1st INTERNATIONAL CONFERENCE

On

Synergy 2025:

A Multi Disciplinary Forum for Collaborative Research and Innovation January 2025

In Online & Offline Mode
10th & 11th January 2025
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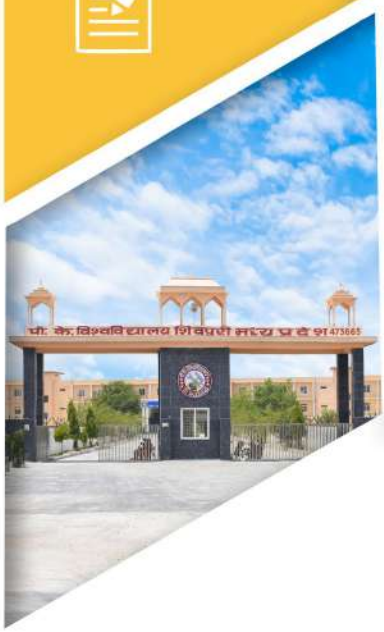

In Collaboration with
P.K. University & CIIS Mumbai

ISBN Number: 978-93-95305-78-5

www.airo.co.in

January 2025
ISBN Number: 978-93-95305-78-5

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Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

"A MACHINE LEARNING TECHNIQUE USED FOR SOCIAL MEDIA FAKE PROFILE DETECTION"

Abhimanyu Nayak
PhD Scholar B.I.T Sindri Dhanbad-828123
(abhin.rs.cse19@bitsindri.ac.in)
Prof(Dr) D.K Singh
Guide
V.C J.U.T Ranchi Jharkhand-834010
(dksingh.bits@gmail.com)

Abstract

Fake profiles have become the most significant problem due to rapid expansion of social media, threatening user privacy, security, and integrity online. This paper aims to improve the precision of false profile identification based on machine learning approaches used in identifying fraudulent accounts. Random Forest, XGBoost, and LSTM are the three machine learning models that are trained and evaluated. Specifically, 75 of the profiles in the MIB dataset are real, while the other 75 are false. This creates a balanced dataset of 150 profiles. The models are assessed using measures such as recall, accuracy, precision, F1-score, and ROC curve. The findings demonstrate that XGBoost performed better than the other models. Its accuracy was 98.7%, precision was 97.8%, recall was 99.0%, and the F1-score was 98.4%, indicating that XGBoost has the potential to detect fake profiles more effectively. It's, on the contrary, quite worse for LSTM, with an accuracy of only 89.3%, whereas the performance for Random Forest resulted at 93.3% accuracy. The confusion matrix and ROC curve analysis further enhanced XGBoost's outstanding performance through its lowest false positive rate and the greatest true positive rate. The study ends with showing how well the machine learning models, specifically XGBoost, detect fake social media profiles, with insights for enhancing social media security and fighting online fraud.

Keywords: *Machine Learning techniques, Fake Profile Detection, Social Media Security, Random Forest, XGBoost, Long Short-Term Memory (LSTM).*

1. INTRODUCTION

Social media is pretty important in today's world. Social media is an integral part of life. Whether it is a case to be aware of celebrities, share pictures or cost hundreds and thousands of dollars, beauty images, or to have both local and distant friends, social media is applied by everyone. It's an excellent place for interacting socially and sharing knowledge. But everything has a flip side. Our lives are significantly affected by social media, but sometimes it turns out to be harmful as well.

ISBN Number: 978-93-95305-78-5

Twitter has 229 million daily active users and 465.1 million monthly active users, according to the company. Plus, every day, Facebook gets six new users, for a total of about half a million. Every day, people share a tremendous amount of information on Twitter. In addition to trending stories, the most recent hashtag, and trip updates are all available on Twitter. The 280-character limit allows for the following actions: replying, liking, commenting, exchanging ideas, and expressing opinions. There are a lot of rumours, but there are also a lot of serious stuff being confirmed. The disparities in social status are becoming more pronounced as a result of these rumours. Misinformation, cyberbullying, exploitation, and privacy concerns have all surfaced recently. Additionally, fictitious profiles are utilized in each of these instances. Anyone, including humans, cybernetic beings, and machines, is capable of fabricating an account. Though they were initially created by people, computers now run the "cyborg" accounts. For several reasons, including spreading conspiracy theories against vaccines and rude and defamatory posts and images, fraudulent profiles created under fictitious names are common.

False profiles are a problem on every social media platform right now. Accumulating a large number of followers, sending out spam, and engaging in phishing are the main goals of most of the fake profiles. Complete online criminal activity is possible with the help of these fraudulent accounts. There is a significant danger of data breach and identity theft due to the bogus accounts. These compromised accounts transfer all user data to distant servers, which can then utilize it against users anytime they visit the URLs they sent. False profiles purporting to represent real people or businesses can damage their reputation and garner them less followers and likes. But among all of these, propaganda on social media stands head and shoulders above the others. Disagreements emerge when false accounts disseminate incorrect and improper content.

1.1. Objectives of the Study

- To create and assess machine learning models (LSTM, XGBoost, and Random Forest) for identifying phony social media profiles.
- To evaluate these models' performances using measures including ROC curve analysis, F1-score, recall, accuracy, and precision.

2. LITERATURE REVIEW

Elyusufi (2020) aimed to track down social media scammer accounts. Techniques used for identifying sham social media profiles may be divided into two: namely, those who focused on observing certain account and profile details. Some of the most damaging kinds of cybercrimes were perceived to be created

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fake social networking profiles. Detection of such an activity even before a user was informed of a spurious profile was of immense importance. A vast amount of literature has suggested wide-ranging algorithms and methods in the identification of fake profiles. This article described how complex persistent threats work through phony identities and included the previously discussed methods for detecting spurious social media pages. To generate an appropriate prediction of actual or artificial profiles, the research analyzed the performance of three supervised machine learning algorithms: Random Forest (RF), Decision Tree (DT-J48), and Naïve Bayes (NB).

Bhattacharya et al. (2021) aimed at designing a model that would help to detect fraudulent social media profiles by applying machine learning methods for improving the accuracy and detection of frauds. Billions of people across the globe connected through various social media applications to exchange images and ideas throughout this pandemic period. Social media has evolved as a prime means of interaction, making it a critical component to boost user interaction. It entertained, allowed for the keeping in touch of far-off friends, was an update on the numbers of coronavirus cases in the world, and even helped many launches and grow online small businesses. However, despite all the benefits of social media, there are serious drawbacks, such as impersonation and fake profiles.Cyborg accounts or human-generated personas, as well as computer-generated bots, have increased the number of these issues on social media sites. Often, these accounts were created with malicious intent. Although the problem was deteriorating, no feasible solution was found. Since Instagram data was easily accessible, it was considered for this project. Machine learning methods that produced the highest accuracy on the dataset were used in the analysis. Accurate identification of fraudulent profiles would enhance user safety on social media sites.

Chakraborty et al. (2022) asserted that XGBoost constituted the most effective machine learning strategy for identifying fraudulent accounts. Many people's lives have been profoundly affected by social networking sites like Facebook, Instagram, LinkedIn, and Twitter. Participants on these sites came from all across the globe. However, the issue of fake profiles still existed. Often created by computers, bots, or humans, these fake accounts were utilized to spread rumors and commit illegal operations such as phishing and identity theft. Based on the criteria which included follower and friend counts, status updates, among other characteristics, the authors of this project provided a detection model that applied several algorithms to distinguish between legitimate and spam Twitter accounts. As informed by the profile details of Twitter, the authors divided phony accounts into three subgroups: INT, TWT, and FSF; actual accounts into two categories, that is, TFP and E13. They have discussed using neural networks, LSTM, XGBoost and

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Random Forest for the detector model. To test the legitimacy of a social media profile, they have chosen the essential attributes. The architecture and hyperparameters were also addressed. This produced output following model training wherein 0 indicated authentic and 1 fraudulent profile. With such cyber security problems arising, the profile could have been blocked or removed once this has been identified. Implementations were done using Python as well as required libraries namely, Sklearn, Numpy, and Pandas.

Mughaid et al. (2023) identified the risks to online social networks and a digital face-processing authentication proposed as a two-factor authentication following the entering of a password using Matlab. The authors got the best accuracy, that is 95%, following deep learning categorization from training the model on a real dataset obtained from a live camera. However, there are many social networks that do not employ these measures of protection yet, and this brings us to one of the major problems of OSNs: fake accounts. These accounts were used by attackers to successfully conduct phishing attacks, malware distribution campaigns, and spam campaigns. Fake accounts can be said to cost companies money in losses, harm their reputation, steal data for negative reasons, and so much more. The analysis of this research is to determine genuine from fraudulent profiles on OSNs. For this purpose, the authors utilized two datasets from Facebook and Instagram that contained both genuine and fake profiles. They used machine learning algorithms such as Naive Bayes, Support Vector Machines (SVM), K-Nearest Neighbour (KNN), Boosted Tree, Neural Networks, SVM Kernel and Logistic Regression Kernel on datasets having different variables. Among them, the best performing model for datasets of detection of Fake Profiles was 97.1% accurate SVM.

3. METHODOLOGY

3.1. Research Design

This study employed a quantitative design and supervised machine learning to detect fraudulent social media profiles. The objective was to design and evaluate algorithms that would classify profiles as either phony or authentic using characteristics derived from social media data. The research employed a controlled experimental environment to test the effectiveness of several machine learning models in detecting fraudulent profiles.

3.2. Dataset Sampling

150 profiles—75 real and 75 fake—of a subset of the MIB dataset were used. Sampling was employed to keep the ratio of genuine to fraudulent profiles equal, so guaranteeing a balanced representation of all

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groups. For the purpose of profile classification, features such as E13 and TFP were utilized for legitimate accounts, whereas TWT, INT, and FSF were utilized for fraudulent accounts. So that machine learning algorithms might make good use of it, this sample dataset was saved in a CSV format.

3.3. Conversion to CSV File

The sampled dataset originally in Excel format was changed to CSV format using a program such as Google Sheets or Microsoft Excel. It ensured compatibility with the various machine learning frameworks for model testing and training.

3.4. Data Pre-processing

Pre-processing was applied on the sampled data to incorporate missing values by replacing with zeros. The dataset was normalized in terms of the numerical value after eliminating the irrelevant categorical data. The data preparation to prepare the data to train the models efficiently involves classification of every profile into "real" or "fake" with Boolean values 1 for real, and 0 for false.

3.5. Model Selection

The sampled dataset was analyzed using the following machine learning models:

1. **Random Forest:** An ensemble technique in which the decision-making result is a majority vote among the predictions from many decision trees.
2. **Extreme Gradient Boosting (XGBoost):** A boosting technique that supports missing data and is further optimized for higher accuracy.

The type of RNN intended for sequential data analysis, and it is Long Short-Term Memory (LSTM). It's actually built for profile evaluation, with activity sequences (like in tweets). To be more precise, this sample with 150 profiles was taken for training, testing, and evaluation purposes so that these models can have enough computational efficiency in identifying those phony profiles.

