species: *sativum*
Scientific name: *Allium sativum*

TRADITIONAL VALUES

Garlic (*Allium sativum*) has been widely used since ancient times in traditional medicine across many countries, including Iran. Both its leaves and cloves possess significant medicinal properties. Garlic is well known for its chemopreventive and anti-tumor effects, particularly its ability to inhibit the growth of cancer cells. Studies have shown that garlic and its bioactive compounds can suppress the development of cancers affecting the liver, colon, prostate, bladder, lungs, skin, stomach, and other organs in both animal and human models.

In addition to its anticancer potential, garlic is commonly used for treating respiratory conditions such as asthma and bronchial disorders due to its antiseptic and expectorant properties. It also helps in lowering blood pressure and acts as an anti-parasitic agent. Garlic extracts, often prepared through maceration, have demonstrated strong antimicrobial activity.

According to the World Health Organization (WHO), a large portion of the global population relies on traditional and complementary medicine, where garlic plays an important role. It is used to treat infections, cardiovascular diseases, digestive issues, and even bacterial conditions such as vaginosis. Garlic exhibits both bactericidal and fungicidal properties, effectively inhibiting the growth of harmful microorganisms. Overall, garlic remains a powerful natural remedy with diverse therapeutic applications.

Studies have shown that garlic has eleven positive effects on one's health, and scientists widely acknowledge these benefits.

1. Compounds in garlic have powerful therapeutic effects.
2. Despite having relatively few calories, garlic is a very nutritious food
3. The common cold can be treated with garlic.

4. Garlic's active ingredients help lower blood pressure.
5. It may lower the chance of developing coronary heart disease.
6. Antioxidants have an essential role in the prevention of Alzheimer's disease and dementia.
7. It may prolong life.
8. It supplements may enhance athletic performance.
9. Its Consumption may aid in the body's detoxification of heavy metals.
10. It may be beneficial to the maintenance of bone health.
11. It has a flavour that will make your mouth wet and is not difficult to add to your diet.

ANTIVIRAL

Garlic and its sulfur constituents verified antiviral activity against coxsackievirus species, herpes simplex virustypes 1 and 2, influenza B, para-influenza virus type 3,vaccinia virus, vesicular stomatitis virus, human immunodeficiency virus type 1 and human rhinovirus type 2. The order of compounds found in garlic for virucidal activity was, ajoene > allicin > allyl methyl thiosulfanate >methyl allyl thiosulfanate; no activity was found for the polar fractions, alliin, deoxyalliin, diallyl disulfide, or diallyl trisulfide. Several laboratory tests have shown that garlic is an effectual treatment for both the influenza B virus and herpes simplex virus. Two independent researchers in Japan and Romania have found that garlic is able to protect living organisms from the influenza virus . Most recently, a double blind placebo con-trolled study has shown significant protection from the common cold virus. As conducted by The Garlic Centre, published in Advances in Therapy, this is the first serious work to show prevention, treatment and reduction of reinfection benefits from taking Allimax Powder capsules once daily

ANTI-DIABETIC

Diabetes mellitus is a common endocrine disorder characterized by hyperglycemia, which can lead to complications affecting the eyes, nerves, blood vessels, skin, and kidneys. One of the key mechanisms involved in diabetic complications is the increased glycation of proteins and the formation of advanced glycation end-products (AGEs), along with free radicals. These processes contribute to oxidative stress and disease progression. Therefore, compounds with both antiglycation and antioxidant properties are considered beneficial in diabetes management.

Garlic (*Allium sativum*) has gained attention for its potential anti-diabetic properties. Studies suggest that aged garlic extract and its key component, S-allylcysteine, exhibit strong antioxidant activity and inhibit the formation of AGEs. These compounds also reduce oxidative stress by limiting the production of glycation-derived free radicals. Experimental studies in animals have consistently shown that garlic can significantly reduce blood glucose levels, particularly in chemically induced diabetic models.

In addition to its hypoglycemic effects, garlic has demonstrated beneficial effects on lipid profiles in diabetic patients. It has been found to lower total cholesterol and low-density lipoprotein (LDL) levels while moderately increasing high-density lipoprotein (HDL) levels. Furthermore, garlic components such as S-allylcysteine may improve complications like erectile dysfunction in diabetic conditions by reducing oxidative damage. Clinical studies indicate that combining garlic with standard treatments like metformin can enhance the reduction of fasting blood glucose levels compared to medication alone. However, some human studies show inconsistent results,

suggesting the need for further research. Overall, the anti-diabetic effects of garlic are mainly attributed to its sulfur-containing compounds, including allicin and related derivatives, which help improve insulin sensitivity and reduce insulin resistance.

ANTIFUNGAL

Garlic (*Allium sativum*) has long been recognized for its potent antifungal properties, with its activity first documented in 1936. One of its key bioactive compounds, ajoene, plays a significant role as a topical antifungal agent. Studies have demonstrated that garlic is highly effective in inhibiting the growth of various fungal species, including Candida, Malassezia furfur, Aspergillus, Cryptococcus, and several dermatophytes. In some cases, garlic has shown antifungal efficacy comparable to standard antifungal drugs such as ketoconazole.

Notably, research reported in a Chinese medical journal highlighted the use of intravenous garlic in treating Cryptococcus meningitis, a rare but serious fungal infection of the brain. The study found garlic to be more effective and less toxic than the commonly used antifungal drug Amphotericin-B. This suggests garlic's potential as a safer alternative in certain severe infections. Experimental studies have also shown that garlic extract significantly reduces fungal colonies, particularly Candida, in animal models. Additionally, garlic enhances phagocytic activity, indicating that it strengthens the body's immune response to fungal infections. Topical applications of garlic oil have proven effective in treating skin-related fungal conditions such as ringworm, warts, and parasitic infections. In animal studies, lesions caused by fungi showed noticeable healing within a week of garlic treatment. Furthermore, garlic has demonstrated antifungal effects against airborne pathogens like Botrytis cinerea and Trichoderma harzianum. Clinical observations also suggest higher patient satisfaction with garlic treatment compared to conventional antifungal agents like nystatin. Overall, garlic represents a promising natural antifungal agent with both therapeutic and preventive potential.

CONCLUSION

Garlic (*Allium sativum*) is an important medicinal plant with extensive traditional and modern therapeutic applications. The presence of bioactive sulfur compounds contributes to its wide range of pharmacological activities, including antimicrobial, antiviral, antifungal, and antidiabetic effects. The reviewed studies highlight garlic's effectiveness in inhibiting pathogenic microorganisms, regulating blood glucose levels, improving lipid metabolism, and enhancing immune function. Its traditional use across different cultures, along with scientific validation, supports its role as a natural and accessible healthcare remedy. However, variability in clinical results indicates the need for further well-controlled human studies to establish standardized dosages, safety, and long-term efficacy. In conclusion, garlic holds great potential as a complementary therapeutic agent and a valuable source for future drug development.

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DETERMINANTS OF TAX PLANNING EFFICIENCY: A COMPARATIVE STUDY OF STATE-LEVEL PSUS IN GUJARAT (2020–2025)

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ABSTRACT

Tax planning is a strategic financial instrument that helps to reduce tax liabilities within legal boundaries. This study investigates the tax planning efficiency of two prominent State Public Sector Undertakings (PSUs) in Gujarat: Gujarat Gas Limited (GGL) and Gujarat State Fertilizers and Chemicals Limited (GSFC). Spanning a five-year period (FY 2020–21 to FY 2024–25), the research utilizes the Effective Tax Rate (ETR) as the primary metric. The study identifies a critical research gap in the fiscal analysis of State-level PSUs compared to Central PSUs. Findings indicate that GSFC leverages its manufacturing-heavy structure for higher tax shielding (achieving an ETR as low as 17.51%), whereas GGL maintains a stable, risk-averse profile with an ETR closely aligned with the statutory rate.

KEYWORDS: TAX PLANNING, EFFECTIVE TAX RATE (ETR), PSUS, GUJARAT GAS, GSFC, CORPORATE FINANCE, DEPRECIATION TAX SHIELD.

1. INTRODUCTION

1.1 Background

Background Taxation represents a substantial non-operating outflow for corporate entities. Unlike tax evasion, tax planning involves the legal exploitation of exemptions, deductions, and incentives under the Income Tax Act, 1961. For State PSUs (SPSUs), efficient tax management is vital to ensure that surplus funds are redirected toward public infrastructure and state welfare projects.

1.2 Objectives of the Study

To analyze the Effective Tax Rate (ETR) trends of GGL and GSFC over a five-year period.
To evaluate the role of depreciation as a strategic tax shield in capital-intensive PSUs.
To provide actionable insights for optimizing the tax burden in state-level entities.

2. LITERATURE REVIEW & RESEARCH GAP

2.1 Theoretical Grounding

Tax Shield Theory: Suggests that companies with high investment in fixed assets utilize depreciation to reduce taxable income, thereby lowering the ETR.

Political Cost Theory: Argues that large, visible entities (like PSUs) often face pressure to maintain higher tax compliance to avoid public scrutiny, which may lead to conservative tax planning.

2.2 Review of Literature

Recent studies (Bharad & Sharma, 2023) emphasize that the shift toward the "New Tax Regime" for corporates in India has forced companies to choose between lower statutory rates and historical deductions. Research on Gujarat-based industries indicates that manufacturing firms (like GSFC) typically have more avenues for tax planning compared to service or distribution-oriented firms (like GGL) due to higher Capex incentives.

2.2 Research Gap

Existing literature heavily favors Central PSUs (CPSUs) or private multi-national corporations. There is a dearth of empirical data specifically addressing the fiscal efficiency of State-level PSUs (SPSUs) in Gujarat. Furthermore, no existing study compares the tax strategies of a service-distribution model (GGL) against a heavy-manufacturing model (GSFC) during the post-2020 economic recovery phase. This paper fills that void.

3. RESEARCH HYPOTHESES

To provide statistical depth, the study tests the following:

H_{01}: There is no significant difference between the ETR of selected PSUs and the Statutory Corporate Tax Rate.

H_{a1}: The ETR of selected PSUs is significantly lower than the Statutory Rate due to effective tax planning.

H_{02}: Asset intensity and depreciation do not provide a significant tax shield for Gujarat PSUs.

H_{a2}: High capital expenditure in manufacturing PSUs (GSFC) leads to a significantly lower ETR compared to distribution-led PSUs (GGL).

4. RESEARCH METHODOLOGY

Research Design: A comparative, descriptive, and analytical research design.

Sampling: Purposive sampling of two leading Gujarat State PSUs.

Data Collection: Secondary data from audited Annual Reports (2020-2025).

Variables: **Independent:** Profit Before Tax (PBT), Depreciation, and Capital Expenditure.
Dependent: Effective Tax Rate (ETR).

Primary Tool: Effective Tax Rate (ETR) Analysis.

Formula: $\text{ETR} = \frac{\text{Current Tax + Deferred Tax}}{\text{Profit Before Tax}} \times 100$

5. DATA ANALYSIS & INTERPRETATION

5.1 Comparative Effective Tax Rate (ETR) Analysis

The statutory corporate tax rate in India is approximately 25.17% (including surcharge and cess).

Table 1: Comparative ETR Analysis (%)

Year	GGL PBT (₹ Cr)	GGL Tax (₹ Cr)	GGL ETR %	GSFC PBT (₹ Cr)	GSFC Tax (₹ Cr)	GSFC ETR %
2020-21	1,704.70	429.20	25.18%	513.32	95.65	18.63%
2021-22	1,713.41	427.77	24.97%	1,304.89	413.99	31.73%
2022-23	2,024.65	499.18	24.65%	1,567.54	274.46	17.51%
2023-24	1,536.21	393.44	25.61%	664.38	140.05	21.08%
2024-25	1,546.60	401.09	25.93%	740.18	166.99	22.56%

Key Findings:

GGL Stability: GGL's ETR remains remarkably close to the statutory rate (avg. 25.2%), indicating a "Low-Risk, High-Compliance" strategy.

GSFC Volatility: GSFC experienced a significant dip in ETR (17.51% in 2022-23) due to high depreciation on plant commissioning, but a spike in 2021-22 likely caused by deferred tax adjustments.

Efficiency Gap: GSFC generally outperforms GGL in tax minimization, leveraging its manufacturing status.

Hypothesis Testing: H_{a1} is accepted for GSFC (as ETR is mostly < 25.17%) but H_{01} is accepted for GGL (as ETR stays close to 25.17%).