4. DATA ANALYSIS

The performance of the trained models on the MIB dataset was evaluated using a variety of metrics, including accuracy, precision, recall, and F1-score. The models employed to detect false profiles produced the following findings:

Table 1: Evaluation of Model Efficiency

Model	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
Random Forest	93.3	91.7	94.7	93.2
XGBoost	98.7	97.8	99.0	98.4

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LSTM	89.3	88.2	90.5	89.3

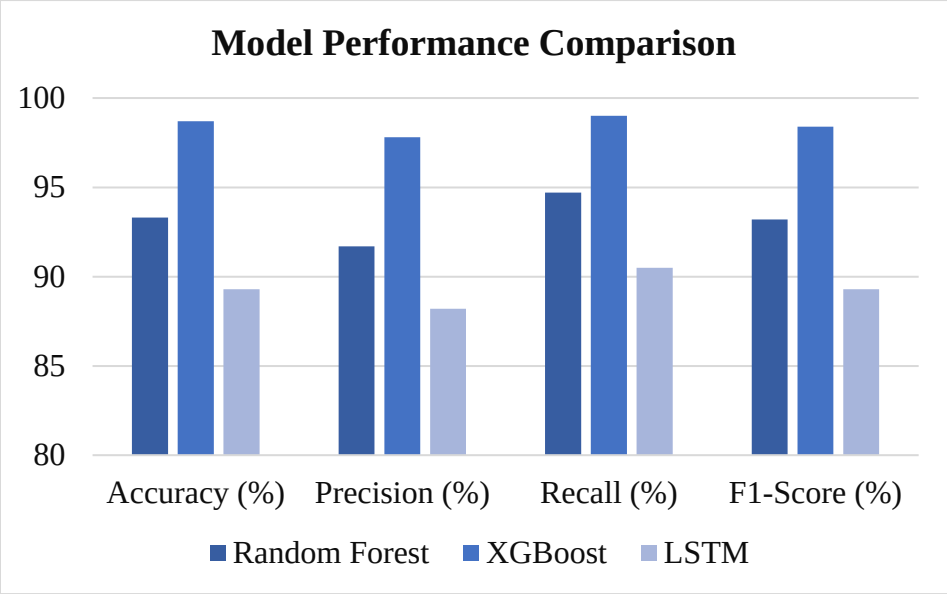

Figure 1: Evaluation of Model Efficiency

Table 1 compares the accuracy, precision, recall, and F1-score, three important metrics for false profile detection, of three machine learning models: Random Forest, XGBoost, and LSTM. With a 98.7 percent accuracy rate, 97.8 percent precision, 99.0 percent recall, and 98.4 percent F1-score, XGBoost has surpassed previous models in detecting fraud profiles with few false positives and negatives. Random Forest is little below XGBoost, but still quite good, with 93.3% accuracy, 91.7% precision, 94.7% recall, and 93.2% F1-score. Although LSTM is functional, it has the weakest metrics—89.3% accuracy, 88.2% precision, 90.5% recall, and an F1-score of 89.3%—which highlights its rather restricted uses in this context. Based on these findings, XGBoost stands out as the top model for spotting fake profiles in the provided dataset.

Table 2: Confusion Matrix for XGBoost Model

Actual \ Predicted	**Real**	**Fake**
Real	72	3
Fake	1	74

The confusion matrix for the XGBoost model is given in Table 2. It indicates a good true positive rate, with 72 real profiles classified as real and 74 false profiles as phony. There are three real profiles classified as phony, which can be referred to as false positives. The other two false negatives were fraudulent profiles

ISBN Number: 978-93-95305-78-5

classified as real. These low misclassifications show that the model is highly applicable for the identification of fake profiles in this investigation and demonstrates remarkable accuracy and dependability in differentiating between actual and fake profiles.

Table 3: Model Comparison – ROC Curve

Model	AUC Score	False Positive Rate	True Positive Rate
Random Forest	0.965	0.07	0.94
XGBoost	0.991	0.03	0.98
LSTM	0.910	0.10	0.89

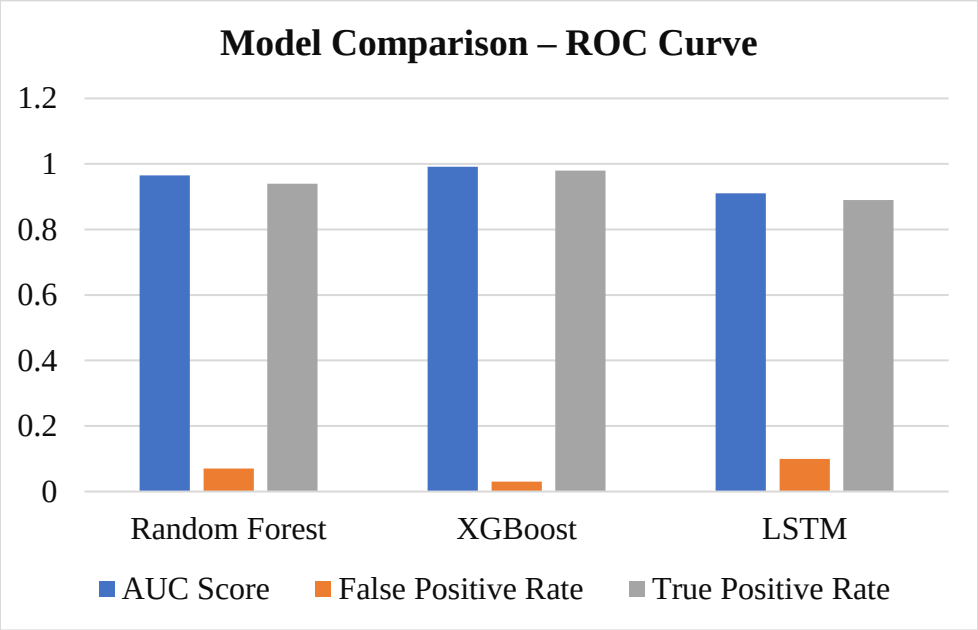

Figure 2: Model Comparison – ROC Curve

Table 3 shows a comparison of the models' measures of the ROC (Receiver Operating Characteristic) curve, such as AUC scores, false positive rate, and true positive rate. In this case, the model XGBoost showed impressive performance with an AUC score of 0.991, and close-to-perfect classification capabilities. The ability of the model in being able to distinguish effectively between a real and spam profile is further supported, since it holds the lowest rate of false positive (0.03) and the highest true positive rate (0.98). The performance on the AUC score with 0.965 means false positive was at 0.07, a true positive of 0.94, and falls on the second position of reliability though a little worse in terms of performance than XGBoost. With a worst case of true positive of 0.89, false positive at 0.10, and the least

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of the AUC scores that have been obtained in 0.910, LSTM was on its worst performance with the poor classification test. This comparison has highlighted XGBoost as the most successful model in the study for detecting phony profiles.

5. CONCLUSION

Machine learning algorithms can detect fake social media accounts, according to the study's last finding. In terms of accuracy, precision, recall, and F1-score, XGBoost outperformed all of the other models that were evaluated. In this scenario, LSTM performed less well; however, Random Forest likewise showed excellent performance. Further evidence for the ROC curve study and confusion matrix is how XGBoost is strong against false positives and negatives; therefore, it stands as the most reliable model in this activity. Findings show that using machine learning techniques adds value to improving fraudulent profiles identification and hence social media security and legitimacy.

REFERENCES

1. *Bharti, N. S. G., & Gulia, P. (2023). Exploring machine learning techniques for fake profile detection in online social networks. Int. J. Electr. Comput. Eng. IJECE, 13(3), 2962.*
2. *Bhattacharya, A., Bathla, R., Rana, A., & Arora, G. (2021, September). Application of machine learning techniques in detecting fake profiles on social media. In 2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions)(ICRITO) (pp. 1-8). IEEE.*
3. *Chakraborty, P., Shazan, M. M., Nahid, M., Ahmed, M. K., & Talukder, P. C. (2022). Fake profile detection using machine learning techniques. Journal of Computer and Communications, 10(10), 74-87.*
4. *Elyusufi, Y., Elyusufi, Z., & Kbir, M. H. A. (2020). Social networks fake profiles detection using machine learning algorithms. In Innovations in Smart Cities Applications Edition 3: The Proceedings of the 4th International Conference on Smart City Applications 4 (pp. 30-40). Springer International Publishing.*
5. *Joshi, U. D., Vanshika, Singh, A. P., Pahuja, T. R., Naval, S., & Singal, G. (2021). Fake social media profile detection. Machine Learning Algorithms and Applications, 193-209.*
6. *Kadam, N., & Sharma, S. K. (2022). Social media fake profile detection using data mining technique. Journal of Advances in Information Technology Vol, 13(5).*
7. *Kaushik, K., Bhardwaj, A., Kumar, M., Gupta, S. K., & Gupta, A. (2022). A novel machine learning-based framework for detecting fake Instagram profiles. Concurrency and Computation: Practice and Experience, 34(28), e7349.*

ISBN Number: 978-93-95305-78-5

8. *Latha, P., Sumitra, V., Sasikala, V., Arunarasi, J., Rajini, A. R., & Nithiya, N. (2022, March). Fake profile identification in social network using machine learning and NLP. In 2022 International Conference on Communication, Computing and Internet of Things (IC3IoT) (pp. 1-4). IEEE.*

9. *Meshram, E. P., Bhambulkar, R., Pokale, P., Kharbikar, K., & Awachat, A. (2021). Automatic detection of fake profile using machine learning on instagram. International Journal of Scientific Research in Science and Technology, 8(1), 117-127.*

10. *Mughaid, A., Obeidat, I., AlZu'bi, S., Elsoud, E. A., Alnajjar, A., Alsoud, A. R., & Abualigah, L. (2023). A novel machine learning and face recognition technique for fake accounts detection system on cyber social networks. Multimedia Tools and Applications, 82(17), 26353-26378.*

11. *Patel, K., Agrahari, S., & Srivastava, S. (2020, June). Survey on fake profile detection on social sites by using machine learning algorithm. In 2020 8th international conference on reliability, infocom technologies and optimization (trends and future directions)(ICRITO) (pp. 1236-1240). IEEE.*

12. *Sahoo, S. R., & Gupta, B. B. (2020). Fake profile detection in multimedia big data on online social networks. International Journal of Information and Computer Security, 12(2-3), 303-331.*

13. *Sahoo, S. R., & Gupta, B. B. (2021). Multiple features-based approach for automatic fake news detection on social networks using deep learning. Applied Soft Computing, 100, 106983.*

14. *Singh, N., Sharma, T., Thakral, A., & Choudhury, T. (2018, June). Detection of fake profile in online social networks using machine learning. In 2018 International Conference on Advances in Computing and Communication Engineering (ICACCE) (pp. 231-234). IEEE.*

15. *Tiwari, V. (2017, May). Analysis and detection of fake profile over social network. In 2017 International Conference on Computing, Communication and Automation (ICCCA) (pp. 175-179). IEEE.*

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

ROLE OF ARTIFICIAL INTELLIGENCE (A.I.) IN INDIAN JUDICIARY SYSTEM

Amar Nath Dixit
Research Scholar
Faculty of Law
Mangalayatan University

Abstract

Justice has dealt with procedural delays for decades, contributing to the rise of Artificial Intelligence (AI) to face the problem. Therefore, it is essential to understand and analyze the implications of AI on speedy trial and how AI can accelerate judicial processes. To this end, we conducted a case study at the Supreme Court of Brazil (STF), collecting documents and conducting interviews for content analysis. The results consolidated a framework model that combines resources and impacts of AI on the velocity of legal decisions demonstrating how and what solutions contribute for judgment, pre-trial, and legal support. Therefore, it is believed that the gain in procedural speed with AI is not just a myth. It can become a reality, but with limitations, because there is a long way between the use of this technology in merely operational tasks and its use in complex activities such as evaluating processes in their entirety. For these future challenges, we highlight research proposals for more effective advances.

Introduction

For decades, the role of the Judiciary in several countries has been considered precarious (Bielen, Peeters, Marneffe, & Vereeck, 2017; French, 1933; Friesen & Information, 1984). In this context, one of the most debated issues is the speedy trial, which is related to the system's ability to respond to the demand by the Judiciary at an appropriate time (Ippoliti, Melcarne, & Ramello, 2014). Nevertheless, it has been observed high costs, long delays for the completion of proceedings and, consequently, procedural congestion (Gomes, Alves, & Silva, 2018).

Notwithstanding historical progress, delays and other problems in public services persist and are addressed continuously with Information and Communication Technology (ICT) (Dutta et al., 2019; Kum, Duncan, & Stewart, 2009). In this sense, Artificial Intelligence (AI) has been drawing attention (Chen, Guo, Gao, & Liang, 2019; de Sousa, De Melo, De Souza, Farias, & Gomes, 2019; Kankanhalli, Charalabidis, & Mellouli, 2019; Levmore & Fagan, 2019). There are courts in several countries that adhere to this technology (Alshahrani, Dennehy, & Mäntymäki, 2021; Julius, 2018).

ISBN Number: 978-93-95305-78-5

Zeleznikow (2017), for example, presents the online dispute resolution systems (Online Dispute Resolution - ODR), which have proved to be a good option for improving the speed. On the other hand, Langbroek (2019) points out that AI does not appear to be the solution for reducing procedural stock or for increasing speed. It only reports that this technology can provide other types of benefits, such as improving the assertiveness of the evidence.

Thus, there are divergent hypotheses, but without checking the implications of AI on speedy trials and the factors associated with this phenomenon. Therefore, it is not clear whether the expected evolution occurs, which is corroborated by recent studies, which warn about the importance of understanding what the implications of new technologies for legal institutions are - with emphasis on AI (Andrade & Joia, 2012; Gomes et al., 2018; Iriberri, 2015; Omoteso, 2012; Wallace, 2017).

In addition to the whole context involving AI and speedy trials, de Sousa et al. (2019) draw attention to the need to investigate the use of AI in specific areas of the public sector, which constitutes a promising research opportunity. This study seeks to understand and analyze the use of AI in the Judiciary, more specifically, the contributions and limitations of this technology in the speedy trial.

To attend this objective, the Brazilian Superior Federal Court (STF) was selected for a case study, considering the analysis perspectives present in the literature. This study analyzes the STF's experience from the point of view of the implications of AI in the speedy trial. It also presents how AI has contributed to accelerating legal proceedings and obtaining a path for quantitative research that allows generalization.

The remainder of this paper is structured as follows. Section 2 presents the main concepts related to AI and speedy trial. Section 3 describes the research methods and techniques applied, detailing the case study and the literature review. Next, section 4 presents the results and discussions. In this section, it discusses the framework of the impact of AI on speedy trial. Finally, section 5 presents the conclusion, demonstrating the limitations of this study, and potential future researches.

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Section snippets

Juridical system and speedy trial

The Judiciary is responsible for compliance with the laws. Hence, it performs five functions: Administrative, Enforceable, Declaratory, Conciliatory, and Judicative. The effectiveness of applying these functions is continuously questioned due to problems related to speedy trial (Whalen-bridge, 2019).

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Speed is related to the time between the filing or termination and trial of a case. It addresses variables of time, productivity, and procedural congestion (Mery, 2015; Staats, Bowler, Hiskey,

Research method

The research presents a qualitative approach and uses the case study technique (Godoy, 1995; Soy, 1997; Yin, 1984). The logic is inductive since starting from particular facts intended to reach a general conclusion (Medeiros, 2006). It is descriptive because it seeks to describe characteristics of a specific phenomenon (Vergara, 1998) and exploratory because it can support the construction of a theory in a not very sedimented field of knowledge, it has a small sample and qualitative data

The federal supreme court and the adoption of technologies based on AI

The institution chosen for the case study was the Federal Supreme Court (STF), the highest Court in the hierarchy of the Brazilian Judiciary system. It is responsible for ensuring that the legal rules follow the dictates of the Brazilian Constitution (Filho, 2016).

Among its main attributions is to judge direct actions of unconstitutionality and declaratory actions of the constitutionality of laws, as well as the plea of noncompliance with a fundamental precept arising from the Constitution

Discussion

In this section, we will analyse the case study results in comparison with the overview presented in the literature. We found that the high volume of demand is the main factor of a negative impact on speed, which causes the congestion of lawsuits, raising the cost of justice.

At this point, it is possible to verify that the managers assign the responsibility for the body's slowness to external factors. Nonetheless, there can be solved, or at least mitigate, reviewing internal aspects, which go

Conclusion

The general scenario of the Judiciary is one of high procedural congestion, generated by high demand and low speed in resolving cases. The social repercussions of this situation are severe, which has placed speed trial as a priority for courts worldwide. In this scenario, the AI application stands out to solve this problem. The question that gave meaning to the research (Artificial Intelligence and speedy trial in the Judiciary: myth, reality or necessity? A case study in the Brazilian Supreme

Authorship statement

ISBN Number: 978-93-95305-78-5

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript. Furthermore, each author certifies that this material or similar material has not been and will not be submitted to or published in any other publication before its appearance in the Government Information

CRediT authorship contribution statement

Weslei Gomes de Sousa: Project administration, Supervision, Validation, Conceptualization, Writing – review & editing, Writing – original draft. Rafael Antunes Fidelis: Writing – review & editing, Writing – original draft, Methodology, Methodology, Formal analysis, Investigation. Paulo Henrique de Souza Bermejo: Project administration, Supervision, Validation, Conceptualization. Ana Gersica da Silva Gonçalo: Writing – original draft, Formal analysis, Investigation, Data curation. Bruno de Souza

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Weslei Gomes de Sousa is Graduated in Electrical Engineering by Institute of Higher Education of Brasilia, with specialization in Software Engineering and MBA in Business Intelligence. Master's in business administration from the University of Brasília (UnB). Project Management Professional (PMP) certified by the Project Management Institute (PMI). Professor in disciplines related to management and information systems. His researches are focused on evaluation and seeking ways to improve the

Bibliography

A. Andrade et al.

Organizational structure and ICT strategies in the Brazilian judiciary system

Government Information Quarterly

(2012)

B. Bačić

Predicting golf ball trajectories from swing plane: An artificial neural networks approach

Expert Systems with Applications

(2016)

S. Castell

The future decisions of RoboJudge HHJ Arthur Ian Blockchain : Dread , delight or derision ? Computer law & security review

The International Journal of Technology Law and Practice

(2018)

A.O. Gomes et al.

Effects of investment in information and communication technologies on productivity of courts in Brazil

Government Information Quarterly

(2018)

M. Janssen et al.

Data governance: Organizing data for trustworthy artificial intelligence

Government Information Quarterly

(2020)

M. Janssen et al.

The challenges and limits of big data algorithms in technocratic governance

Government Information Quarterly

(2016)

A. Kankanhalli et al.

IoT and AI for smart government: A research agenda

Government Information Quarterly

(2019)

E. Kazim et al.

A high-level overview of AI ethics

Patterns

(2021)

T. Krupiy

A vulnerability analysis: Theorising the impact of artificial intelligence decision-making processes on individuals, society and human diversity from a social justice perspective

Computer Law and Security Review

(2020)

H.C. Kum et al.

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Supporting self-evaluation in local government via knowledge discovery and data mining

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(2009)

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Weslei Gomes de Sousa is Graduated in Electrical Engineering by Institute of Higher Education of Brasilia, with specialization in Software Engineering and MBA in Business Intelligence. Master's in business administration from the University of Brasília (UnB). Project Management Professional (PMP) certified by the Project Management Institute (PMI). Professor in disciplines related to management and information systems. His researches are focused on evaluation and seeking ways to improve the efficiency of routines and processes in public sector. In general, the initiatives are related on application of information technology or the impact of the use of IT. Recently, his publication entitled “Analysis of variables for measuring the efficiency of public spending by function of government” was published by the journal Administração Pública e Gestão Social. Another important work, named “How and where is artificial intelligence in the public sector going? A literature review and research agenda” is published by Government Information Quarterly.

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January 2025
ISBN Number: 978-93-95305-78-5

REVIEW PAPER ON WATERMARKING ALGORITHM FOR PROTECTING SOFTWARE CODE AGAINST CYBER-ATTACK.

Bharati Devidas Patil
Research scholar
Department of computer science and Engineering,
P.K. University, Shivpuri (MP), India
bharatip175@gmail.com
Prof. Dr. Rohita Yamaganti Research
Supervisor
Department of computer science and Engineering,
P.K. University, Shivpuri (MP), India

Abstract

We identify three types of attack on the intellectual property contained in software and three corresponding technical defenses. A defense against reverse engineering is obfuscation, a process that renders software unintelligible but still functional. A defense against software piracy is watermarking, a process that makes it possible to determine the origin of software. A defense against tampering is tamper-proofing, so that unauthorized modifications to software (for example, to remove a watermark) will result in nonfunctional code. We briefly survey the available technology for each type of defense. In the past, being able to download open-source code or clone it and then subsequently modify it, encouraged development of software without authorization. Often, developers and organizations mentioned the copyright of the open source, at the most.

1. Introduction

In today's digital era, software is integral to our daily lives, powering everything from our smartphones to critical infrastructure. However, with the widespread distribution of software, concerns about copyright infringement and unauthorized modifications are growing. Traditional methods like code obfuscation often fall short in providing comprehensive protection. This is where source code watermarking comes into play, offering a robust solution to enhance software security.

In the past, being able to download open-source code or clone it and then subsequently modify it, encouraged development of software without authorization. Often, developers and organizations mentioned the copyright of the open source, at the most.

1.1 What is Source Code Watermarking?

Source code watermarking involves embedding a unique, covert marker within the code. This marker serves multiple purposes, including copyright assertion, software traceability, and tamper detection.

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Unlike obfuscation, watermarking does not alter the functionality of the code, making it a more reliable and transparent method for protecting intellectual property.

1.2 Need for Source Code Watermarking

The primary reasons for adopting source code watermarking are:

- Copyright Protection: Watermarking asserts ownership and helps in resolving disputes related to intellectual property.
- Software Traceability: It helps track the distribution and usage of software, identifying unauthorized copies.
- Tamper Detection: Watermarks can reveal unauthorized modifications, ensuring the integrity of the software.

2. The Process of Watermarking

Implementing watermarking involves several steps:

1. Embedding: Inserting the watermark into the source code. This can be done at various stages of the development lifecycle.
2. Compilation: Converting the watermarked source code into executable form.
3. Distribution: Distributing the software with the embedded watermark.
4. Verification: Detecting and verifying the watermark in the distributed software to ensure integrity and ownership.

Following figure 1 shows watermark embedding Process

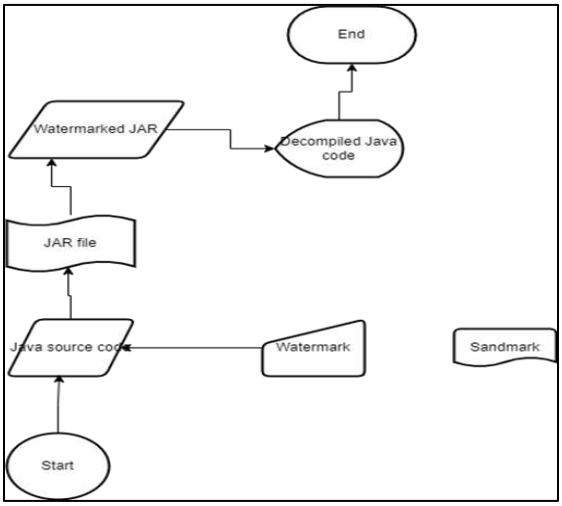

Fig 1 watermark embedding process

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Following figure 2 shows watermark recognition process which uses input file and key to recognize watermark.

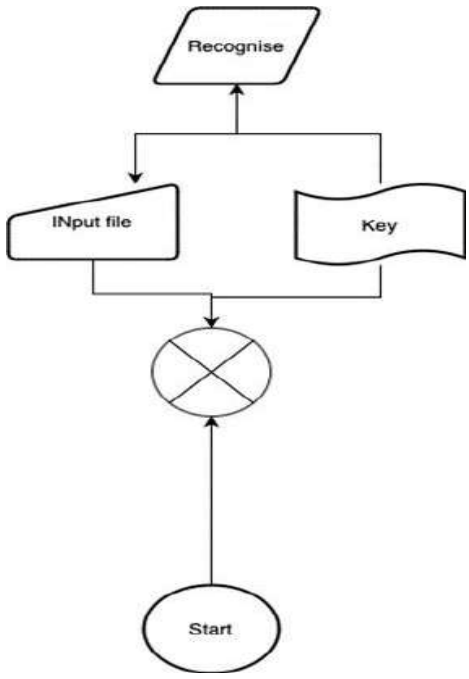

Fig.2 Process of recognizing watermark

3. Literature Review

There are several watermarking techniques, each with its own strengths and applications. Watermarking techniques can be based on three major categories, based on robustness & embedding techniques.