5.2 The Role of Depreciation as a Tax Shield

Depreciation is a non-cash expense that reduces taxable profit. Under Section 32 of the Income Tax Act, PSUs can claim higher depreciation than what is shown in the books for "Accounting Purposes."

Table 2: Depreciation and Tax Savings (₹ in Crores)

Year	GGL Depreciation (₹ Cr)	GGL Tax Saving	GSFC Depreciation (₹ Cr)	GSFC Tax Saving
2020-21	340.84	85.79	176.45	44.41
2021-22	384.91	96.88	178.18	44.85
2022-23	428.26	107.79	181.51	45.69
2023-24	474.30	119.38	183.02	46.07
2024-25	510.64	128.53	191.57	48.22

5.3 Deferred Tax Analysis

Deferred tax arises due to "timing differences" between book profit and taxable profit.
GSFC Trend: Usually shows higher Deferred Tax Liabilities due to large-scale plant commissioning.
GGL Trend: Shows a more stable Deferred Tax profile due to the consistent nature of the pipeline business.

6. FINDINGS AND DISCUSSION

Based on the five-year data analysis, the following findings emerged:
Strategic Compliance: Both PSUs follow a "Conservative Tax Planning" approach, ensuring zero litigation while minimizing outgo.
Asset Intensity: GSFC exhibits higher tax planning potential through depreciation because of its manufacturing nature compared to GGL's service/distribution nature.
Profitability Link: There is a positive correlation between high profit years and higher engagement in tax-saving investments (Section 80G, etc.) in both companies.
Hypothesis Validation:
H_{a1} Accepted for GSFC: Its ETR is significantly lower than the statutory rate.
H_{a2} Accepted: Manufacturing status provides a superior tax shield compared to the distribution model.
Statutory Consistency: Both firms have successfully managed to keep their ETR close to or below the marginal tax rate, indicating efficient tax management.

7. RECOMMENDATIONS

Capital Investment Timing: PSUs should align the commissioning of new projects with high-profit quarters to utilize immediate depreciation benefits.

R&D Incentives: GSFC should explore more "Research and Development" tax credits available for the chemical industry.
Digital Tax Management: Adopting AI-based tax forecasting tools can help GGL manage its quarterly advance tax payments more accurately to avoid interest penalties.

7. CONCLUSION

The study concludes that tax planning in Gujarat PSUs is a sophisticated balance of regulatory compliance and financial optimization. Gujarat Gas Limited demonstrates stability and consistency, making it a "Low Risk" tax planner. On the other hand, GSFC utilizes its capital-intensive structure to create significant tax shields. Overall, the tax planning strategies of these selected PSUs are effective and contribute to the financial robustness of the State of Gujarat.

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ARTIFICIAL INTELLIGENCE IN MATHEMATICS: THE COMPUTATIONAL COMPLEXITY OF NEURAL-SYMBOLIC REASONING AND THE AUTOMATION OF MATHEMATICAL DISCOVERY

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ABSTRACT

The integration of Artificial intelligence (AI) into pure and applied mathematics has transitioned from basic computational assistance to a fundamental role in the generation of new mathematical knowledge. This research paper examines the shift from classical symbolic.

Computation to modern neural- symbolic architectures, which combine the pattern recognition capabilities of deep learning with the logical rigor of formal proof assistants. The study begins by evaluating the impact of Transformer-based models on the automation of symbolic integration and the resolution of ordinary differential equations (ODEs). It further shows how Graph Neural Networks are utilized to identify structural properties in graph theory. A core focus of the paper is the Deep Learning for Theorem Proving, which utilizes reinforcement learning to navigate the infinite search spaces of formal logic. Furthermore.

The research addresses the international collaboration efforts to build a Global Library of Formalization which ensures that machine led discoveries are accessible and verifiable. By analysing the large-scale language models and automated reasoning, this paper argues that the future of mathematical research lies in an augmented intuition model. This model posits that AI does not replace the mathematician but rather extends the human cognitive capacity for abstraction. Finally, the study assesses the ethical implications of AI-authored proofs, particularly regarding the loss of human interpretability in complex derivations. This analysis provides an overview of the current state and future trajectories of AI within Mathematics, which can be led to new discoveries.

KEYWORDS: NEURAL-SYMBOLIC REASONING, AUTOMATED THEOREM PROVING, GRAPH NEURAL NETWORKS, AUTO-FORMALIZATION, ALGORITHM OPTIMIZATION

INTRODUCTION: THE EPISTEMOLOGICAL SHIFT

For millennia, mathematics has been the ultimate arbiter of human logic, relying on the deductive bridge between axioms and theorems. [24] However, the rise of artificial intelligence is forcing an epistemological shift. We are entering an era where inductive processes learning from data are being used to fuel deductive outcomes. This paper investigates how AI models are being trained to reason through mathematical structures, moving beyond simple arithmetic to engage with the abstract beauty of topology, number theory and algebraic geometry.

The Primary challenge is applying AI to mathematics is the requirement for absolute precision. Unlike natural language processing, where a slight grammatical error is tolerable, a single misplaced sign in mathematical proof renders the entire structure invalid.[23]

Therefore, the international research community has focused on developing architectures that can maintain mathematical consistency across high dimensional state spaces. The goal is no longer just to solve equations but to understand the underlying symmetries that govern mathematical universes.

NEURAL-SYMBOLIC ARCHITECTURES: BRIDGING THE GAP

The divide between sub-symbolic AI (Neural Networks) and symbolic AI (Logic-based systems) has long been a hurdle in computer science. [3] Mathematics, however, is providing the perfect laboratory for merging these two fields. Neural-symbolic reasoning involves using the intuitive, fast pattern recognition of a neural network to suggest likely directions for a proof, while a symbolic engine verifies those suggestions against rigid axioms.

One of the most successful applications of this is in the domain of symbolic regression. Traditional regression models find the best-fitting parameters for a fixed equation. AI-driven symbolic regression, however, searches the space of all possible mathematical expressions to find the equation itself. This has profound implications for mathematical physics, where AI is now discovering the laws of motion and conservation from raw observational data without prior knowledge of the underlying calculus. [16] These systems effectively re-derive the laws of nature by identifying the simplest mathematical symbolic string that explains the data, a process that mirrors Occam's Razor in scientific inquiry. [13]

LARGE LANGUAGE MODELS AS MATHEMATICAL TRANSLATORS

A significant breakthrough in recent years is the realization that mathematics can be treated as a language. Large Language Models (LLMs) trained on vast corpuses of mathematical literature have demonstrated an uncanny ability to translate informal mathematical prose into formal logical statements. This process, known as Auto-formalization, is the key to scaling mathematical research. [10] When a mathematician describes a theorem in English, the AI can translate that intent into a formal language like Lean or Isabelle. This allows for real-time verification of ideas. Furthermore, LLMs are being used to generate proof sketches high-level outlines of how a proof might proceed-which human researches can then refine. [15]

This collaborative workflow Reduces the mechanical burden of mathematics, allowing researches to focus on high-level conceptual breakthroughs. [12] By bridging the gap between human-readable Latex documents and machine-verifiable code, LLMs are creating a unified interface for the global mathematical community. [19]

THE CONVERGENCE OF QUANTUM MATHEMATICAL PHYSICS AND AI-DRIVEN TOPOLOGY

A burgeoning frontier in international mathematical research is application of Geometric Deep Learning (GDL) to the classification of Calabi-Yau manifolds and the resolution of the Landscape problem in string theory. This domain represents a high-stakes intersection of algebraic geometry and quantum mathematical physics, where the dimensionality of the moduli spaces often renders traditional algorithmic classification intractable. Recent collaborative studies have demonstrated that neural networks can predict the Hodge numbers of manifold surfaces with over 99% accuracy, bypassing the need for computationally expensive Groebner basis calculations [9]. This suggests that AI can identify topological invariants through non-linear pattern recognition that traditional

symbolic computation fails to capture, effectively guiding the human mathematician's intuition toward new geometric properties [25] .

Furthermore, the integration of Physics Informed Neural Networks (PINNs) into the study of partial differential equations (PDEs) has allowed researchers to probe the regularity of solutions in complex fluid dynamics. By embedding fundamental conservation laws directly into the neural network's loss function, global research teams are producing informed AI agents that do not merely approximate data but remain strictly bounded by the physical axioms of the universe [16]. This shift toward Axiom-Constrained Machine Learning represents a sophisticated evolution in the global research landscape, moving the field away from black-box statistical modelling and toward rigorous framework for discovery [23]. As these models became more adaptable globally where the distinctions between pure mathematical abstraction and applied artificial intelligence are increasingly obscured by the necessity of multi-disciplinary collaboration. Notably, as we henceforth transition into the analysis of Graph Neural Networks (GNNs), it becomes undeniably apparent that the previously discussed axioms serve as the primary foundation for these breakthroughs, alternatively known as the new frontier of computational discovery, ultimately facilitating a comprehensive bridge to our detailed case study, which rigorously examines the transformative impact of specialized GNN architectures Internationally.

CASE STUDY: GRAPH THEORY AND GRAPH NEURAL NETWORKS (GNNS)

In the realm of combinators, Graph Neural Networks (GNNs) have become an essential tool. Graphs are mathematical structures used to model relations between objects and finding specific properties within large graphs is often NP-hard. AI models are now being used to predict the chromatic number of a graph or to identify cliques that were previously undiscovered.

International research terms have recently used GNNs to make progress on the Hadwiger-Nelson Problem, which concerns the minimum number of colours required to colour the plane such that no two points at a distance of 1 have the same colour. The AI's ability to visualize and manipulate high-dimensional graph data has provided human mathematicians with new counterexamples, effectively narrowing the search space for a final proof. [23] This study show that when the search space is too vast for human observation, AI act as a high-powered lens, focusing the mathematician's attention on the most promising structural anomalies. [13]

While the application of Graph Neural Networks (GNNs) provides a robust framework for understanding discrete structures in combinatorics, the utility of AI is not limited to finite systems. The transition from discrete nodes of graph theory to the continuous and infinite domains of analytical mathematics represents the next major hurdle. Specifically, the predictive power observed in GNNs is now being translated into the realm of complex analysis and number theory.[8] By moving from the study of relational structures to the study of functional distributions, AI is beginning to provide insights into some of the most profound mysteries of the mathematical universe, most notably the distribution of prime numbers.

AI IN NUMBER THEORY: NAVIGATING THE RIEMANN LANDSCAPE

One of the most profound applications of artificial intelligence in pure mathematics is its burgeoning role in number theory, particularly regarding the distribution of prime numbers.

For centuries, the Riemann Hypothesis has stood as Holy Grail of mathematics. Recent international research has utilized deep learning to analyse the zeros of the Riemann zeta function. [9] By treating the zeros as a point process, researchers have trained neural networks to identify subtle correlations that mirror the behaviour of eigenvalues in random matrix theory.

The AI's ability to process billions of data points has allowed for the discovery of local patterns in the zeta function that were previously invisible to human analyst. While the AI has not yet provided a global proof, it has successfully identified new bounds for the De Bruijn-Newman constant, a value closely tied to Riemann Hypothesis. [20] This demonstrates that AI is not merely a tool for verification but a sophisticated instrument for mathematical exploration, pushing the boundaries of what is computationally observable in the landscape of complex analysis.

ALPHADEV AND THE DISCOVERY OF SORTING EFFICIENCY

In the domain of applied mathematics and computer science, the discovery of faster algorithms is a primary objective. In 2023, DeepMind introduced AlphaDev, an AI system that utilizes reinforcement learning to discover optimized computer science algorithms.[6] Unlike Alpha Tensor, which focused on matrix multiplication, AlphaDev operated at the level of assembly instructions-the DNA of computing which is new beneficiary discovery.

The mathematical significance of AlphaDev lies in its discovery of a new sorting algorithm that is significantly faster than those manually optimized by humans over decades. The AI viewed the problem of sorting as a pathfinding mission in a discrete mathematical space. By finding a shorter sequence of operations to achieve a sorted state, the AI provided a more efficient solution to a problem fundamental to global data processing. This success suggests that many of our optimal mathematical algorithms are, in fact, local minima, and that AI can help the mathematical community leap to more efficient global structures. [7]

THE PHILOSOPHY OF PROOF IN THE AGE OF MACHINE LOGIC

As AI begins to generate proofs that are thousands of pages long or proofs that exist only as verified code in a system like Lean-the mathematical community faces a crisis of comprehensibility. Traditionally, a proof was considered a means of understanding. If a proof is verified by a machine but cannot be fully grasped by a human mind, does it fulfil its purpose? [14] This has led to the emergence of Interpretable AI for Maths. Now, researchers are now focusing on distillation techniques, where a complex, machine proof broke down into series of lemmas that a mathematician understand. The goal is to ensure why of a theorem is not lost in the how of the AI's computation. [5] This ensures that mathematics remain a collaborative dialogue between human intuition and machine precision, rather than a unilateral declaration by an opaque algorithm.