Here we shall consider based on embedding techniques, these are the following:

3.1 Static Watermarking:

Embeds the watermark into the code structure, making it a part of the compiled program. This method is highly resilient against reverse engineering. This technique hides a watermark within the source code by introducing a fake expression, assigned to a new local variable. The watermark is identified by this variable's unique name [1,2].

How It Works:

- The watermark is represented as a numeric value, divided into two-digit segments.
- These segments are embedded into the program by modifying existing constants in the code.
- The watermark is encoded in the sum of these altered constants.

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3.2 Zero-Digital Watermarking

Zero watermarking is a unique method that protects code without altering it. Instead of embedding visible marks, it analyzes the code to identify key features like its structure and meaning and mathematically converts these features into a "watermark." This watermark is stored separately, leaving the original code untouched [3].

KeySplitWatermark

The KeySplitWatermark algorithm is a cutting-edge software protection method that uses blind zero watermarking to embed ownership information within source code without altering its functionality. Does not modify the original code but uses external metadata to assert ownership. This method is highly secure but can be complex to implement [4,5].

EmbeddingPhase:

The algorithm operates in two stages: embedding and extraction. During embedding, the code is analyzed to identify frequently used keywords and characters. These are used to segment the code, and a unique key is generated based on these segments and code properties. This key, along with the original watermark, can be registered with a trusted third party, such as a Certification Authority (CA), for ownership verification.

ExtractionPhase:

In the extraction phase, the code is re-partitioned using the registered keywords. Statistical analysis is conducted to identify the most frequent characters in each segment, forming a characteristic list. The watermark key is then used to extract the embedded watermark, which is compared to the registered one to verify ownership.

3.2 Dynamic Watermarking:

Inserts the watermark during program execution. It adapts to runtime conditions, making it harder to detect. It embeds a watermark within a program's runtime structure. The watermark is extracted by running the program with a specific input sequence, known as the watermark key. This dynamic watermarking method embeds the watermark into a graph structure that evolves during the program's execution[6]. The algorithm operates through several sequential phases:

1. Annotation: The source code is annotated by inserting calls to the `annotator.mark()` function at specific locations, marking spots for potential watermark insertion.
2. Compilation: The annotated program is compiled and packaged into a Java jar file.

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3. Tracing: The program is executed using a secret input sequence, generating a trace file that records the sequence of mark () calls.
4. Embedding: The watermark is embedded into the program using the data from the tracing phase, seamlessly integrating it into the program's runtime structure.

4. Common Types of Cyber Attacks

- Malware:

  A malware cyberattack involves malicious code used to infiltrate and compromise a computer system, network, or device without the owner's consent. Many users are familiar with viruses, but others include worms, trojans, and ransomware. Once installed on a host device, malware is programmed to spread to other areas. Its damage can range from minor inconveniences to severe data breaches and financial losses[5].

- Phishing and Spear Phishing:

  Spear phishing is a more targeted form in which an email is customized for specific individuals or organizations using personal details to appear more convincing. An example might be a request from the CFO to someone in accounts payable to perform a financial transaction by clicking a link or someone receiving a shared file from their boss that they are to click on to open. These tailored approaches make spear phishing attacks particularly deceptive and potentially more successful than broader phishing attempts [5].

- Ransomware:

  The motive behind a ransomware attack is extortion. Ransomware is delivered through phishing emails or malicious downloads. The malware then encrypts the victim's files and makes them inaccessible. The attackers then demand a ransom for a decryption key to unlock the files. This cyberattack can cause significant disruption and financial damage to individuals and organizations. Ransomware has consistently ranked as one of the most concerning cyber threats for business leaders in recent years [4].

- Distributed Denial-of-Service (DDoS):

  A Distributed Denial-of-Service (DDoS) attack aims to disrupt the regular traffic of a targeted server, service, or network by overwhelming it with a flood of internet traffic from multiple sources. Attackers typically use a network of compromised computers and devices called bots to generate this traffic. DDoS attacks can cause websites and online services to become slow or unavailable, resulting in lost business, damaged reputation, and potential data breaches [7].

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- SQL Injection:

  In a SQL injection attack, a threat actor inserts unauthorized SQL code into application queries to access database information. Attackers manipulate user input fields, such as login forms or search bars, by inserting malicious SQL code. When the application processes this input without proper sanitization, it inadvertently executes the malicious SQL commands within the database. This technique can allow attackers to bypass authentication, access sensitive data, modify database contents, or perform administrative operations.

- Cross-Site Scripting (XSS):

  Cross-site scripting (XSS) attacks involve the injection of malicious scripts into trusted websites. These scripts are often in the form of JavaScript code. When unsuspecting users visit these compromised pages, their browsers execute the injected scripts. These scripts can steal sensitive data like cookies, session tokens, or login credentials. This allows them to perform actions on behalf of the user, such as making unauthorized transactions. XSS attacks are classified into three main types: stored, reflected, and DOM-based, with each varying in how the malicious script is injected and executed.

- Botnets:

  Botnets are networks of compromised computers or devices that one or more attackers control. These infected machines are called “bots” or “zombies” and are unknowingly enlisted to perform coordinated malicious activities after being compromised through malware infection. Botnets can consist of thousands or even millions of devices, including computers, smartphones, and IoT gadgets. They are commonly used for DDoS attacks, spam campaigns, and cryptocurrency mining.

5. Different Strategies to Prevent Cyber Attacks

Below are some strategies outlining how to avoid cyber-attacks. There are many ways to prevent cyber-attacks, and when implemented collectively, they will help create a multilayer strategy that will significantly contribute to cyber-attack protection [7]:

- Use Strong, Unique Passwords: The first step in preventing unauthorized access is creating strong, unique passwords. A strong password should include a mix of upper- and lower-case letters, numbers, and special characters. It would be best to consider using a password manager to securely store and generate complex passwords to reduce the risk of password reuse.
- Enable Multi-Factor Authentication (MFA): Multi-factor authentication adds an extra layer of security by requiring two or more verification methods to access an account. These typically include

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something you know (password), something you have (smartphone or security token), and/or something you are (biometric data).

- Regularly Update Software: Software updates often include critical security patches that address newly discovered vulnerabilities. Your organization should have an effective patch management strategy. This starts by maintaining an inventory of all software and their versions and enabling automatic updates for all software, if possible. Regularly check for updates and apply manually when necessary. Be sure to prioritize critical security updates.
- Implement Firewalls and Endpoint Protection: A network perimeter firewall serves as the first line of defense against cyber threats, but you should also implement firewalls throughout the local network to isolate, segregate, and protect critical servers and sensitive data. Firewalls can be paired with endpoint protection software on all devices to create a comprehensive security barrier against malware, ransomware, and other cyber threats.
- Reduce Privileges and Manage Data Access: Cybercriminals very often try to render an impact on the data an organization has in its possession, either extorting the organization or abusing the data for other purposes, like getting close to the next, bigger target. Reducing privileges given to identities (accounts) in your organization, converting administrative accounts to ephemeral ones, and governing data access are interrupting the tools, tactics, and procedures used by cybercriminals [8.9].
- Encrypt and Backup Data: Unfortunately, achieving complete immunity from cyberattacks is unrealistic, as zero-day vulnerabilities and evolving threat landscapes are persistent challenges in the digital world. Regular backups are essential to restore systems and recover data in case of a successful attack. Encrypting sensitive and proprietary data as encryption renders the data unreadable without the proper decryption keys [10].

6. Conclusion

In this paper we have discuss different types of watermarking technique such as static, Dynamic and zero watermarking. Along with that we discuss Cyber attcks and its different types. Source code watermarking is a powerful tool in the arsenal of software security. By embedding unique markers into the code, developers can protect their intellectual property, ensure traceability, and detect tampering. In this work, we proposed KeySplitWatermark, a novel zero watermarking approach to protect software code against cyber-attacks. The algorithm is blind and adds watermark logically into the code using the inherent properties of code and provides a robust solution.

ISBN Number: 978-93-95305-78-5

References

[1] A. R. Javed, M. O. Beg, M. Asim, T. Baker, and A. H. Al-Bayatti, "Detecting motion-based side-channel attack using smart phone keystrokes", J. *Ambient Intell. Humanized Comput.*, pp. 114, Feb. 2020.

[2] A. K. Abdulrahman and S. Ozturk, "A novel hybrid DCT and DWT based robust watermarking algorithm for color images", *Multimedia Tools Appl.*, vol. 78, no. 12, pp. 1702717049, Jun. 2019.

[3] W. Hu, R.-G. Zhou,J.Luo,andB.Liu, LSBs-basedquantumcolorimages watermarking algorithm in edge region, Quantum Inf. Process., vol. 18, no. 1, p. 16, Jan. 2019.

[4] Z. Jalil and A. M. Mirza, "An invisible text watermarking algorithm using image watermark, in Innovations in Computing Sciences and Software Engineering." *Dordrecht, The Netherlands*: *Springer*, 2010.

[5] C. Iwendi, Z. Jalil, A. R. Javed, T. Reddy G., "Keysplitwatermark: Zero Watermarking Algorithm For Software Protection Against Cyber-Attacks",*Ieee Acess* ,March2020 .

[6] M.E. Kumar, G.T. Reddy, K. Sudheer, M. Reddy, R. Kaluri, D. S. Rajput, and K. Lakshmanna, "Vehicle theft identi cation and intimation using gsm &iot", in *Proc. Mater. Sci. Eng. Conf., vol.* 4, 2017.

[7] G. T. Reddy, R. Kaluri, P. K. Reddy, K. Lakshmanna, S. Koppu, and D. S. Rajput, "A novel approach for home surveillance system using IoT adaptive security", *in Proc. Int. Conf. Sustain. Comput. Sci., Technol. Manage.*, vol. 3. 2019.

8] G. T. Reddy, K. Sudheer, K. Rajesh, and K. Lakshmanna, "Employing data mining on highly secured private clouds for implementing a security asa-service framework", J. *Theor. Appl. Inf. Technol.*, vol. 59, no. 2, pp. 317326, 2014.

[9] R. Raghavan, J. K. Singh, T. G. Reddy, K. Sudheer, P. Venkatesh, and S. O. Olabiyisi, "A case study: Home environment monitoring system using Internet of Things", *Int.* J. *Mech. Eng. Technol.,* vol. 8, no. 11, pp. 173180, 2017.

[10] J. Epstein, S. Matsumoto, and G. McGraw, "Software security and SOA: Danger, willrobinso", *IEEE Secure. Privacy Mag.*, vol.4, no.1, pp. 8083, Jan. 2006.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

IMPACT ON PERSONAL LIBERTY OF WOMEN IN INDIA

Dr. Bijay Kumar Yadav
Associate Professor Law
Gitarattan International Business School

Abstract

This study explores the multifaceted impact on personal liberty of women in India, a complex interplay of socio-cultural, economic, and legal factors that shape their autonomy and rights. Despite constitutional guarantees and progressive legal reforms aimed at gender equality, Indian women continue to face systemic barriers to their personal liberty, including patriarchal norms, gender-based violence, limited access to education, and economic dependence. The research highlights the disparity between urban and rural settings, emphasizing how geography and socio-economic status influence the degree of freedom women can exercise.

It examines the role of societal expectations in restricting choices related to career, marriage, and mobility, as well as the impact of recent legislative measures such as the Criminal Law (Amendment) Act, 2013, and the Maternity Benefit (Amendment) Act, 2017. Through a critical lens, the paper identifies gaps in implementation and enforcement of legal provisions, while advocating for systemic changes, including gender-sensitive education, economic empowerment, and improved access to justice. This abstract underscores the urgent need for a collective societal effort to dismantle structural barriers and promote a culture of respect and equality, ensuring that Indian women can fully realize their personal liberty in all spheres of life.

Keywords: Personal liberty, Women in India, Gender equality, Patriarchy, Socio-cultural barriers, Legal reforms, Gender-based violence, Economic empowerment, Autonomy, Education, Urban-rural disparity, Constitutional rights, Legislative measures, Access to justice, Systemic change.

INTRODUCTION:

Personal liberty, a cornerstone of any democratic society, signifies an individual's freedom to act according to their will within the confines of the law. In India, personal liberty is constitutionally protected under **Article 21** of the Indian Constitution, which guarantees the right to life and personal liberty. However, the evolving socio-political landscape, legal challenges, and societal norms have led to significant debates over the extent and limitations of this liberty.

Personal liberty is a cornerstone of democratic societies, representing the autonomy and freedom of individuals to make choices that govern their lives. In India, where the constitutional framework

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guarantees equality and liberty to all, the question of personal liberty for women is both legally significant and socially transformative. Despite progressive legal measures, women in India often face systemic and societal challenges that curtail their personal freedoms.

BOOK REVIEW:

1. Law, Justice, and Gender: The Politics of Women's Rights in India by Flavia Agnes

Flavia Agnes critically examines the legal system's role in shaping women's rights in India. The book unpacks how patriarchal values persist in the legal framework, even as progressive laws aim to protect women. It provides in-depth case studies and challenges the gap between legal theory and implementation. While the legal terminology may be dense, its insights into systemic issues make it a must-read for anyone studying gender justice in India.

2. Gendering Caste Through a Feminist Lens by Uma Chakravarti

This book highlights the intersection of caste and gender in India, emphasizing how the caste system reinforces patriarchal control over women's lives. Chakravarti provides historical and cultural analyses, making the work a crucial read for understanding how structural inequalities limit women's autonomy. Its concise yet impactful narrative makes it accessible for general readers and scholars alike.

3. The History of Doing by Radha Kumar

Radha Kumar offers an engaging historical account of the feminist movements in India from the 19th century to the 1990s. With a mix of illustrations and narrative, the book demonstrates how women's struggles for liberty have evolved. It's particularly valuable for its documentation of grassroots activism, though it leaves room for more critical engagement with contemporary issues.

4. Seeing Like a Feminist by Nivedita Menon

This book provides a contemporary feminist critique of societal norms, legal structures, and cultural practices in India. Menon challenges conventional ideas about equality and freedom, presenting nuanced arguments about the ways patriarchy intersects with other forms of oppression. Its informal and provocative tone makes it both enlightening and accessible.

5. Women in Modern India by Geraldine Forbes

Forbes explores the changing roles of women in Indian society, from colonial times to the modern era. The book sheds light on women's participation in nationalist movements, education, and labor, highlighting the ongoing struggles for personal liberty. It provides a well-rounded historical perspective but focuses less on contemporary feminist discourse.

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1. Constitutional Safeguards

India's Constitution provides a robust framework to protect personal liberty:

Article 21: It ensures that no person shall be deprived of life or personal liberty except according to a procedure established by law.

Fundamental Rights: Articles 19 and 22 supplement personal liberty by ensuring freedoms like speech, assembly, and protection against arbitrary detention.

However, these rights are subject to reasonable restrictions, which sometimes lead to controversies over their interpretation and application.

2. Judicial Interpretations

The judiciary has played a crucial role in expanding the scope of personal liberty:

Maneka Gandhi v. Union of India (1978): The Supreme Court ruled that the "procedure established by law" must be just, fair, and reasonable.

Puttaswamy v. Union of India (2017): Recognized the right to privacy as an intrinsic part of personal liberty under Article 21.

These decisions underscore the dynamic and expansive nature of personal liberty in India.

3. Challenges to Personal Liberty

While the constitutional provisions are robust, several issues challenge the practical realization of personal liberty:

Preventive Detention Laws: Laws like the National Security Act (NSA) allow detention without trial, raising concerns about potential misuse.

Freedom of Speech and Expression: Restrictions on free speech through laws like Section 124A (sedition) and Section 66A (now struck down) of the IT Act have been criticized for curbing dissent.

Surveillance and Privacy: The introduction of mass surveillance programs, like the Central Monitoring System (CMS) and controversies surrounding Aadhaar, has sparked debates about privacy infringement.

CONSTITUTIONAL FRAMEWORK AND LEGAL PROTECTIONS

The Constitution of India enshrines the principles of equality and personal liberty through Articles 14, 15, 19, and 21. Article 14 guarantees equality before the law, while Article 15 prohibits discrimination on the grounds of sex. Article 19 ensures freedoms such as speech, expression, and movement, and Article 21 guarantees the right to life and personal liberty.

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Several legislative acts, such as the Dowry Prohibition Act (1961), the Protection of Women from Domestic Violence Act (2005), and the Sexual Harassment of Women at Workplace (Prevention, Prohibition, and Redressal) Act (2013), have been enacted to safeguard women's rights and liberty. However, societal attitudes, patriarchal norms, and enforcement issues often undermine these protections.

RECURRING CHALLENGES TO PERSONAL LIBERTY

1. Honor-Based Restrictions In many parts of India, family and community honor are placed above individual freedoms, particularly for women. Practices such as "honor killings" and restrictions on inter-caste or inter-religious marriages continue to infringe upon women's right to choose their partners.

2. Control over Mobility

In both rural and urban areas, women face limitations on their mobility, justified in the name of safety or cultural norms. This affects their access to education, employment, and public spaces, directly impacting their autonomy.

3. Reproductive Rights

While abortion is legally permissible under the Medical Termination of Pregnancy Act, 1971, societal stigma and familial pressures often deny women the right to make decisions about their bodies. Access to contraception and sexual health education remains inadequate in many regions.

4. Workplace Harassment and Gender Pay Gap

Sexual harassment and unequal pay in workplaces further constrain women's professional liberty. Despite legal frameworks, societal apathy and institutional lapses create barriers to justice and equality.

LEADING CASES SHAPING PERSONAL LIBERTY FOR WOMEN

1. Vishaka v. State of Rajasthan (1997)

This landmark judgment laid down guidelines to prevent sexual harassment at workplaces. The court held that sexual harassment violates a woman's fundamental rights under Articles 14, 19, and 21. These guidelines later led to the enactment of the Sexual Harassment of Women at Workplace Act in 2013.

2. Shakti Vahini v. Union of India (2018)

The Supreme Court declared honor killings and other forms of coercion in the name of family honor unconstitutional, emphasizing that the right to choose a partner is integral to personal liberty under Article 21.

ISBN Number: 978-93-95305-78-5

3. Joseph Shine v. Union of India (2018)

The Supreme Court struck down Section 497 of the Indian Penal Code, which criminalized adultery, as unconstitutional. The judgment highlighted that treating women as the property of their husbands violated their dignity and autonomy.

4. KS Puttaswamy v. Union of India (2017)

The court's affirmation of the right to privacy as a fundamental right under Article 21 has profound implications for women. It extends to bodily autonomy, including reproductive rights and freedom of expression, protecting women from intrusive practices and surveillance.

5. Sabarimala Case (Indian Young Lawyers Association v. State of Kerala, 2018)

The Supreme Court's verdict allowing women of all ages to enter the Sabarimala temple challenged patriarchal norms disguised as religious practices. The judgment emphasized that equality and liberty cannot be compromised in the name of tradition.

CONCLUSION

While India has made significant strides in safeguarding personal liberty, challenges persist in translating these rights into reality for all citizens. A continued commitment to upholding democratic values, fostering inclusivity, and ensuring accountability will be pivotal in addressing these issues and securing personal liberty for future generation.

Despite legal advancements, the personal liberty of women in India remains contested, constrained by societal norms, inadequate enforcement, and resistance to change. Progressive judicial pronouncements have played a vital role in expanding freedoms and challenging systemic inequalities. However, achieving true liberty for women requires not just legal reform but also a transformation in societal attitudes, education, and empowerment. Ensuring that women have the autonomy to make choices in every sphere of life is essential for a truly egalitarian society.

REFRENCES:

Books:

1. "India's Daughter" by Ravish Kumar (2015)
2. "We Were Never Asking" by Meena Kandasamy (2017)
3. "Karachi, You're Killing Me!" by Jerry Pinto (2014)
4. "The Silence Breakers" by Tarana Burke (2018)

Academic Books:

ISBN Number: 978-93-95305-78-5

1. "Gender in India" by Veena Das (2007)
2. "Reinventing India: Liberalization, Hindu Nationalism, and Popular Culture" by Ruchira Gupta (2003)

Academic Articles:

1. "Gender, Violence, and the State in India" by Ritu Menon and Kamla Bhasin (1998)
2. "Feminist Legal Theory and the Indian Context" by Flavia Agnes (2005)
3. "The Politics of Women's Rights in India" by Maitreyi Ganapathy (2012)

Additional Resources:

- **Government Reports:**
  - National Crime Records Bureau (NCRB) annual reports
  - National Commission for Women (NCW) annual reports
- **NGO Reports:**
  - Amnesty International India
  - Human Rights Watch
- **Academic Journals:**
  - Economic and Political Weekly
  - Indian Journal of Gender Studies
  - Feminist Review

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

DATA IMBALANCE HANDLING TECHNIQUES IN DISEASE PREDICTION MODELS

Deepak Yashwantrao Bhadane
Research Scholar,
P.K. University, Shivpuri, M .P. India, Pin- 473665,
dybhadane@gmail.com
Dr. Indrabhan Supdu Borse
Research Guide,
Department of Computer Science & Engineering
P. K. University, Shivpuri, M .P. India, Pin- 473665, Madhya Pradesh, India
indrabhan2000@gmail.com

Abstract

A class imbalance occurs when there is a significant difference among the two categories of the target variable, with numerous occurrences of one class and few instances of the other. This issue has grown more common in many domains that use models for forecasting, such as illness forecasting techniques, which use information mining and machine learning to solve issues in the healthcare industry. Since the method attends to acquire additional about the larger class owing to its a large sample and acknowledge fewer of the minority class in response to its reduced quantity, class disparity specifically triggers an algorithm powered by machine learning to incorrectly identify events from the minority group even though it can accomplish high precision. This happens since the method might just categorize every case as the a majority class in an information set in class disparity. Public confidence in the consequences of the choice based on the prejudiced result is also impacted by this problem, in addition to the algorithm's forecast outcomes. If this issue of class imbalance is not resolved, the predictive model may label the minority class samples incorrectly, which might undermine the validity of the model's findings. This article offers a thorough analysis of methods for fixing data imbalance and the difficulties associated with doing so.

Keywords: Undersampling. Oversampling, SMOTE, Bagging, Boosting, Class Imbalance, Data Imbalance.

1. INTRODUCTION

Since a business's or organization's capacity to grow and flourish mostly rests on how effectively it comprehends and utilizes the data it has gathered, data has become more vital in today's society. Every company or organization nowadays produces massive volumes of data across a range of areas, such as banking, business, finance, and healthcare. Medical data may be provided by hospitals, physicians, care

ISBN Number: 978-93-95305-78-5

providers, and insurance organizations [1-6]. Upon obtaining the required medical datasets, the next steps would be to analyze and develop suitable modeling algorithms to extract significant information for probable prediction.

Thanks to the rapid improvements in data collection and storage technology, organizations may now get vast amounts of data. The databases are so large that conventional data analysis techniques and instruments are out of date. Data mining is the process of combining sophisticated algorithms with traditional data analysis methods to manage large volumes of data [1-6]. The exciting opportunities it has offered for finding and analyzing new forms of data as well as assessing old types of data in new ways have made the whole process of converting raw data into useful information conceivable.

A branch of computer science known as machine learning (ML) uses a range of statistical, probable, and optimization methods to help computers "learn" from previous encounters and find difficult connections in large, noisy, or complicated data sets. Solutions in medicine, specifically ones that rely on intricate proteomics and genomic information, are especially well-suited for this capacity. As a result, cancer detection and diagnosis heavily rely on machine learning. Machine learning has just recently been used to predict and prognosticate cancer. This latter strategy is especially interesting since it aligns with the emerging trend of predicted personalized medicine. This work was put together by carefully examining the various data imbalance handling procedures, the kinds of data that were utilized, and how well these techniques performed in terms of unevenly distributed data [1]. Due to prejudice against the majority class, imbalanced datasets are more likely to provide altered results, which lower the effectiveness of tools for predictive analysis. This article provides a comprehensive overview of how to deal with unbalanced datasets.