INTERNATIONAL COLLABORATIVE AND THE GLOBAL LIBRARY

The future of AI in mathematics is inextricably linked to the formalization movement. Organizations such as the International Mathematical Union (IMU) are discussing the creation of a centralized, machine-readable library of all known mathematical results. Such a library would serve as the ultimate training set for future AI models, creating a feedback loop where each new discovery immediately informs the next.

This global infrastructure would democratize mathematical research. A researcher in a developing nation could use an AI assistant to developing nation could use an AI assistant to verify their conjectures against the entire history of human mathematics, [21], by passing the traditional gatekeeping of elite institutions. Collaborative efforts, such as the Liquid Tensor Experiment led by Peter Scholze, demonstrate how formalization can be scaled through recursive learning and international partnership. [17] This shift toward open-source truth is perhaps the most transformative aspect of the AI revolution, moving mathematics from an artisanal craft practiced by a few to a highspeed, globalized scientific enterprise. This would act as the ultimate training set for future reinforcement learning agents, allowing for the scaling of mathematical intuition through recursive learning. [18]

CONCLUSION

The integration of Artificial Intelligence into mathematics marks the end of the era of the human calculator and the beginning of the era of the mathematical architect. AI has proven its ability to identify patterns in Knot theory, optimize matrix multiplication, and verify the most rigorous of proofs. While challenges regarding explainability and the loss of human intuition remain, the synergy between inductive machine learning and deductive symbolic logic offers a path toward solving problems that have remained stagnant for centuries.

Ultimately, AI does not diminish the role of the mathematician; it elevates it. By automating the mechanical and the tedious, AI allows the human mind to focus on the truly abstract and the deeply creative. As we move forward, the definition of a mathematical discovery will continue to evolve, reflecting a unique partnership where machine efficiency and human conceptual depth become two sides of the same coin.

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SCREENING, ISOLATION, AND OPTIMIZATION OF ANTIBIOTIC PRODUCTION BY ACTINOMYCETES DERIVED FROM COASTAL REGION SOIL

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ABSTRACT

Antibiotics are among the most significant secondary metabolites produced by a wide range of microorganisms. The phenomenon of antibiotic production, referred to as antibiosis, involves the inhibition or destruction of pathogenic organisms by the metabolic products of another microorganism. The southern region of Gujarat, particularly its coastal zones, is recognized as a biodiversity hotspot harbouring numerous unexplored microorganisms with potential economic importance. This study aimed to evaluate the antimicrobial activity of such microorganisms against pathogenic and multidrug-resistant bacterial strains. A total of 12 soil samples were collected from diverse ecological niches in the Valsad district of Gujarat, including coastal areas, dung piles, riverbanks, and agricultural fields. From these samples, 80 microbial isolates were obtained and subjected to primary screening. Based on secondary screening, 32 potent isolates were selected for further investigation. Antimicrobial activity was assessed against coliforms and multidrug-resistant cocci, with a particular focus on Actinomycetes due to their pronounced inhibitory effects. Morphological and colony characteristics of the selected isolates were recorded, and preliminary identification was carried out using biochemical tests. Additionally, a comparative analysis was performed to evaluate antibiotic production between crude and extracted forms. The findings indicate the presence of economically valuable microorganisms in the soil of the Valsad district, highlighting their potential as a source of novel antimicrobial compounds.

KEYWORDS: ANTIBIOSIS, PRIMARY/SECONDARY SCREENING, ANTIMICROBIAL ACTIVITY, ACTINOMYCETES, CRUDE EXTRACTION, INHIBITION.

1.0 INTRODUCTION

The discovery of penicillin by Alexander Fleming marked the advent of the first antibiotic, ushering in a transformative era in chemotherapy. Since then, antibiotics have played a critical role in saving countless lives and have significantly contributed to the global rise in life expectancy. Notably, approximately 80% of all clinically relevant antibiotics are derived from the genus *Streptomyces* and other members of the order Actinomycetes (Letizia Lo Grasso et. al., 2016). A chemical compound originating from fungi or bacteria possesses the capacity to eliminate microorganisms and treat bacterial infections. At the time of their initial discovery, antibiotics were widely regarded as "wonder drugs" due to their unprecedented therapeutic efficacy.

According to the World Health Organization (WHO, 2009), the overprescription and injudicious use of antibiotics have led to a significant rise in antibiotic resistance among various bacterial pathogens. In recent years, multidrug-resistant strains have emerged at a pace exceeding the rate of new antibiotic discovery. Of particular concern are methicillin-resistant *Staphylococcus*

aureus (MRSA) and vancomycin-resistant *Staphylococcus aureus* (VRSA), which exemplify the growing threat of antimicrobial resistance (Gordon RJ et al., 2008) and Penicillin-resistant strains of *Streptococcus pneumoniae* have been documented by Bizuye et al. (2013) and Staneu et al. (2011). In response to the growing challenge of antimicrobial resistance, Ilic et al. (2005) emphasized the urgent need for the replacement of existing antibiotics and the development of novel therapeutic agents effective against drug-resistant pathogens. In this context, the discovery and production of new antibiotics, along with the application of combination antibiotic therapy, have been shown to delay the emergence of microbial resistance and may produce beneficial synergistic effects in the treatment of infectious diseases.

Adwan et al. (2008) reported that antibiotic synergism between conventional antibiotics and bioactive extracts represents a novel strategy, exhibiting significant activity against both pathogens and host cells. Furthermore, Moncheva et al. (2002) noted that scientists and pharmaceutical industries are increasingly implementing novel screening programs aimed at discovering previously unknown Actinomycetes from underexplored environments, such as marine waters. Novel Actinomycetes are considered promising candidates for the identification of unknown bioactive compounds capable of combating resistant pathogens. In light of these considerations, the present study was undertaken to isolate potent Actinomycetes from diverse soil sources collected from various regions of the Valsad district, Gujarat.

2.0 MATERIALS AND METHODS

2.1 Sample Collection and Processing

Soil samples were obtained from the coastal region of Valsad District, Gujarat, India. Each sample was collected using a sterile spatula and placed into clean, dry polythene bags under aseptic conditions.

2.2 Isolation of Actinomycetes

The soil samples were serially diluted, and appropriate dilutions were spread onto starch casein agar plates. The inoculated plates were incubated at 37 ± 3°C for 48 hours, following the method described by Joseph Devadass et al. (2016).

2.3 Screening for Antimicrobial Activity

The selected potent isolates were evaluated for antimicrobial activity against both Gram-positive and Gram-negative multidrug-resistant pathogenic organisms using the point inoculation method. Sterile nutrient broth (20 mL) was prepared for each potent isolate, inoculated with the respective multidrug-resistant pathogen, and subsequently poured into sterile Petri plates. The potent isolates were then spotted onto the surface of nutrient agar plates pre-seeded with the multidrug-resistant bacterial strains. The plates were incubated at 37 ± 3°C for 24 hours. Potent isolates were selected based on the diameter of the zone of inhibition, and the results were recorded as per the methodology described by Shanmugaraju et al. (2013).

2.4 Biochemical Characterization

The isolated Actinomycetes were subjected to a series of biochemical tests to aid in their preliminary identification. These included citrate utilization, starch hydrolysis, indole production, methyl red (MR) test, Voges–Proskauer (VP) test, nitrate reduction, hydrogen sulfide (H_2S) production, catalase activity, and gelatine liquefaction.

2.5 Agar Well Diffusion Method

The antimicrobial activity of the potent isolates was assessed using the agar well diffusion method. Overnight (24-hour) cultures of multidrug-resistant pathogenic bacteria were inoculated into sterile nutrient broth and evenly poured into sterile Petri plates, where the medium was allowed to solidify. Wells of 8 mm diameter were aseptically bored into the nutrient agar plates using a sterile corn borer. For each potent isolate, 5 mL of a 24-hour nutrient broth culture was transferred aseptically into a sterile centrifuge tube and centrifuged at 5,376 × g for 10 minutes. Approximately 100 µL of the resulting supernatant was collected using a micropipette and dispensed into the prepared well. The plates were then incubated at 37 ± 3°C for 24 hours. Following incubation, the zones of inhibition were measured and recorded.

2.6 Identification of Antibiotic Substances from Potent Isolates

2.6.1 Confirmation of Antimicrobial Activity

To confirm the production of antibiotic substances by the potent isolates, an agar well diffusion method was employed. Overnight cultures of multidrug-resistant pathogenic bacteria were inoculated into sterile nutrient broth and poured into sterile Petri plates, allowing the medium to solidify. Wells of 8 mm diameter were aseptically prepared in the seeded nutrient agar plates using a sterile corn borer. For each potent isolate, 5 mL of a 24-hour nutrient broth culture was aseptically transferred into a sterile centrifuge tube and centrifuged at 5,376 × g for 10 minutes. Approximately 100 µL of the resulting supernatant was dispensed into each well. The plates were incubated at 37 ± 3°C for 24 hours, after which the zones of inhibition were measured and recorded. To evaluate the effect of incubation duration on antibiotic production, the remaining supernatant was further incubated for 48, 72, and 96 hours. At each time interval, the above procedure was repeated, and the corresponding zones of inhibition were recorded.

2.6.2 Comparative Analysis of Antibiotic Production and Growth Kinetics

To compare antimicrobial activity between the two most potent isolates, each isolate was inoculated into a production medium and incubated on an environmental shaker at 100 rpm and 37°C for 72 hours. Following incubation, the culture broth was centrifuged at 5,373 × g for 15 minutes, and the supernatant was collected as the crude antibiotic source. Antimicrobial activity was assessed at 24-hour intervals by measuring the zone of inhibition. Concurrently, microbial growth was monitored by measuring optical density at 660 nm every hour. A growth curve was subsequently plotted with time (hours) on the x-axis and optical density on the y-axis to establish the growth profile of the isolates.

2.7 Optimization of Physicochemical Parameters for Antibiotic Production

2.7.1 Effect of Carbon Source on Antibiotic Production

The production medium was prepared using nutrient broth supplemented with five different carbon sources. Each carbon source 1% glucose, 1% sucrose, 1% glycerol, and 1% starch was individually dissolved in starch casein broth and dispensed into separate 250 mL conical flasks. One milliliter of a selected potent isolate culture was inoculated into each flask, followed by overnight incubation at room temperature on an environmental shaker set at 100 rpm. After incubation, 5 mL of the culture was aseptically transferred into sterile centrifuge tubes and centrifuged at 5,373 × g for 10 minutes. The resulting supernatant was used to assess antibiotic production via the agar well diffusion method, and the zone of inhibition was measured.

2.7.2 Effect of Nitrogen Source on Antibiotic Production

The production medium was prepared using nutrient broth amended with four different nitrogen sources. Each nitrogen source 1% ammonium sulfate, 1% peptone, 1% urea, and 1% arginine was dissolved in 100 mL of distilled water and placed in separate 250 mL conical flasks. One milliliter

of the selected potent isolate culture was inoculated into each flask. All flasks were incubated for 24 hours at room temperature on an environmental shaker at 100 rpm. Following incubation, 5 mL of the culture was aseptically collected into sterile centrifuge tubes and centrifuged at 5,373 × g for 10 minutes. The supernatant was then evaluated for antibiotic production using the agar well diffusion method, and the zone of inhibition was recorded.

3.0 RESULTS AND DISCUSSION

3.1 Screening and Isolation of Antimicrobial Compound-Producing Actinomycetes

The screening and isolation of Actinomycetes capable of producing antimicrobial compounds were conducted using an appropriate agar medium adjusted to pH 7.0. A total of forty-eight potent isolates were selected based on the presence of clear zones of starch and casein hydrolysis surrounding their colonies. All selected isolates exhibited antimicrobial activity and displayed diverse morphological characteristics. For the purposes of the present study, sixteen out of the forty-eight isolates, designated A1 through A16, were selected for further investigation. The results of the screening process, including the distribution of isolates and the statistical proportion of Actinomycetes recovered from different sources, are presented in Figures 1 and 2.