2. PREDICITVE MODELS IN HEALTHCARE

Utilising data, statistics, and machine learning algorithms, predictive modelling is a potent and developing subject in healthcare that aims to enhance patient care, expedite medical procedures, and predict future health outcomes. [1] Thanks to technological developments, the availability of large healthcare datasets, and a growing understanding of its potential to completely transform healthcare delivery, it has been increasingly well-known in recent years. Clinical expertise, data analysis, and prediction algorithms are all used in this interdisciplinary approach to help healthcare workers make better decisions, use resources more effectively, and improve patient outcomes while cutting costs.

ISBN Number: 978-93-95305-78-5

Fundamentally, predictive modeling in the healthcare industry depends on the extraction and examination of big datasets that include a wide range of patient records, medical histories, test results, and other characteristics relevant to healthcare [1-6]. To produce a thorough information repository, these data sources are painstakingly selected, cleansed, and organised. The development of predictive models that can predict a range of health-related events, including illness diagnoses, treatment outcomes, readmissions, and even the probability that a person would develop a certain medical condition, is based on this resource.

Predictive modeling's capacity to support early illness identification and prevention is among its most important benefits in the healthcare industry [7-9]. These algorithms can identify individuals who might be more susceptible to specific illnesses by examining past data and finding trends. For example, depending on lifestyle choices, genetic predisposition, and past medical data, a predictive model can assist in identifying those who are more likely to acquire diabetes. In order to stop the illness from developing, healthcare professionals can then take proactive measures with tailored treatments, such lifestyle changes or early screenings.

Predictive modeling [1] is also essential for allocating healthcare resources as efficiently as possible. Effectively managing resources, such as beds, personnel, and medical supplies, are a continuous issue for hospitals and healthcare systems. Hospitals may more effectively manage resources and shorten wait times by using predictive algorithms to estimate patient admission rates. In addition to increasing patient pleasure, this guarantees more economical operation of healthcare institutions.

Improving drug adherence is a significant use case for predictive modelling. A common problem in healthcare is prescription non-adherence, which can result in lower health outcomes and higher medical expenses [3-5]. By taking into account a number of variables, such as socioeconomic status, prior adherence history, and the complexity of their drug regimens, predictive models can assist in identifying patients who are at risk of non-adherence. To increase adherence rates and optimise patient outcomes, healthcare practitioners can then use focused interventions, including patient education programs or drug reminders.

Another crucial component of predictive modeling in the medical field is risk stratification. Patients with chronic illnesses, the elderly, or those recuperating from major operations are examples of high-risk patients who these models can identify and may need extensive care management. Healthcare providers

ISBN Number: 978-93-95305-78-5

may lower hospital readmissions, ER visits, and total healthcare expenses by giving high-risk patients priority treatment.

Furthermore, public health programs heavily rely on predictive modelling. Models can forecast disease outbreaks, monitor the spread of infectious illnesses, and evaluate the effectiveness of immunization campaigns by using population-level data. Predictive modelling was crucial in directing public health policy, resource allocation, and vaccination distribution plans during the COVID-19 pandemic, underscoring its vital significance in preserving public health.

In the healthcare industry, patient privacy and ethical issues are crucial when using predictive modeling. Two critical issues that the discipline has to solve are safeguarding private patient information and making sure that forecasts are produced impartially and without prejudice. An continuing ethical conundrum that calls for careful rules and regulations is finding a balance between using data to better medical care and protecting patient rights and anonymity.

One driver that is revolutionizing the healthcare sector is predictive modelling. The way healthcare is provided is changing as a result of its capacity to use data and advanced analytics to improve patient care, predict health outcomes, and allocate resources effectively. Predictive modeling's potential to improve patient outcomes and healthcare systems overall will only increase as technology develops and more data becomes accessible. As predictive models continue to develop and influence the direction of healthcare, it is crucial to approach this subject with ethical considerations at the forefront to protect patient privacy and equity.

3. DISEASE IDENTIFICATION AND RISK ASSESSMENT

Risk assessment and disease diagnosis have become essential components of contemporary healthcare, transforming our knowledge of, approach to, and management of diseases. From conventional clinical evaluations to state-of-the-art artificial intelligence algorithms, these domains cover a wide range of scientific and technical developments with the goal of enhancing patient outcomes and lowering the burden of illness [1-6]. This section explores the complexities of risk assessment and illness diagnosis, emphasizing their importance in modern medicine.

The process of determining a particular sickness or condition in a person based on a collection of clinical signs, symptoms, and laboratory testing is known as disease diagnosis. This essential component of healthcare enables doctors to determine the kind and severity of a patient's condition, allowing them to create individualized treatment regimens. From basic physical examinations to advanced imaging

ISBN Number: 978-93-95305-78-5

procedures like computed tomography (CT) scans and magnetic resonance imaging (MRI), diagnostic methods have changed dramatically over time. These cutting-edge instruments make it easier to identify anomalies and offer comprehensive insights into the interior workings of the body [1-6].

A new age of illness diagnosis has emerged in recent decades as a result of the merging of genetics and molecular biology. For example, genetic testing makes it possible to identify particular genetic variants linked to hereditary disorders, facilitating family planning and early intervention. Furthermore, by customizing therapies to a patient's genetic composition, precision medicine has improved therapeutic results and reduced side effects. In order to diagnose and track conditions including cancer, diabetes, and cardiovascular illnesses, biomarkers—such as protein or gene expression profiles—have become more popular. These biomarkers provide important information about how a disease develops and how well a therapy works.

Risk prediction [1-6] aims to estimate the probability of acquiring specific diseases or health issues in the future, whereas disease diagnostics concentrates on recognising current health concerns. In preventive medicine, risk prediction is essential because it enables medical professionals to take proactive steps to lower the likelihood of disease onset. Cardiovascular risk assessment, which estimates a person's probability of having a heart attack or stroke by taking into consideration variables including age, gender, family history, smoking status, blood pressure, and cholesterol levels, is a perfect illustration of risk prediction. In order to reduce the risk, this information helps doctors prescribe drugs or lifestyle changes.

Artificial intelligence (AI) and data-driven methods have become increasingly potent instruments for predicting illness risk in recent years [8]. To develop predictive models, machine learning algorithms may examine enormous datasets that include details on patient demographics, genetic markers, environmental influences, and medical history. These algorithms have the ability to spot underlying connections and patterns that human therapists would miss. AI-based models, for instance, have been used to forecast the risk of Alzheimer's disease, diabetes, and cancer with very high accuracy. Through the facilitation of early interventions and customised risk reduction measures, this technology has the potential to improve preventive care.

The usage of electronic health records (EHRs) is a prominent illustration of AI-driven risk prediction. EHRs allow healthcare organizations to gather a multitude of patient data, such as clinical notes, test results, and medical history [11]. This data may be analysed by machine learning algorithms to find people who are at risk for certain illnesses. An algorithm may, for example, identify trends in EHR data that point

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to a patient's elevated risk of sepsis, enabling rapid treatment and perhaps saving lives. Additionally, by identifying patients who are at a high risk of hospital readmission, AI-driven prediction models can assist healthcare systems in allocating resources more effectively, hence lowering healthcare expenditures.

The use of mobile health applications and wearable technology in healthcare is another aspect of risk prediction. These devices gather information on a person's heart rate, activity levels, sleep habits, and other variables in real time. Artificial intelligence (AI) systems may evaluate this data to determine a person's risk of obesity, diabetes, or sleep apnoea. Additionally, wearable technology may give consumers tailored feedback and suggestions, enabling them to adopt better lifestyles [13].

Risk assessment and illness diagnosis are essential elements of contemporary healthcare. In the end, they improve patient outcomes and lessen the total cost of disease on society by facilitating early disease identification, individualized treatment, and proactive preventative measures. A new age of precision medicine and preventative care has been ushered in by the merging of cutting-edge technology like artificial intelligence (AI) and genetic testing. The prospect of earlier illness identification and more successful risk reduction grows as we make progress in these areas, portending a better and healthier future for people and communities everywhere.

4. RESEARCH MOTIVATION

In the healthcare industry, predictive data analytics methods have been shown to be very helpful for early disease detection and for enhancing medication and therapeutic treatment, which helps to reduce the rising death rate from diseases like COVID-19, diabetes, heart disease, breast cancer, and chronic kidney disease. By merging mathematical models, computer applications, and clinical data, researchers were able to construct a sizable number of models over the course of several persistent attempts, producing an incredibly valuable multidisciplinary study with societal value. Quality assurance and management are two ongoing activities that oversee quality improvement. The rise in many fatal diseases has been linked to a shift in eating patterns from traditional to fast food, changes in the climate caused by increasing pollution, and a lack of physical exercise.

Early disease detection in this situation will be crucial to keeping the illness under control with the appropriate, closely watched therapy. A preliminary review of some of the already available models reveals substantial knowledge gaps in the areas of exploratory data analysis, data treatment analysis, and classifier constraints. By employing hybrid frameworks, one may increase accuracy in terms of synergy with the rapidly expanding mathematical and computational models. Due to prejudice against the majority

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class, imbalanced datasets are more likely to provide distorted results, which lowers the effectiveness of predictive analytics tools. A thorough analysis of how to deal with unbalanced datasets is suitably provided in view of these findings.

5. DATA IMBALANCE PROBLEM

If the positive and negative values in a dataset are nearly equal, it is said to be balanced. On the other hand, unbalanced datasets are unique situations in which there is an uneven distribution of values across the classes, giving rise to two separate classes: the majority, or negative class, and the minority, or positive class [1, 7, 8, 9, 10]. Both balanced and unbalanced datasets are shown in Figure 1, with the positive values displayed in orange and the negative values in blue.

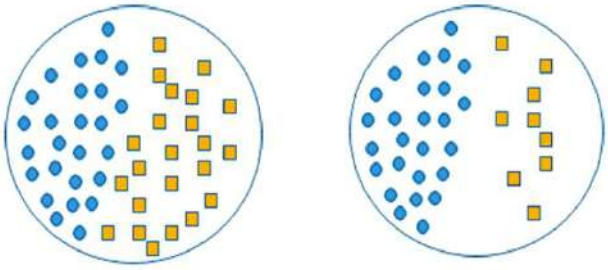

Figure 1. Balanced dataset Vs Imbalanced dataset [1[

6. CLASS IMALANCE PROBLEM TACKLING PROCEDURES

Extremely unbalanced class distributions are a sign of class imbalance issues [87]. A class imbalance may exist in the dataset if samples from one or more classes significantly outnumber those from other classes. Because class imbalance affects the quality and reliability of the output from the machine learning assignment, it has to be addressed using specific techniques and measures. There are three main approaches to addressing the problem of class inequality [1]:

1. Data Driven Methods
2. Algorithm Based Methods
3. Feature Based Methods

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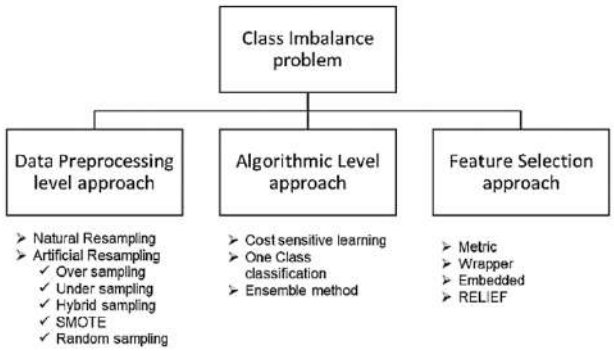

Figure 2. **Different approaches to tackle Class Imbalance Problem [1]**

7. DATA PRE-PROCESSING LEVEL APPROACH

The main objective of this strategy is to resample the data. A pre-processing method called resampling is used to change the class distribution before the model is trained. There are two types of resampling [1, 11, 12, 13, 14, 15]:

7.1 Natural Resampling: The imbalance problem in the dataset is part of its nature of the dataset. the main goal is to the majority class. It's not always possible, but it's simple to obtain.