Figure No. 1: Distribution of bacteria and actinomycetes in different soil types.

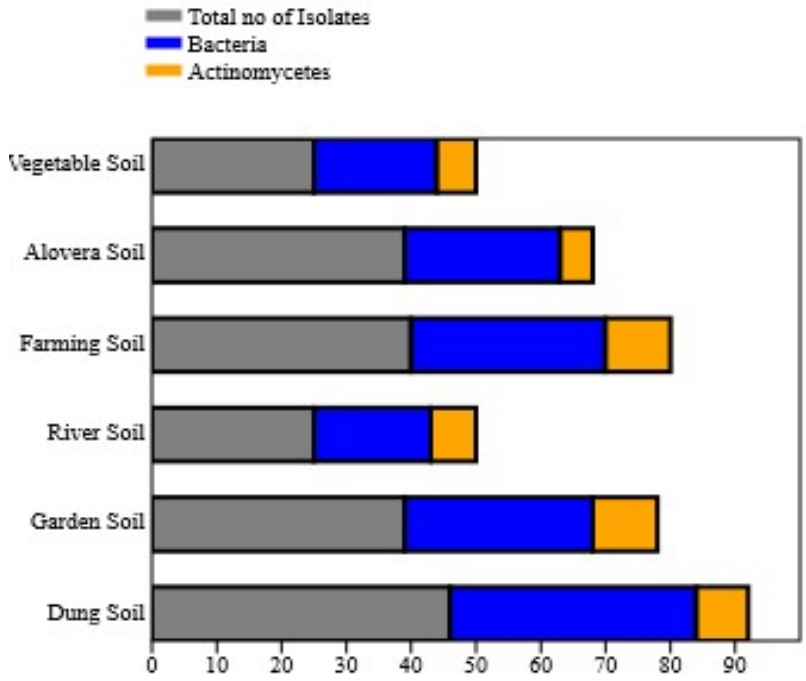




Figure No. 2: Isolates based on zone of inhibition on solid media.

3.2 Antimicrobial Activity of Potent Isolates Against Multidrug-Resistant Pathogens by Point Inoculation Method:

A comparative study of the antimicrobial activity of the selected isolates was conducted against multidrug-resistant pathogenic test organisms using the point inoculation method. Antimicrobial activity was evaluated based on the diameter of the zone of inhibition observed around each isolate against the test cultures. From these experiments, sixteen potent isolates were selected, and their antagonistic activity was assessed against *Staphylococcus aureus*, *Escherichia coli*, *Enterobacter aerogenes*, and *Bacillus megaterium*. The results are presented in Table 2 and Figure 2. To determine the optimal antimicrobial activity of the potent isolates, the point inoculation method was performed over different incubation periods of 24, 48, and 72 hours. The diameters of the zones of inhibition recorded at each time interval are illustrated in Figures 3 and 4.

Based on comparative antimicrobial activity of potent isolates of Actinomycetes by point inoculation techniques out of sixteen only the two best potent isolates A3 and A16 had maximum antimicrobial activity they are selected for further studies for its identification, production, and optimization.

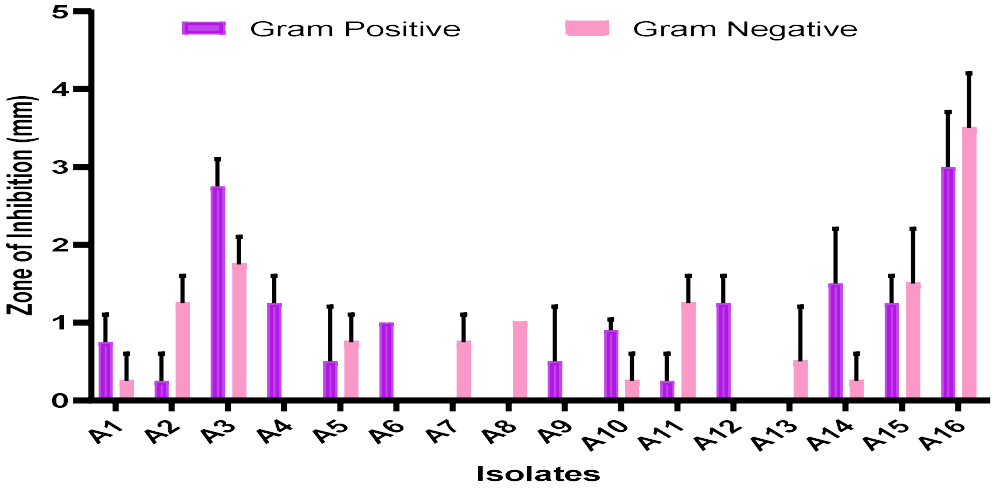


Figure No. 3: Study of antimicrobial activity by potent isolates at 72 hours.

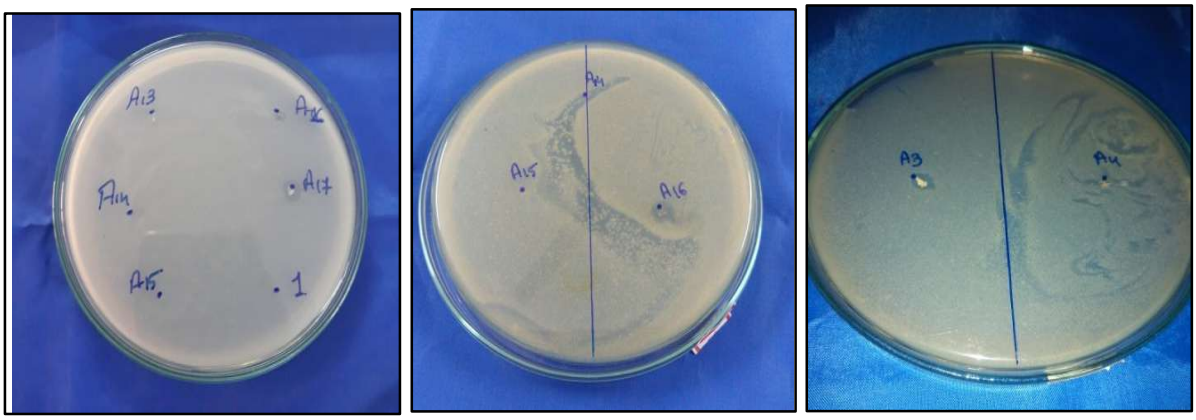


Figure No. 4: Point inoculation method by isolates.

3.3 Colony characteristics and identification of potent isolates:

Based on antimicrobial activity selected two potential isolates A3 and A16 which are great antimicrobial effect against gram positive and gram-negative bacteria as a broad-spectrum activity. For identification of potential isolates perform morphological and biochemical identification of isolates. Depicted in tables 3 & 4 representing various cultural characteristics and morphological

characteristics of potent isolates A3 and A16. We also observed both isolates gram-positive filamentous Actinomycetes but their spore arrangement was various obtained in Figure no 5.

Table No. 1: Colony characteristic of antibiotic-producing potent isolates.

Sr. No.	Characteristics	A3	A16
1	Size	Big	Big
2	Shape	Irregular	Irregular
3	Margin	Rhizoidal	Rhizoidal
4	Elevation	Raised	Raised
5	Texture	Rough	Rough
6	Pigmentation	Chalky white	White
7	Opacity	Opaque	Opaque
8	Reverse site pigmentation	-	Brown

Table No. 2: Morphological characteristic of antibiotic-producing potent isolates.

Isolates	Reverse site pigment	Morphology
A3	-	Gram-positive Filament with spore
A16	Brown	Gram-Positive Filament with spore

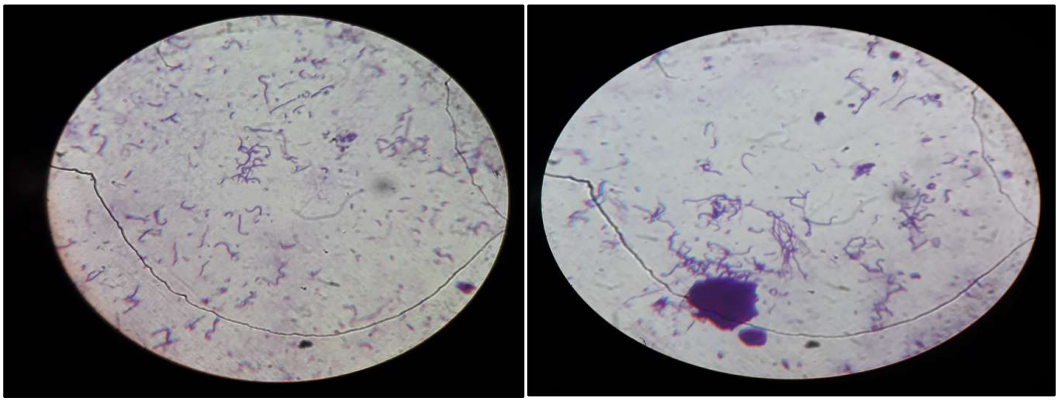


Figure No.5: Gram staining of a potent isolate.

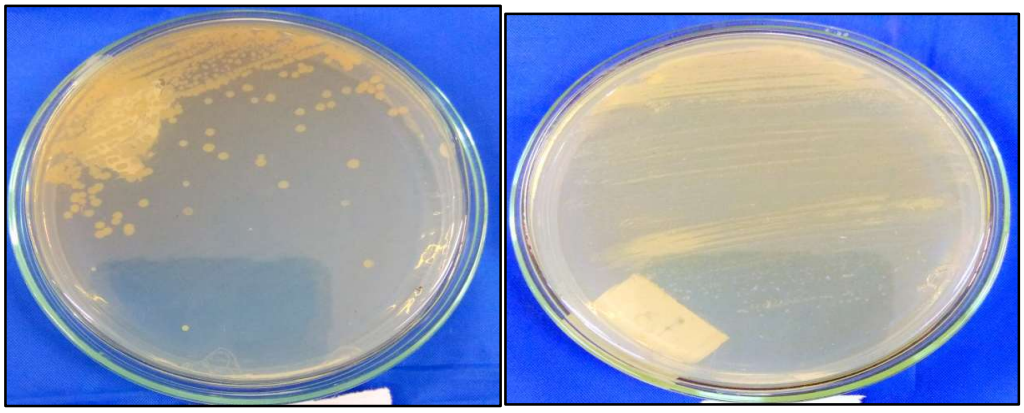


Figure No. 6: Isolation of A3 and A16.

3.4 Biochemical tests of potent isolates:

Most of the microorganisms can be identified by their Colony characteristics, Morphological Characteristics, and Biochemical characteristics. So, A3 and A16 Colony & Morphological characteristics are obtained in Tables 3 and 4. Its Biochemical Characteristics are observed in Table no 3.5. Results of biochemical test carried out a tentative identification of potent isolates A3 and A16. The results A3 was maybe *Streptomyces sp.*& A16 was maybe *Saccharothrix sp.* This type of the same result was reported by S.A.Jani *et al.,* 2015 and Hu *et al.,* 2020.