7.2 Artificial Resampling

It can be accomplished by:

Undersampling: The elimination of cases from the dominant class is carried out at arbitrary from the collection of cases..

Oversampling: instances from the minority class are added to the dataset where the replication is done either randomly or using an algorithm.

SMOTE : S-MOTE oversamples to produce fresh minority class examples by inter-plotting several minority class examples. The freshly generated examples of a majority group are called synthesised observations, and they are obtained by determining the nearest neighbours of each minority group.

Random sampling: The last type of distributed that is produced by the resampling approach can be parameterised to any ratio or fixed to a completely symmetrical allocation. It is the simplest technique to utilise and may be applied to both undersampling and over-sampling.

Random Undersampling: Certain significant and useful information is removed from the dataset in order to compensate for the knowledge loss brought on by under-sampling. For instance, a k-means calculation may be used to implement a cluster-based under-sampling technique.

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Random Oversampling: The minority class's class distribution is introduced to the training dataset after being randomly copied or altered. One way to improve performance is as follows. This approach could be helpful for machine learning algorithms that are affected by a skewed distribution. The outcome is too appropriate.

7.3 Algorithmic methods

Cost-sensitive learning: The learning algorithms charge for inaccurate categorisation. This branch of machine learning focuses on training models using data that has unequal costs or penalties in order to produce predictions. The major objective is to reduce a loss function in order to sway the algorithm in the minority class's favor [16. 17.

One-class classification: The uni-class categorisation branch of machine learning provides techniques for identifying anomalies and outliers. The categorisation target differs from other categories in that it is a one-class objective. It ignores the other classes, the outliers, and only considers the new target class [16, 17]. By fitting a model to the normal data, or OCC for short, one may determine if fresh sample is usual or noise.

Ensemble method: It on each classifier using random subsets during training. Predictions from many classifiers are combined. There are two resample techniques used: bagging and boosting [18, 19, 20].

Bagging approach uses a distinct bootstrap of the dataset to train each classifier. Bootstrap is a subset of N samples that is chosen at random and changed more often. The majority decision of the classifiers is the final result after the models have been trained [1].

Boosting models for classification are trained using the class that is the most difficult to predict. A random sample of the dataset is used to train the first classifier. The majority class in the next sample will be the one with the most records that were incorrectly categorised. On the other hand, although this boosting strategy outperforms bootstrap sampling, it's not necessarily more effective than using just one classifier [21-25.

7.4 Feature Based Techniques

Excessive dataset dimensionality may have a major negative effect on a model's performance. It is thus essential to choose the most beneficial features and get rid of the distracting ones. There are different unique feature based techniques [1, 13, 14, 15, 16]:

Metrics: It classifies the information by ranking attributes according to their payout.

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Wrapper: The algorithm is trained on a selected group of information by ranking features. The framework scores among the most valuable sets of variables based on how well learners learn. When the set of variables presents extremely large, it poses an issue since the parameter selections undergo training multiple times.ability to categorise the documents according to the payout.

Embedded: It seeks to identify the framework's optimal portion of characteristics. An instance is SVM's recurrent features removal method. The relationships between attributes are taken into consideration by integrated and wrapping, although the amount of consideration required significantly rises with large dimensionality datasets [17]. [18]. Even though the metric approach merely counts the role of features rather than the relationships between them, it is the most effective way to handle large data sets.

8. CHALLENGES OF IMBALANCED DATASETS

The following four challenges are involved in dealing with Imbalanced datasets [1, 25-29]

Challenge 1- Bias: The degree of bias between the classes. The closer the ratio between the classes, the higher the chances the classifier will perform better. The dataset can be in different degrees of bias 1:10, 1:00, 1:1000, 1:10000 and so on.

Challenge 2- Overlap: When there is no clear boundary between the two classes, the minority and majority classes occupy the same area. The higher the degree of overlap between classes the more difficult for classifiers to distinguish between them.

Challenge 3- Dataset size: The more samples that artificial intelligence systems have, the greater learning they receive and, thus, the quality of the predictions that is produced.

Challenge 4- Feature Vector size: Whether the data is balanced or not, the classifier has a harder time building an appropriate model the higher the feature vector size. Engineers often do a dimensionality step before applying a machine learning algorithm to the dataset. They just take into account the most important factors in this way. Therefore, if our dataset is also of an imbalanced kind and includes a lot of features, dimensionality reduction may be a really fantastic step to do before you start the research. The present study somewhat addresses the first two problems, bias and overlap. Different sampling techniques have been proposed to reduce bias and the degree of overlap between the majority and minority groups in a dataset.

9. CONLUSION

Class imbalances have been a difficult issue in the data mining field in recent years. If a particular group in the information has instances that are greater than the others, it is referred to as the dominant class;

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when there are less instances, it is referred to as the minority class. Because the bigger class had more impacts on the categorization, the circumstance resulted in a less-than-ideal classification. A class imbalance arises whenever any of the groups in the data set has a greater amount of occurrences than the others; these instances are referred to as majority classes and minority classes, respectively. The difficult terrain of uneven data has been thoroughly examined in this book, including everything from its fundamental causes and impacts to a thorough analysis of strategies and evaluation measures meant to alleviate this problem. These principles emphasize the necessity of experimentation, parameter tweaking, and the exploration of different approaches in order to tailor solutions to specific datasets and problem circumstances.

References

1. Govind M. Poddar, Rajendra V. Patill, Satish Kumar N, “Approaches to handle Data Imbalance Problem in Predictive Machine Learning Models: A Comprehensive Review”, *Int J Intell Syst Appl Eng*, vol. 12, no. 21s, pp. 841–856, Mar. 2024.
2. Gaikwad, V. S. ., Shivaji Deore, S. ., Poddar, G. M. ., V. Patil, R. ., Sandeep Hirolikar, D. ., Pravin Borawake, M. ., & Swarnkar, S. K., “Unveiling Market Dynamics through Machine Learning: Strategic Insights and Analysis”,. International Journal of Intelligent Systems and Applications in Engineering, 12(14s), 388–397, 2024.
3. Tarambale, M. ., Naik, K. ., Patil, R. M. ., Patil, R. V. ., Deore, S. S. ., & Bhowmik, M., Detecting Fraudulent Patterns: Real-Time Identification using Machine Learning. International Journal of Intelligent Systems and Applications in Engineering, 12(14s), 2024
4. Iqbal H. Sarrkar, “Machine Learning: Algorithms, Real-World Applications and Research Directions.” SN Computer Science, 2:160, 2021
5. Hafsa Habehh, Sunil Gohel, “Machine in Healthcare”, Current Genomics, vol. 22, issue 4, pp, 291-300, Dec. 2021.
6. Sun, Y., Wong, A. K. C., and Kamel, M. S., “Classification of imbalanced data: a review,” International Journal of Pattern Recognition and Artificial Intelligence, vol. 22, no. 4, pp. 687–719, 2009..
7. Guo Haixiang, Li Yijing, Jennifer Shang, Gu Mingyun, Huang Yuanyue, Gong Bing, "Learning from class-imbalanced data: Review of methods and applications" , Expert Systems with Applications,Volume 73, pp. 220-239, 2017.

ISBN Number: 978-93-95305-78-5

8. Salim Rezvani, Xizhao Wang, "A broad review on class imbalance learning techniques" , Applied Soft Computing, Volume 143, 2023,\
9. Barandela, R., Sánchez, J. S., García, V., & Rangel, E., “Strategies for Learning in Class Imbalanced Datasets. Pattern Recognition”, 36(3), 849-851, 2003
10. Haixiang, G., Yijing, L., Shang, J., Mingyun, G., Yuanyue, H., “Learning from Class-imbalanced Data: Review of Methods and Applications”, Expert Systems with Applications”, 73, 220-239, 2017.
11. Mukhtar shah, “Imbalanced Data in Machine Learning: A Comprehensive Review”, Department of Machine Learning, University of Jumeirah.
12. Chawla, N., et al., “Special issues on learning from imbalanced data sets,” ACM SigKDD Explorations Newsletter, vol. 6, no. 1, pp. 1–6, 2004
13. Wongvorachan T, He S, Bulut O., “A Comparison of Undersampling, Oversampling, and SMOTE Methods for Dealing with Imbalanced Classification in Educational Data Mining.”, Information, 14(1):54., 2023
14. Suwarna J, Kirti N. Mahajan, Yogesh B. Pawar, Yogita D. Bhise, Bharti Jagdale, Rajendra V. Patil, “Plant Growth Analysis using IoT and Reinforcement Learning Techniques for Controlled Environment”, Advances in Nonlinear Variational Inequalities, 27(3), pp. 706–715, 2024
15. Sangeeta Kakarwal, Rahul Mapari, Pranoti Prashant Mane, Madhuri Pravin Borawake, Dhanraj R. Dhotre, Rajendra V. Patil, “A Novel Approach for Detection, Segmentation, and Classification of Brain Tumors in MRI Images Using Neural Network and Special C Means Fuzzy Clustering Techniques”, Advances in Nonlinear Variational Inequalities, 27(3), pp. 837–872, 2024
16. Akira Tanimoto, So Yamada, Takashi Takenouchi, Masashi Sugiyama, Hisashi Kashima, "Improving imbalanced classification using near-miss instances", Expert Systems with Applications,Volume 201,2022,.
17. Tomek, I., ”Two Modifications of CNN”, IEEE Transactions on Systems, Man, and Cybernetics (SMC-6): 769-772, 1976
18. Patil, R. M. ., Patil, R. V. ., Pagare, U. B. ., Navandar, R. K. ., Mapari, R. ., Bhowmik, M. ., & Deore, S. S, “Anomaly Detection in Network Security: Deep Learning for Early Identification.”, International Journal of Intelligent Systems and Applications in Engineering, *12*(19s), 133–144, 2024
19. Dennis L Wilson, “ Asymptotic properties of nearest neighbor rules using edited data”, IEEE Transactions on Systems, Man, and Cybernetics, (3):408–421, 1972.

20. Ajiknya More, " Survey of resampling techniques for improving classification performance in unbalanced datasets", Computer Science Mathematics, arXiv.org, 2016
21. Rajendra V. Patil, Dr. Renu Aggarwal, Dr. Shailesh Shivaji Deore, “Edge Segmentation based Illumination Invariant Feature Detector Phase Congreuncy”, 2024 5th International conference on Mobile Computing and Sustainable Informatics (ICMCSI), pp. 91-96, Jan. 2024.
22. K. C. Jondhale , R. V. Patil, “Edge Based technique to estimate Number of clusters in K-means Color Image Segmentation”, 3rd IEEE International Conference on Computer Science and Info Tech, Chegndu , China, 2010
23. Ajiknya More, " Survey of resampling techniques for improving classification performance in unbalanced datasets", Computer Science Mathematics, arXiv.org, 2016
24. Smith, M.R., Martinez, T., Giraud-Carrier, C. An instance level analysis of data complexity”, Mach Learn 95, 225–256, 2014.
25. Chawla, Nitesh V., et al., “SMOTE: Synthetic Minority Over-Sampling Technique,” Journal of Artificial Intelligence Research, vol. 16, no. 1, pp. 321–357, 2002.
26. Rajendra V. Patil, Govind M. Poddar, Bhuvaneshwari Jolad, Bharati Devidas Patil, Dharmesh Dhabliya, Avinash M. Pawar, “Game Theory Applications in Smart Grid Energy Management”, Advances in Nonlinear Variational Inequalities, 28(1), pp. 46-60, 2025
27. Sagar V. Joshi, Rajendra V. Patil, Manoj Tarambale, Balkrishna K Patil, Vinit Khetani, Yatin Gandhi, “Stochastic Processes in the Analysis of Electrical Load Forecasting”, Advances in Nonlinear Variational Inequalities, 28(1), pp. 15-29, 2025.
28. Nemade, B. ., Bharadi, V. ., Alegavi, S. S., & Marakarkandy, B., “ A Comprehensive Review: SMOTE-Based Oversampling Methods for Imbalanced Classification Techniques, Evaluation, and Result Comparisons”, International Journal of Intelligent Systems and Applications in Engineering, 11(9s), 790–803, 2023
29. Rajendra V. Patil, Dr, Renu Aggarwal, Ritesh, Sonawane, Govind M. Poddar, Shailesh Shivaji Deore, , Vaishali Turai, “Automatic Marker Generation to Similarity Based Region Merging Algorithm using Edge Information” , Journal of Electrical Systems, 20 (3s), pp. 2227-2240, 2024
30. Bagui, S.S., Mink, D.; Bagui, S.C., Subramaniam, S, “Determining Resampling Ratios Using BSMOTE and SVM-SMOTE for Identifying Rare Attacks in Imbalanced Cybersecurity”, Data. Computers 2023, 12, 204.