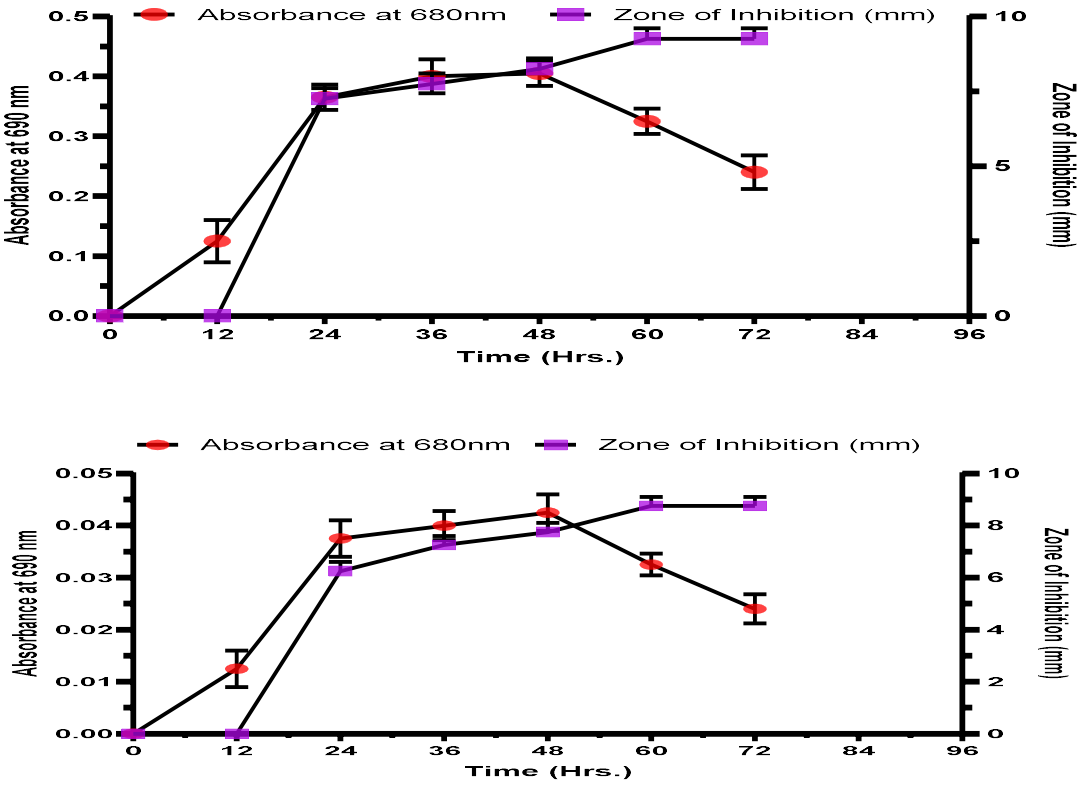
Table No.3: Result of biochemical activity of potent isolates A3 and A16.

Sr. No.	Tests	A3	A16
1	Methyl red	+ve	+ve
2	Voges-Proskauer	-ve	-ve
3	Citrate utilization	-ve	-ve
4	Hydrogen sulphide (H_2S) production	-ve	+ve
5	Catalase	+ve	+ve
6	Indole production	+ve	-ve
7	Starch hydrolysis	+ve	+ve
8	Casein hydrolysis	+ve	+ve
9	Nitrate reduction	-ve	-ve
10	Gelatin liquefaction	-ve	-ve
11	Lactose	-ve	-ve
12	Maltose	-ve	-ve

3.5 Comparison between growth curve and antagonistic production by potent isolates:

After identification of A3 and A16 isolates, To Initiation Study of antimicrobial compound production by potent isolates which methods in detailed described in 7 Figure no 7 represented the production of antimicrobial compounds by potent isolates A3 and A16 against Test culture of Gram-positive and Gram-negative bacteria.

The result indicated that isolate A3 gave optimum antimicrobial compound activity in the middle of the stationary phase in the growth curve. Maximum antimicrobial activities were given by isolate A3 at 48 hours. Figure 7 (1) indicating that the antimicrobial compound maximally produced in the stationary phase at 48 hours. After that, the isolate A3 growth has gone into the death phase but the antimicrobial activity continued. So, Figure indicated comparison between growth curve and antimicrobial compound production by isolate A3 the produced antimicrobial compound may be Antibiotic. Further identification we going for Molecular-level and structure level Approaches for identification of a group of antibiotic. Figure 7 (2) represented a comparison between the growth curve and Antimicrobial compound production by Isolate A16. Results indicated that A16 gave optimum antimicrobial activity in the middle of stationary phase but after that isolate gone in death phase the antimicrobial activity also decreases as same as cell numbers decrease., so it indicated that A16 was produced antimicrobial compound maybe not antibiotic.



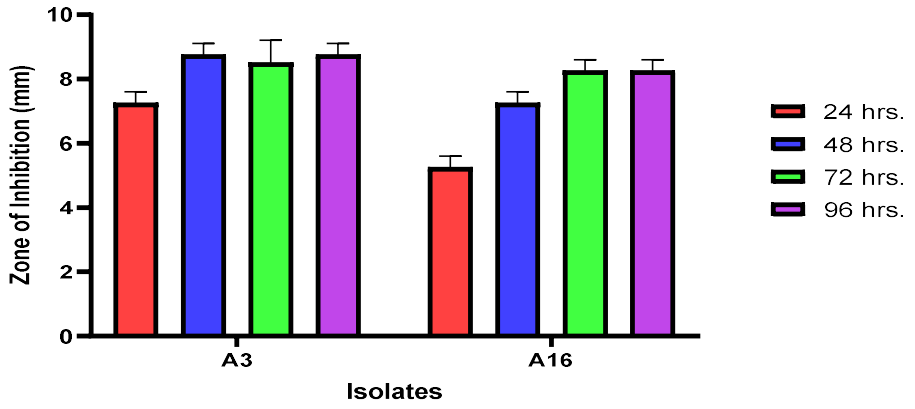
(2)

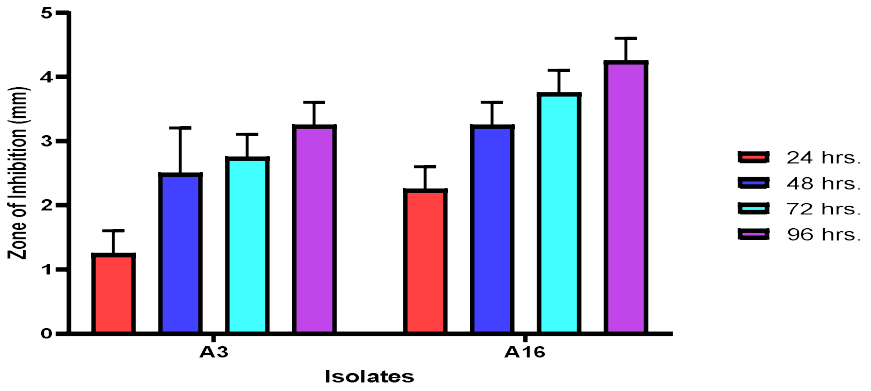
Figure No.7: 1) Comparison of growth curve and Antibiotic production A3.

2) Comparison of growth curve and Antibiotic production A16.

3.6 Antibiotic production by potent isolates A3 and A16:

Results indicated that A3 and A16 both isolates gave maximum Antibiotic production against test gram-positive bacteria than gram-negative bacteria. In Production by A3 isolate maximum activity gave 48 hours against gram-positive organisms and maximum activity gave 24 hours against gram-negative organisms. After this, the activity was the same as well as after 72 hours be continued. I.e. the isolate was may be produced the highest antibiotic activity at 48 hours against gram-positive organisms and 24 hours against gram-negative organisms. In Production by A16 isolate maximum activity gave 24 hours against gram-positive organisms and maximum activity gave 24 hours against gram-negative organisms. The activity was decreased after 24 hours which are observed in 48 and 72 hours obtained in figure 8. I.e. the isolate was not may be produced Antibiotic.





(2)

Figure No. 8: Antibiotic production by A3 and A16 against (1) Gram positive and (2) Gram Negative.

3.7 Antibiotic Production and Optimization of certain parameter:

3.7.1 Effect of carbon source in antibiotic production:

The growth of bacteria and antagonistic compound production by microorganisms is influenced by carbon source. Optimized different carbon sources in antibiotic production were carried out by well diffusion method and a result of potent isolate A3 antibiotic production against gram-positive pathogenic organism and antibiotic production against gram-negative pathogenic organism show in figure no. 9. Results indicated that A3 gave the highest antibiotic production against gram-positive organism in medium supplemented with 1% glycerol at 48 hours then same activity against compare gram-negative organism in medium supplemented with 1% sucrose gave highest antibiotic production at 24 hours.

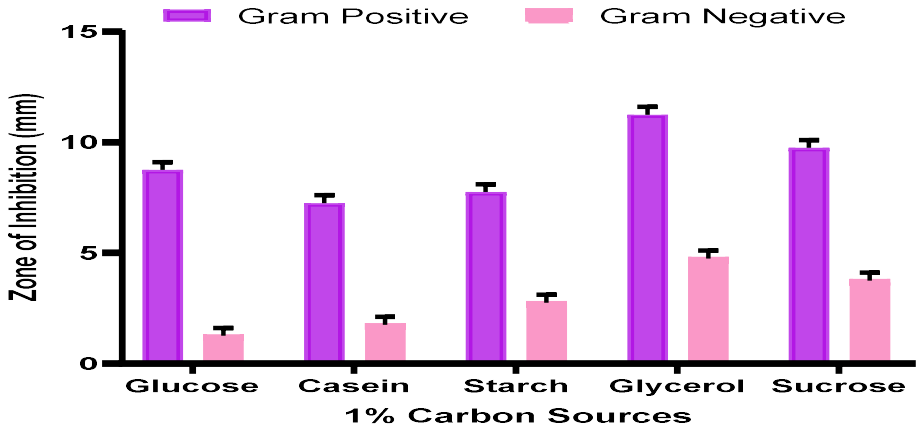


Figure No.9: Effect of Carbone source on Antibiotic production by A3.

Another potent isolate A16 antibiotic production against gram-positive pathogenic organisms and antibiotic production against gram-negative pathogenic organisms show in figure no. 10. The result indicated that A16 gave the highest antibiotic production against gram-positive organism in medium supplemented with 1% sucrose at 48 hours, then same activity compared to a gram-negative organism in medium supplemented with 1% glucose gave maximum activity at 48 hours. Similar kind of results also reported for *Streptomyces albidoflavus* (K.J.P. Narayana *et al.*, 2008) gave antibiotic production maximum in glycerol and maltose & minimum in Sucrose and fructose, *Streptomyces sp.* KOD10 (S.Febina Bernice Sharon *et al*., 2014) gave antibiotic production maximum in Dextrose, glycerol, and galactose & minimum in sucrose and glucose. And *Arthrobacter sp.* SAS16 (S. satapathy *et al.,* 2017) gave antibiotic production maximum in glycerol & minimum in glucose,

starch, and sucrose, *Streptomyces sp.* RUPA-08PR (F.A.Ripa *et al.,* 2009) gave antibiotic production maximum in Glucose and Sucrose & minimum in Lactose, galactose, and maltose, *Streptomyces rochei* (N.Gopi *et al.,* 2011) gave antibiotic production maximum in glycerol, glucose and starch & minimum in sucrose and Arabinose, *Streptomyces fradiae* (Sunanda Kumari Kadiri *et al.,* 2015) gave antibiotic production maximum in Arabinose, Dextrose and maltose & minimum in Sucrose and Lactose.

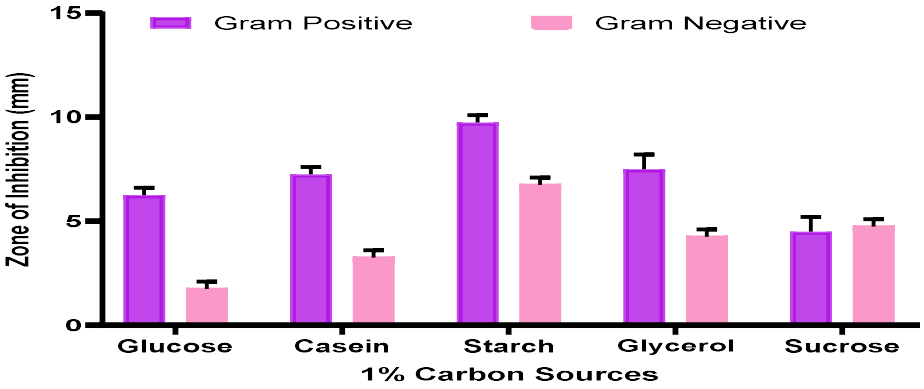


Figure No 10: Effect of Carbone source on Antibiotic production by A16.

3.7.2 Effect of Various Nitrogen source in antibiotic production:

The growth and antagonistic compound production by microorganisms are influenced by nitrogen sources. The effect of various nitrogen sources in antibiotic production was observed by the good diffusion method and a result of potent isolate A3 antibiotic production against gram-positive pathogenic organisms and A3 antibiotic production against gram-negative organisms show in figure no. 11. The result indicated that A3 gave the highest antibiotic production against gram-positive organism in medium supplemented with 1% peptone and 1% ammonium sulfate gave maximum antibiotic production at 48 hours, that kind of similar activity compared against gram-negative organisms in medium supplemented with 1% peptone gave maximum antibiotic production at 48 hours.

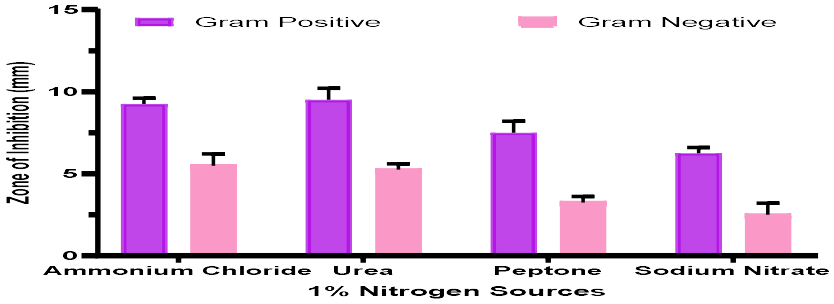


Figure No. 11: Effect of Nitrogen source on Antibiotic production by A3.

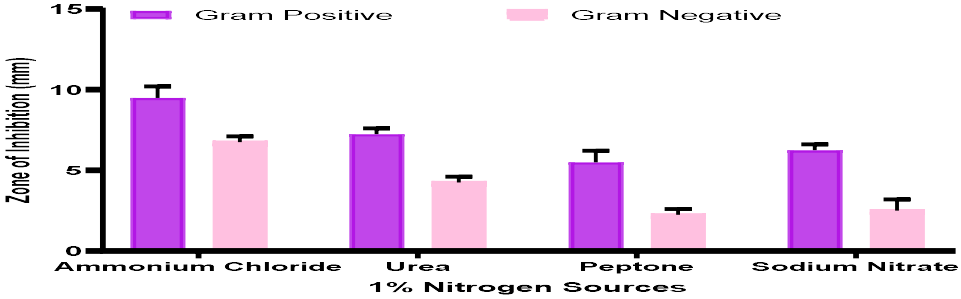


Figure No.12: Effect of Nitrogen source on Antibiotic production by A16

Another potent isolate A16 antibiotic production against gram-positive pathogenic organisms and antibiotic production against gram-negative pathogenic organisms show in figure no.12. The result indicated that A16 gave the highest antibiotic production against gram-positive organisms in medium supplemented with 1% ammonium sulfate gave maximum production 48 hours, that kind similar activity compared against gram-negative organisms in medium supplemented with 1% peptone gave maximum production at 24 hours.

Similar kind of results also reported for, *Streptomyces sp.* KOD10 (S.Febina Bernice Sharon *et al*., 2014) gave antibiotic production maximum in Yeast extract & minimum in peptone and casein. And *Arthrobacter sp.* SAS16 (S. satapathy *et al.,* 2017) gave antibiotic production maximum in casein and asparagine & minimum in ammonium sulfate and peptone, *Streptomyces sp.* RUPA-08PR (F.A.Ripa *et al*., 2009) gave antibiotic production maximum in both nitrogenous compounds yeast extract and sodium nitrate & minimum in ammonium chloride and ammonium sulfate, *Streptomyces rochei* (N.Gopi *et al.,* 2011) gave antibiotic production maximum in peptone and soybean & minimum in beet extract and ammonium sulfate, *Streptomyces fradiae* (Sunanda Kumari Kadiri *et al.,* 2015) gave antibiotic production maximum in casein, soybean, and peptone & minimum in ammonium chloride, ammonium sulfate, and L-.asparagine.

4.0 CONCLUSION

To conclude the results obtained in this study demonstrated that Antibiotic production capacity is not including all of the microorganisms present in the soil. Follows by our Aim best antimicrobial compound producing Actinomycetes we isolate from Dung site soil and Farming soil. Out of sixteen isolates, we get 8 isolates i.e. 50% in dung site soil and Farming soil. The comparative study of antimicrobial activity against gram-positive organisms and gram-negative organisms by sixteen isolates based on the zone of inhibition by point inoculation method. We selected two potent isolates A3 and A16 gave the highest Antimicrobial activity against the gram-positive and gram-negative both types of organisms. Both the isolates A3 and A16 may be identified as a *Streptomyces sp.* and *Saccharothrix sp.* The highest antimicrobial compound production was observed at 48 hours by isolate A3 & A16, The product produced by A3 and A16 is saved for a long time to checked antimicrobial may be antibiotic or not. The results indicated the product produced by isolate A3 is may be antibiotic but A16 maybe not produced antibiotic but maybe it has cytotoxic/antagonistic/antimicrobial characteristics. Effect of carbon sources in antibiotic production we recorded optimum antibiotic production medium containing sucrose by isolate A16 compared to isolate A3 was given in medium containing Glycerol. Effect of Nitrogen sources in antibiotic production we recorded optimum antibiotic production medium containing ammonium sulfate and peptone by isolate A3 compared to isolate A16 was given in medium containing ammonium sulfate and peptone by isolate A16

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CONSTITUTIONAL VALIDITY OF RESERVATION POLICIES IN INDIA

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ABSTRACT

Reservation policies in India represent one of the most significant tools for achieving social justice and equality. Rooted in the historical context of caste-based discrimination, these policies aim to uplift marginalized communities, including Scheduled Castes (SCs), Scheduled Tribes (STs), and Other Backward Classes (OBCs). The Indian Constitution provides a robust framework for such affirmative action through provisions under Articles 14, 15, and 16. However, the constitutional validity of reservation policies has been a subject of continuous debate and judicial scrutiny. Issues such as the 50% ceiling limit, the concept of the creamy layer, reservation in promotions, and the introduction of Economically Weaker Sections (EWS) have raised important legal and constitutional questions. This paper examines the evolution, constitutional provisions, landmark judicial decisions, and contemporary challenges associated with reservation policies in India. It concludes that while reservation policies are constitutionally valid, their implementation must align with the principles of equality, fairness, and the basic structure of the Constitution.

1. INTRODUCTION

India's social structure has historically been shaped by caste-based hierarchies that resulted in systemic discrimination and exclusion of certain communities. After independence, the framers of the Constitution recognized the need to address these inequalities and incorporated provisions for affirmative action in the form of reservations.

Reservation policies aim to ensure representation and equal opportunities in education, employment, and political participation. While they promote social justice, they also generate debates regarding meritocracy, reverse discrimination, and long-term effectiveness.

The constitutional validity of these policies has been tested repeatedly before the judiciary. The Supreme Court has played a crucial role in interpreting the scope and limitations of reservations, ensuring that they conform to constitutional principles.

2. CONSTITUTIONAL FRAMEWORK

2.1 Article 14: Equality before Law

Article 14 guarantees equality before the law and equal protection of laws. However, it permits reasonable classification. Reservation policies are justified as a form of positive discrimination aimed at achieving substantive equality.

2.2 Article 15: Special Provisions

Article 15(1): Prohibits discrimination on grounds of caste, religion, etc.

Article 15(4): Allows special provisions for socially and educationally backward classes.

Article 15(5): Permits reservation in educational institutions, including private institutions (except minority institutions).

Article 15(6): Provides reservation for Economically Weaker Sections (EWS).

2.3 Article 16: Public Employment

Article 16(1): Ensures equality of opportunity in public employment.
Article 16(4): Allows reservation for backward classes.
Article 16(4A): Provides reservation in promotions for SCs and STs.
Article 16(6): Introduces EWS reservation in employment.

2.4 Directive Principles of State Policy

Articles 38 and 46 emphasize the promotion of social justice and protection of weaker sections, reinforcing the legitimacy of reservation policies.

3. HISTORICAL EVOLUTION

3.1 Pre-Independence Era

Reservation policies began during British rule to address caste inequalities, particularly in education and government jobs.

3.2 Post-Independence Developments

After independence, reservations were initially provided for SCs and STs. Later, the Mandal Commission recommended extending reservations to OBCs.

3.3 Mandal Commission Implementation

The implementation of OBC reservation in 1990 marked a turning point, leading to widespread protests and legal challenges.

4. JUDICIAL INTERPRETATION

4.1 Champakam Dorairajan Case (1951)

The Supreme Court invalidated caste-based reservations, leading to the First Constitutional Amendment introducing Article 15(4).

4.2 Indra Sawhney Case (1992)

A landmark judgment that:
Upheld OBC reservations
Introduced the **50% ceiling rule**
Established the **creamy layer concept**
Disallowed reservation in promotions (later modified)

4.3 M. Nagaraj Case (2006)

The Court upheld reservation in promotions but required:
Proof of backwardness
Inadequate representation
Maintenance of efficiency

4.4 Jarnail Singh Case (2018)

The Court simplified conditions for reservation in promotions and reinforced the creamy layer principle.

4.5 Janhit Abhiyan Case (2022)

The Supreme Court upheld the 103rd Constitutional Amendment introducing EWS reservation, even if it breaches the 50% limit.

5. KEY CONSTITUTIONAL ISSUES

5.1 50% Ceiling Rule

The 50% cap aims to balance equality and affirmative action. However, several states have attempted to exceed this limit.

5.2 Creamy Layer Principle

This principle excludes economically advanced individuals within backward classes from reservation benefits.

Debate:

Should it apply to SCs and STs as well?

5.3 Reservation in Promotions

While it ensures representation, it raises concerns about administrative efficiency and merit.

5.4 Economic Reservation (EWS)

EWS reservation marks a shift toward economic criteria.

Controversy:

Whether economic criteria alone justify reservation.

5.5 Equality vs Merit Debate

Critics argue that reservations undermine merit, while supporters emphasize historical injustice and structural inequality.

6. BASIC STRUCTURE DOCTRINE

The **Basic Structure Doctrine** is a fundamental principle of Indian constitutional law which limits the amending power of Parliament under Article 368. According to this doctrine, while Parliament has the authority to amend the Constitution, it cannot alter or destroy its "basic structure" or essential features.

The doctrine was established in the landmark case of **Kesavananda Bharati v. State of Kerala (1973)**. In this case, a 13-judge bench of the Supreme Court held that Parliament can amend any part of the Constitution, including Fundamental Rights, but it cannot change its core framework. This judgment created a balance between parliamentary sovereignty and judicial review.

The Constitution does not explicitly define what constitutes the "basic structure." However, the Supreme Court has identified several essential features over time. These include the **supremacy of the Constitution, rule of law, separation of powers, judicial review, federalism, secularism, democracy, independence of the judiciary, and protection of fundamental rights**. These elements are considered essential for maintaining the identity and integrity of the Constitution.

The doctrine has been applied in several important cases such as **Indira Gandhi v. Raj Narain (1975)** and **Minerva Mills v. Union of India (1980)**, where the Court struck down constitutional amendments that violated basic features. It ensures that Parliament cannot use its amending power to undermine democratic values or establish authoritarian rule.

7. CHALLENGES IN IMPLEMENTATION

7.1 Political Misuse

Reservation policies are sometimes expanded for electoral gains.

7.2 Lack of Updated Data

Absence of reliable data on backwardness affects policy effectiveness.

7.3 Social Divisions

Reservation policies can create tensions between different social groups.

7.4 Ineffective Targeting

Benefits may not always reach the most disadvantaged individuals.

8. COMPARATIVE ANALYSIS

8.1 United States

Affirmative action is based on race but faces strict judicial scrutiny.

8.2 South Africa

Policies focus on correcting historical injustices from apartheid.

8.3 Lessons for India

Need for periodic review
Better targeting of beneficiaries
Balanced approach to equality and merit

9. RECOMMENDATIONS

Reservation policies in India must be continuously refined to ensure that they effectively promote social justice while maintaining constitutional balance. First, there is a need for **periodic review of reservation policies**. Reservations were intended as temporary measures, but they have continued for decades without comprehensive evaluation. Regular assessments based on socio-economic data can help determine their relevance and impact.

Second, the government should focus on **data-driven policy formulation**. A nationwide caste-based socio-economic census would provide accurate information about backwardness and representation, ensuring that benefits reach genuinely disadvantaged groups.

Third, the concept of the **creamy layer should be expanded and strictly implemented**. Extending this principle to all categories, where appropriate, can prevent the misuse of reservation benefits by economically advanced individuals within reserved groups. Fourth, there should be a **balanced inclusion of economic criteria** along with social backwardness. The introduction of EWS reservation is a step in this direction, but clearer guidelines and safeguards are necessary to avoid overlap and inequality. Fifth, emphasis must be placed on **improving access to quality education and skill development**. Reservation alone cannot eliminate inequality; it must be complemented by strong educational infrastructure and capacity-building initiatives. Finally, **political interference in reservation policies should be minimized**. Decisions regarding inclusion or expansion of quotas should be based on objective criteria rather than electoral considerations.

10. CONCLUSION

Reservation policies in India are constitutionally valid and essential for achieving social justice. They reflect the commitment of the Constitution to uplift marginalized communities and promote equality. However, their implementation must be carefully managed to ensure fairness, efficiency, and adherence to constitutional principles. The judiciary has played a critical role in maintaining this balance by imposing limits and safeguards.

Ultimately, the success of reservation policies depends on their ability to address inequality without undermining merit or social harmony. A balanced and evidence-based approach is necessary to ensure that these policies continue to serve their intended purpose in modern India.

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ARTIFICIAL INTELLIGENCE AND THE RIGHT TO PRIVACY UNDER INDIAN CONSTITUTIONAL LAW

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ABSTRACT:

The rapid advancement of Artificial Intelligence (AI) has significantly transformed governance, commerce, and everyday life, raising serious concerns regarding the protection of individual privacy. In the Indian constitutional framework, the right to privacy has been firmly recognized as a fundamental right under Article 21 following the landmark judgment in Justice K.S. Puttaswamy Retd. v. Union of India. This development has profound implications for the regulation of AI technologies, which rely heavily on the collection, processing, and analysis of personal data.

This study examines the intersection of AI and the right to privacy under Indian constitutional law, focusing on how emerging technologies challenge traditional legal safeguards. It critically analyzes issues such as data surveillance, algorithmic decision-making, profiling, and the potential misuse of personal information by both state and private entities. The research further evaluates the adequacy of existing legal frameworks, including the Digital Personal Data Protection Act, 2023, in addressing privacy risks posed by AI systems.

Additionally, the paper explores the role of constitutional principles such as legality, necessity, and proportionality in regulating AI-driven data practices. It highlights the need for transparency, accountability, and ethical AI governance to ensure that technological innovation does not erode fundamental rights. The study concludes by suggesting reforms to strengthen data protection mechanisms and judicial oversight, thereby balancing technological progress with the preservation of individual autonomy and dignity.

KEYWORDS: ARTIFICIAL INTELLIGENCE, RIGHT TO PRIVACY, ARTICLE 21, DATA PROTECTION, SURVEILLANCE, ALGORITHMIC GOVERNANCE, CONSTITUTIONAL LAW, DIGITAL RIGHTS, INDIA.

INTRODUCTION:

The emergence of Artificial Intelligence (AI) has fundamentally altered the way information is generated, processed, and utilized in modern society. From predictive analytics and facial recognition to automated decision-making systems, AI technologies are increasingly embedded in governance, law enforcement, healthcare, and financial services. While these innovations offer efficiency and accuracy, they also pose significant challenges to individual privacy, particularly in a data-driven ecosystem where personal information is constantly collected and analyzed.

In the Indian context, the constitutional recognition of the right to privacy as a fundamental right under Article 21, affirmed in Justice K.S. Puttaswamy (Retd.) v. Union of India, marked a transformative moment in the protection of civil liberties. The judgment established that privacy is intrinsic to life and personal liberty, encompassing informational privacy, bodily integrity, and decisional autonomy. However, the rise of AI technologies has complicated the practical enforcement of this right, as vast quantities of personal data are processed through opaque algorithms, often without meaningful consent or accountability.

AI systems, by their very nature, depend on large datasets, which frequently include sensitive personal information. This raises concerns regarding surveillance, profiling, and potential misuse by both state authorities and private corporations. Technologies such as biometric identification systems, including large-scale initiatives like Aadhaar, illustrate the tension between technological advancement and the preservation of privacy. While such systems aim to enhance service delivery and governance, they also create risks of data breaches, unauthorized access, and mass surveillance.

This study seeks to explore the intersection between Artificial Intelligence and the constitutional right to privacy in India. It examines whether existing legal safeguards are sufficient to address emerging technological risks and evaluates the role of constitutional principles such as proportionality, necessity, and due process in regulating AI-driven systems. By analyzing legal developments, judicial interpretations, and policy frameworks, the research aims to propose a balanced approach that safeguards fundamental rights while fostering responsible innovation in AI.

REVIEW OF LITERATURE:

The intersection of Artificial Intelligence and the right to privacy has attracted significant academic and judicial attention in recent years. Scholars have widely acknowledged that AI-driven technologies, particularly those involving big data analytics and machine learning, present unprecedented challenges to traditional notions of privacy and data protection. The foundational basis of privacy in India stems from the landmark judgment in Justice K.S. Puttaswamy (Retd.) v. Union of India, where the Supreme Court emphasized informational privacy and the need for robust safeguards against arbitrary state intrusion.

Legal scholars such as Upendra Baxi and Gautam Bhatia have critically analyzed the implications of this judgment, highlighting the evolving nature of privacy in the digital age. Their work underscores the importance of balancing individual rights with state interests, particularly in the context of emerging technologies. Additionally, international perspectives, including the European Union's General Data Protection Regulation (GDPR), have influenced Indian discourse by emphasizing principles such as consent, purpose limitation, and accountability in data processing.

Several studies have examined the risks posed by AI systems, including algorithmic bias, lack of transparency, and mass surveillance. Researchers argue that AI can lead to "profiling" and "predictive governance," where individuals are assessed and categorized based on data patterns, often without their knowledge. This concern is particularly relevant in India, where large-scale digital initiatives like Aadhaar have raised debates regarding data security and the potential for misuse of personal information.

Further, scholars have explored the adequacy of India's legislative framework, especially the Digital Personal Data Protection Act, 2023, in addressing privacy concerns associated with AI. While the Act introduces key concepts such as data fiduciaries and user consent, critics argue that it lacks comprehensive provisions on automated decision-making and algorithmic accountability. Comparative studies suggest that India's approach is still evolving and requires stronger enforcement mechanisms and clearer guidelines on AI governance.

Judicial decisions beyond Puttaswamy, such as Kharak Singh v. State of Uttar Pradesh and Maneka Gandhi v. Union of India, have also contributed to the development of privacy jurisprudence by

expanding the scope of personal liberty and due process. These cases provide a constitutional foundation for analyzing modern technological challenges, including those posed by AI.

OBJECTIVES OF THE STUDY:

To analyze the concept and scope of the right to privacy as a fundamental right under Article 21 of the Indian Constitution, with special reference to the judgment in Justice K.S. Puttaswamy v. Union of India.
To examine the nature, functioning, and growing use of Artificial Intelligence in governance, law enforcement, and commercial sectors in India.

To identify and evaluate the key privacy challenges posed by AI technologies, including data surveillance, profiling, and algorithmic decision-making.

To assess the adequacy and effectiveness of existing legal and regulatory frameworks, particularly the Digital Personal Data Protection Act, 2023, in safeguarding individual privacy against AI-related risks.
To explore the role of constitutional principles such as legality, necessity, proportionality, and due process in regulating the use of AI technologies.

To study the implications of large-scale data-driven initiatives like Aadhaar on informational privacy and data protection.

To suggest legal and policy reforms for ensuring transparency, accountability, and ethical use of AI while protecting fundamental rights.

RESEARCH METHODOLOGY:

The present study adopts a doctrinal and analytical research methodology to examine the interface between Artificial Intelligence and the right to privacy under Indian constitutional law. The research is primarily based on secondary sources of data, including constitutional provisions, statutes, judicial decisions, scholarly articles, books, reports, and online databases.

The doctrinal approach involves a detailed analysis of legal texts and judicial pronouncements, particularly the landmark case of Justice K.S. Puttaswamy (Retd.) v. Union of India, which forms the foundation of privacy jurisprudence in India. Other relevant case laws and constitutional interpretations have also been examined to understand the evolution and scope of the right to privacy. The study further analyzes statutory frameworks such as the Digital Personal Data Protection Act, 2023 to evaluate their effectiveness in addressing privacy concerns arising from AI technologies. Comparative references to international legal standards and practices have also been considered to provide a broader perspective on data protection and AI regulation.

An analytical method has been used to critically assess the impact of AI on privacy rights, focusing on issues such as surveillance, data processing, algorithmic bias, and lack of transparency. The research also incorporates a conceptual analysis of constitutional principles like proportionality, necessity, and due process to determine their applicability in regulating AI-driven systems.

LEGAL FRAMEWORK:

The legal framework governing the intersection of Artificial Intelligence and the right to privacy in India is rooted in constitutional principles, judicial interpretations, and statutory provisions. The cornerstone of privacy protection lies in Article 21 of the Indian Constitution, which guarantees the right to life and

personal liberty. This right was expansively interpreted by the Supreme Court in Justice K.S. Puttaswamy (Retd.) v. Union of India, where privacy was recognized as an intrinsic part of fundamental rights. The judgment also established key principles such as legality, necessity, and proportionality as essential tests for any restriction on privacy.

In addition to constitutional protections, statutory law plays a crucial role in regulating data and privacy concerns arising from AI technologies. The enactment of the Digital Personal Data Protection Act, 2023 marks a significant step toward creating a structured data protection regime in India. The Act introduces concepts such as data fiduciaries, data principals, consent requirements, and obligations for lawful processing of personal data. However, while the Act addresses general data protection concerns, it does not comprehensively regulate specific challenges posed by AI, such as automated decision-making, algorithmic transparency, and accountability.

Furthermore, sector-specific regulations and guidelines also contribute to the legal landscape. Government initiatives and digital governance programs, including Aadhaar, have been subject to judicial scrutiny to ensure that they comply with privacy standards. The Supreme Court, in its Aadhaar judgment, upheld the validity of the scheme but imposed limitations to safeguard individual privacy and prevent misuse of data.

legal framework in India represents a developing structure that attempts to balance technological advancement with constitutional safeguards. However, there remains a clear need for more specific regulations and guidelines tailored to Artificial Intelligence, ensuring that innovation does not come at the cost of fundamental rights, particularly the right to privacy.

FINDINGS AND SUGGESTIONS:

Findings:

The study reveals that the rapid growth of Artificial Intelligence has outpaced the development of legal safeguards necessary to protect the right to privacy in India. Although the Supreme Court, in Justice K.S. Puttaswamy (Retd.) v. Union of India, firmly established privacy as a fundamental right under Article 21, its practical enforcement in the context of AI remains limited and evolving.

It is observed that AI systems depend heavily on large-scale data collection, which increases the risk of privacy violations, including unauthorized surveillance, data breaches, and misuse of personal information. Programs such as Aadhaar demonstrate both the benefits and risks of centralized data systems, where efficiency in governance may come at the cost of individual privacy.

The study also finds that the Digital Personal Data Protection Act, 2023, while a significant legislative step, does not comprehensively address challenges specific to AI, such as algorithmic transparency, automated decision-making, and accountability. The reliance on user consent is often inadequate, as individuals may not fully understand or control how their data is processed by AI systems.

Another key finding is the lack of transparency in AI algorithms, which undermines principles of fairness, natural justice, and due process. The potential for bias and discrimination in AI-driven decisions further raises concerns about equality and dignity, which are essential components of constitutional rights.

Suggestions:

1. Comprehensive AI Regulation:

There is a need for specific legislation or regulatory guidelines dedicated to Artificial Intelligence, addressing issues such as algorithmic accountability, transparency, and ethical use.

2. Strengthening Data Protection Laws:

The scope of the Digital Personal Data Protection Act, 2023 should be expanded to include provisions on automated decision-making, profiling, and the right to explanation.

3. Enhancing Transparency and Accountability:

AI systems should be designed with transparency mechanisms that allow individuals to understand how decisions affecting them are made. Developers and organizations must be held accountable for the outcomes of AI systems.

4. Judicial Oversight:

Courts should play an active role in interpreting constitutional principles in the context of emerging technologies, ensuring that privacy rights are not compromised by technological advancements.

5. Data Minimization and Purpose Limitation:

Organizations should collect only necessary data and use it strictly for specified purposes, reducing the risk of misuse and unauthorized access.

6. Public Awareness and Digital Literacy:

Individuals should be educated about their data rights and the functioning of AI systems, enabling informed consent and better protection of personal information.

7. Independent Regulatory Authority:

Establishing a strong and independent data protection authority can ensure effective enforcement of privacy laws and accountability of both state and private entities.

In conclusion, while AI presents immense opportunities for growth and innovation, it also necessitates a cautious and rights-based approach. Strengthening legal frameworks and aligning them with constitutional values is essential to ensure that technological progress does not undermine the fundamental right to privacy in India.

CONCLUSION:

The rapid evolution of Artificial Intelligence has introduced transformative changes across various sectors, but it has also posed serious challenges to the protection of the right to privacy under Indian constitutional law. As recognized in Justice K.S. Puttaswamy (Retd.) v. Union of India, privacy is a fundamental right intrinsic to life and personal liberty under Article 21. However, the increasing reliance on AI systems, which depend on large-scale data collection and processing, has complicated the practical realization of this right.

This study highlights that while India has made notable progress through judicial recognition and legislative measures such as the Digital Personal Data Protection Act, 2023, the existing framework remains insufficient to fully address the unique challenges posed by AI. Issues such as algorithmic opacity, data surveillance, profiling, and lack of accountability continue to threaten individual autonomy and dignity. Moreover, initiatives like Aadhaar illustrate the delicate balance between technological advancement and the safeguarding of constitutional rights.

The analysis underscores the need for a more robust, technology-specific regulatory approach that integrates constitutional principles such as legality, necessity, and proportionality into AI governance. Ensuring transparency, accountability, and fairness in AI systems is essential to maintain public trust and uphold the rule of law.

In conclusion, the future of AI in India must be guided by a rights based framework that prioritizes the protection of privacy while encouraging responsible innovation. A balanced approach combining strong

legal safeguards, judicial vigilance, and ethical AI practices is necessary to ensure that technological progress enhances, rather than undermines, the fundamental rights guaranteed by the Constitution.

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TAX CHALLENGES IN THE DIGITAL ECONOMY: A STUDY OF GLOBAL MINIMUM TAX FRAMEWORK (OECD BEPS 2.0)

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ABSTRACT

The rapid digitalization of the global economy has fundamentally transformed traditional business models, creating significant challenges for existing tax systems. Multinational enterprises (MNEs), particularly digital companies, can generate substantial profits in jurisdictions without physical presence, leading to tax base erosion and profit shifting (BEPS). In response, the Organization for Economic Co-operation and Development (OECD), through its BEPS 2.0 initiative, has introduced a two-pillar solution, with Pillar Two establishing a global minimum tax framework.

This study examines the tax challenges arising from the digital economy and evaluates the effectiveness of the global minimum tax under the OECD BEPS 2.0 framework. The research adopts a descriptive and analytical methodology using both primary and secondary data. Primary data is collected through a structured questionnaire from 100 respondents, including tax professionals, academicians, and corporate employees. Secondary data is obtained from OECD reports, research articles, and policy papers.

The study highlights that the global minimum tax aims to ensure that large multinational enterprises pay a minimum tax rate of 15% in each jurisdiction, thereby reducing incentives for profit shifting and tax avoidance. The findings indicate that 82% of respondents believe that BEPS 2.0 will improve global tax fairness, while 76% agree that it will reduce tax evasion practices. However, challenges such as compliance complexity, administrative burden, and differences in national tax policies remain significant concerns.

OECD

The study concludes that while the global minimum tax framework represents a major step toward international tax reform, its successful implementation requires global cooperation, policy harmonization, and capacity building in developing countries. The paper provides recommendations for improving the effectiveness of BEPS 2.0 and addressing the evolving challenges of digital taxation.

KEYWORDS: DIGITAL ECONOMY, BEPS 2.0, GLOBAL MINIMUM TAX, OECD, TAX AVOIDANCE, MULTINATIONAL ENTERPRISE

1. INTRODUCTION:

The digital economy has revolutionized global business operations, enabling companies to operate across borders without a physical presence. Digital giants can generate significant revenues in multiple jurisdictions while paying minimal taxes, creating challenges for traditional tax frameworks.

One of the major issues arising from digitalization is Base Erosion and Profit Shifting (BEPS), where multinational enterprises shift profits to low-tax jurisdictions to minimize tax liability. This practice reduces government revenues and creates inequality in taxation.

To address these challenges, the OECD introduced the BEPS 2.0 framework, consisting of two pillars:

Pillar One: Redistribution of taxing rights

Pillar Two: Global Minimum Tax

The global minimum tax ensures that multinational enterprises pay at least 15% tax on profits in each jurisdiction, reducing tax competition and profit shifting.

OECD

The implementation of BEPS 2.0 represents a significant shift in international taxation, aiming to create a fair and transparent tax system in the digital age.

2. LITERATURE REVIEW:

Studies show that digitalization has increased tax avoidance opportunities for multinational firms.

OECD reports emphasize the need for coordinated global tax reforms.

OECD

Research indicates that the global minimum tax reduces incentives for profit shifting.

KPMG

BEPS 2.0 aims to ensure taxation where economic activities occur.

KPMG

Scholars highlight challenges such as compliance burden and policy coordination.

Research Gap:

Limited empirical studies analyze stakeholder perceptions and practical challenges of BEPS 2.0, especially in developing economies like India.

3. OBJECTIVES OF THE STUDY:

To examine tax challenges in the digital economy

To analyze the global minimum tax framework (BEPS 2.0)

To evaluate its effectiveness in reducing tax avoidance

To identify implementation challenges

To provide policy recommendations

4. RESEARCH METHODOLOGY:

Research Design:

Descriptive and Analytical

Data Collection:

Primary Data: Questionnaire (100 respondents)

Secondary Data: OECD reports, journals

Sampling Technique:

Convenience sampling

Tools:

Percentage analysis

Tables and charts

5. DATA ANALYSIS & INTERPRETATION:

Table 1: Awareness of BEPS 2.0

Response	Percentage
Yes	88%
No	12%

Majority respondents are aware of BEPS 2.0.

2: BEPS 2.0 Improves Tax Fairness

Response	Percentage
Strongly Agree	45%
Agree	37%
Neutral	10%
Disagree	8%

82% agree BEPS improves fairness.

Table 3: Reduction in Tax Avoidance

Response	Percentage
Yes	76%
No	24%

Majority believe tax avoidance will reduce.

Table 4: Challenges of BEPS 2.0

Challenge	Percentage
Complexity	35%
Compliance burden	25%
Policy differences	20%
Implementation cost	20%

Complexity is the major issue.

6. FINDINGS:

Digital economy creates major tax challenges
BEPS 2.0 improves fairness and transparency
Global minimum tax reduces profit shifting
High compliance burden remains a concern
Developing countries face implementation challenges

7. SUGGESTIONS:

Simplify global tax rules
Strengthen international cooperation
Provide technical support to developing countries
Improve transparency in multinational reporting
Harmonize tax policies globally

8. CONCLUSION:

The digital economy has significantly disrupted traditional taxation systems, necessitating global reforms. The OECD BEPS 2.0 framework, particularly the global minimum tax, represents a landmark initiative in addressing tax avoidance and ensuring fairness.

However, challenges such as complexity, compliance costs, and global coordination must be addressed for effective implementation. With proper policy measures, BEPS 2.0 can play a crucial role in shaping the future of international taxation.

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THE INTERCONNECTION BETWEEN LITERATURE AND LANGUAGE: A STUDY OF EXPRESSION, CULTURE, AND IDENTITY

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ABSTRACT

Literature and language share an inseparable relationship, as language serves as the medium through which literature is created, interpreted, and preserved. This research paper explores the deep connection between literature and language, focusing on how language shapes literary expression and how literature, in turn, enriches and evolves language. The study highlights the role of literature in reflecting cultural identity, social values, and historical contexts, while also examining how linguistic diversity influences literary forms and styles.

Through qualitative analysis, this paper discusses various literary genres such as poetry, prose, and drama, demonstrating how authors use language creatively to convey emotions, ideas, and cultural narratives. It also explores how literature contributes to language development by introducing new vocabulary, expressions, and stylistic innovations. Furthermore, the paper examines the impact of regional languages and multilingualism on literary richness, particularly in a diverse country like India.

The findings suggest that literature not only preserves language but also transforms it over time, making it dynamic and adaptable. Language acts as both a tool and a subject of literary exploration, enabling writers to experiment with meaning, structure, and style. Ultimately, the study emphasizes that literature and language are mutually dependent, playing a crucial role in shaping human communication, cultural identity, and intellectual growth.

KEYWORDS: LITERATURE, LANGUAGE, CULTURE, IDENTITY, EXPRESSION, LINGUISTICS

INTRODUCTION

Language is the foundation of human communication, while literature is the artistic expression of that communication. Together, they form a powerful combination that shapes human thought, culture, and identity. Literature cannot exist without language, and language finds its richest expression through literature.

This research paper aims to explore the relationship between literature and language, focusing on how they influence each other. Language provides the structure and vocabulary necessary for literary creation, while literature enhances language by expanding its expressive potential.

In today's globalized world, understanding this relationship is more important than ever. Literature reflects social realities, cultural values, and historical experiences, all of which are communicated through language. Therefore, studying literature also means studying language in its most creative and meaningful form.

ROLE OF LANGUAGE IN LITERATURE

Language is the primary tool used by writers to create literature. Without language, there would be no stories, poems, or plays. The effectiveness of a literary work depends largely on how skillfully language is used.

Writers use various linguistic techniques such as metaphor, symbolism, imagery, and tone to convey meaning. For example, poetic language often includes rhythm and rhyme, while prose focuses more on narrative flow and clarity.

Language also determines the style of a literary work. A formal language style may be used in academic or classical literature, while informal or conversational language is often found in modern writing. The choice of language influences how readers interpret the text.

Moreover, language allows writers to express emotions and ideas in a powerful way. Through carefully chosen words, authors can evoke feelings such as joy, sadness, anger, or hope.

LITERATURE AS A REFLECTION OF CULTURE

Literature serves as a mirror of society. It reflects the traditions, beliefs, values, and experiences of a particular culture. Since language is closely tied to culture, literature written in a specific language often carries cultural meanings that may not be easily translated.

For example, Indian literature in languages like Hindi, Gujarati, and Tamil reflects regional customs, traditions, and social issues. Folk tales, myths, and classical texts preserve cultural heritage and pass it on to future generations.

Language plays a crucial role in this process. It carries cultural symbols, idioms, and expressions that are unique to a community. Through literature, these elements are preserved and celebrated.

INFLUENCE OF LITERATURE ON LANGUAGE DEVELOPMENT

Literature not only uses language but also contributes to its development. Many new words, phrases, and expressions originate from literary works. Famous writers often introduce innovative language styles that influence everyday communication.

For instance, literature can:

Expand vocabulary

Introduce new expressions

Influence grammar and syntax

Shape language trends

Over time, literary works become part of the linguistic heritage of a society. They help standardize language and provide models for correct and creative usage.

LITERARY GENRES AND LANGUAGE USE

Different literary genres use language in unique ways:

*Poetry

Poetry uses highly expressive and condensed language. It often includes:

Rhythm and rhyme

Figurative language
Emotional intensity
*Prose
Prose includes novels, short stories, and essays. It uses:
Narrative structure
Descriptive language
Character dialogue
*Drama
Drama is written for performance. Language in drama includes:
Dialogues
Monologues
Stage directions
Each genre demonstrates the flexibility and richness of language.

MULTILINGUALISM AND LITERARY DIVERSITY

In multilingual societies like India, literature exists in multiple languages. This diversity enriches literary expression and allows for a wide range of perspectives.

Writers often mix languages or translate works from one language to another. This creates cross-cultural understanding and expands the reach of literature.

However, translation can be challenging because some meanings and cultural nuances may be lost. Despite this, multilingual literature plays a vital role in promoting unity and diversity.

LANGUAGE, IDENTITY, AND LITERATURE

Language is closely linked to identity. It reflects who we are, where we come from, and how we see the world. Literature uses language to explore personal and social identity.
Through literature, writers express:
Personal experiences
Cultural identity
Social issues
Readers, in turn, connect with these themes and gain a deeper understanding of themselves and others.

CHALLENGES IN LITERATURE AND LANGUAGE

Despite their importance, literature and language face several challenges:
Decline in reading habits
Dominance of global languages like English
Loss of regional languages
Difficulty in translation
These challenges can affect the preservation and growth of literature. Therefore, efforts must be made to promote reading and protect linguistic diversity.

CONCLUSION

The relationship between literature and language is deeply interconnected. Language provides the foundation for literary expression, while literature enriches and develops language.

Together, they play a crucial role in shaping culture, identity, and communication. Literature preserves cultural heritage, reflects social realities, and promotes creativity. Language, on the other hand, evolves through literary innovation and usage.

In conclusion, literature and language are not separate entities but parts of a unified system that defines human expression. Understanding this relationship helps us appreciate the power of words and the beauty of literary art.

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