ISBN Number: 978-93-95305-78-5

31. Rajendra V. Patil., Dr. Renu Aggarwal. Edge Information based Seed Placement Guidance to Single Seeded Region Growing Algorithm. International Journal of Intelligent Systems and Applications in Engineering, 12(12s), 753–759, 2024
32. Rajendra V. Patil, Dr. Renu Aggarwal, Govind M. Poddar, M. Bhowmik. Manohar K. Patil, Embedded Integration Strategy to Image Segmentation Using Canny Edge and K-Means Algorithm. International Journal of Intelligent Systems and Applications in Engineering, 12(13s), 01–08, 2024.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

EFFECT OF PRE-SOWING TREATMENT AND SEED SIZE ON GERMINATION IN *ALANGIUM LAMARCKII*

Devendra Kumar And Sachin Singh
Ecological Research Laboratory
Department of Botany,
P. K. University Shivpuri (M. P.)

ABSTRACT

The effect of pre-sowing treatment on seed germination of *Alangium lamarckii* was studied using mechanical scarification, sulphuric acid treatment (5, 10 and 15 minutes) and dry heat treatment at 60, 80, and 100 ^{0}C (15, 30, and 60 minutes). The percentage germination was different between these treatments. Seeds of treated with sulphuric acid for 10 minutes showed better germination (100%). Germination was higher at 60 ^{0}C dry heat incubation compared to 80 ^{0}C and 100 ^{0}C.

Introduction

Alangium lamarckii a member of family *Cornaceae* is a moderate sized deciduous tree with a rather open crown. This is one of the most beautiful of Indian flowering trees, vernacular name is Akola (Troop, 1921). The Fruit an indehiscent pod, (min. 9) 17-24 x (min. 3) 4-6 cm, stalked, covered with short brown hairs, pale yellowish-brown or grey when ripe, in the lower part flat, with a single seed near the apex. Seed ellipsoid, flattened, about 3cm long. It contains sugar, tartaric acid, malic acid, oxalic acid, one more acid catharatic acid considered the purgative principal of the drug (Bhatytacharya, 2000). Natural regeneration of this species is very limited (Singh, 1982).

We know much about the species potential in terms of growth and productivity. There are certain factors (intrinsic and extrinsic) which determine seed germination. Critical among intrinsic factors are seed coat impermeability and status of the embryo. Likewise, external environmental factors such as temperature and moisture can affect seed germination. The power of germination of *Alangium lamarckii* is lost during the storage (Arya and Arya, 2006). The seed coat of *Alangium lamarckii* is very hard due to the advancement of aril and crauncle during the time of megagametogenesis. Seed coat imposed dormancy is a delaying mechanism, which prevent germination under condition that might prove to be unsuitable for establishment, thereby, distribution germination both in time and space. Berry, N. et. al. (2021). Find best pre-sowing treatment for enhancement of germination in *G. arborea*. Seeds were treated with different treatment includes growth regulators (GA_3 100 and 20ppm), acid scarification (H_2SO_4), cold water and untreated seeds as control. Among all the treatments seeds treated with GA_3 (200ppm) recorded the

ISBN Number: 978-93-95305-78-5

higher germination percentage (98.88%) followed by H_2SO_4 (93.33%) as compared to untreated seeds in control. Khan, M. R. (2015) also studies the effect of different treatments on the seed germnation on *Pterocarpus marsupium*. Kumar, V. (2020) has studies Pre-sowing treatment in *Terminelia bellirica* and observed that Seeds of *Terminelia bellirica* shows best germination (100%) in seeds treated with H_2SO_4 for 10 minutes. Adebisi and Bello (2015) has studies in pre-sowing treatment in *Gmelina arborea*.

Therefore, large, medium and small sized seeds of *Alangium lamarckii* were treated with sulphuric acid, dry heat exposures and mechanical scarification to determine the germination.

Material and Methods

For experiment Seeds were collected from 20-22 years old *Alangium lamarckii* trees situated at Banguan and Orchha forests in the month of April to May 2023. For investigation, the seeds were divided into three categories on the basis of their weight. Large (0.21-0.30g), medium (0.11-0.20g) and Small (0.05-0.10g). The seeds were treated mechanically as well as with chemicals. Effect of temperature was also studied on seed germination.

Various Pre-sowing treatment made are summarized as under.

1. A small piece of the seed coat from distal end of cotyledon was removed mechanically using a nail clipper and sown (Scarification).
2. Seeds were treated with concentrated H_2SO_4 (98%) for 5, 10, 15 minutes and after treatment, the seeds were rinsed for about 3 minutes under tap water.
3. Dry heat treatment was given by keeping the seeds in preheated oven at 60^o, 80^o and 100^oC for 15, 30 and 60 minutes and then sown.
4. The treated seeds were sown in Polythene bags of 25cm X 10cm sized at Botanical garden, P. K. University Campus, Shivpuri. The experiment was set up in completely randomized design and replicated twice. Regularly watering was done in the experiment. After the germination data were collected and statistically analyzed.

Results and Discussion

The seeds of *Alangium lamarckii* were subjected to various Pre-treatments for enhancing germination percentage. It is interesting to note that all of the treatments were quite effective in enhancing seed germination percentage (table-1).

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Mechanical treatment

Removal of small part of seed from distal end before sowing enhanced seed germination (36.3%) as compared to 16.7% germination with intact seed coat (Control) in medium sized seeds while in small sized seeds no germination occurred. Other sized seeds showed poor germination. With the perusal of the results it has been concluded that the enhanced germination in the medium sized seeds was due to better inbibition of water through the seed coat.

Effect of acid treatment

Treatment with concentrated H_2SO_4 enhanced seed germination (Table-1). High germination (100%) was obtained by treatment with the acid for 10 minutes in large and medium sized seeds. Acid treatment with concentrated $H2SO_4$ for 5 minutes also showed good results (100%) in large sized seeds only but other large sized seeds did not show good results in 5 minutes acid treatment while treatment with 15 minutes showed less germination in all sized seeds. Thus, the suitable timing of breaking the dormancy of *Alangium lamarckii* by acid treatment (Con. H_2SO_4) was 10 minutes. Acid scarification with concentrated H_2SO_4 for 30 minutes improved seed treatment to the extent of 83% in *Acacia* (Natarajan and Rai, 1998). However, H_2SO_4 treatment for 60 minutes in *Acacia nilotica* seeds improved germination up to 90% (Zodape, 1991). During the course of present investigation treatment with concentrated $H2SO_4$ for only 10 minutes was found to be much effective and enhanced seed germination could have been the reason that the seed coat of the seed would have become fully permeable to water.

Dry heat treatment

Rate of germination differed significantly between dry heat treatment a well as incubation periods. In *Alangium lamarckii* the germination response to various dry heat treatments was not good. In general, dry heat treatment was not good. In general, dry heat treatment at 60^{o} C gave better results than other temperature. Temperature exposure for 30 minutes and above proved lethal in *Butea monosperma*. Dry heat treatment of *Pongamia galbra* at 25^{o} C showed maximum germination (Singh, et. al., 2005).

TABLE-1 Effect of Seed treatment on seed germination of *Alangium lamarckii*

Treatment	Categories of Seeds		
	Large	Medium	Small
Scarification (Mechanical)	21.1 (3.1)	36.3 (4.2)	0 (0)

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Sulphuric acid			
5 minutes	100	66.7	50
	(9.1)	(8.3)	(6.3)
10 minutes	100	100	83.3
	(16.7)	(12.5)	(6.7)
15 minutes	50	66.7	66.7
	(8.3)	(8.3)	(11.1)
Dry heat, 60^{o}C			
15 minutes	50	33.3	50
	(3.33)	(2.1)	(3.1)
30 minutes	66.7	33.3	16.7
	(6.1)	(4.2)	(2.8)
60 minutes	0	33.3	16.7
	(0)	(3.3)	(2.8)
Dry heat, 80^{o}C			
15 minutes	33.3	16.7	33.3
	(1.5)	(1.3)	(2.6)
30 minutes	31.3	16.7	0
	(4.2)	(3.3)	(0)
60 minutes	16.7	16.7	16.7
	(1.7)	(2.1)	(1.7)
Dry heat, 100^{o}C			
15 minutes	16.7	16.7	16.7
	(2.8)	(1.1)	(2.1)
30 minutes	16.7	0	0
	(3.3)	(0)	(0)
60 minutes	0	0	0
	(0)	(0)	(0)
Control	0	16.7	0
	(0)	(1.1)	(0)

ISBN Number: 978-93-95305-78-5

References

1. ADEBISI, M. A. and BELLO, F. Y. (2015). Seed germination and seedling vigour attributes of Gmelina (*Gmelina arborea*) seed saffected by fruit maturity levels and pre storage investigation treatment under ambient tropical conditions. *Nigeria Agricultural Journal.* 45 (1): 155-170.
2. ARYA, CHITRA AND ARYA, ARUN (2006). Effect of storage on seed viability and germination of certain Leguminous trees. *Indian For*., 132 (5): 601-608.
3. BERRY, N., SHUKLA, A. and BARADE, E., (2021). Pre-sowing treatment of seeds and its impact on germination of *Gmelina arborea* Roxb. *The Pharma Innovation Journal*, 10 (10): 239- 243.
4. BHATTACHARYA, S. K. (2000). Hand book of medicinal plant. Popular offset services. Jaipur: 78.
5. KHAN, M. R. (2015). The effect of different Treatments on the seed germination of *Pterocarpus marsupium* Roxb. *Weekly Sci Res. J*. 2 (28): 22.
6. KUMAR, V., (2020). Effect of Pre-sowing seed treatment on Germination of *Terminelia bellirica* (Gaetn.). *Indian J. of Ecology.* 43 (1): 237-238.
7. NATARAJAN, N AND RAI, R. S. V. (1998). Studies on maximization of germination in *A. auriculiformis. Indian J. For.,* 11 (4): 304-306.
8. SINGH, R. V., (1982). Folder trees of India Oxford and IBH Pub. Co. New Delhi. 82-83pp.
9. SINGH, K. P., DHAKE, G. AND CHAUHAN, S. V. S. (2005). Effect of mechanical and chemical treatments on seeds germination in *Pongamia galbra* L. *Seed Res*. 33 (2): 169-171.
10. TROOP, R. S. (1921). The Silviculture of Indian Trees, Vol I, II and III, Charendon Press, Oxford.
11. Zodape, S. T. (1991). The improvement of germination of some forest species by acid scarification. *Indian For*., 117 (1): 65-67.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

AI & ML ALGORITHMS TO IMPROVE THE PROCESS OF VLSI DESIGNING & TECHNOLOGY – A BRIEF REVIEW

Dipmala M.Patil[1]*, Dr. Satnam Singh[2]

[1*]Department of Electronics & Communication Engineering, Institute of Engineering. University, Shivpuri(M.P.)Thanra Village, Tehsil Kanera,NH-27,Dist.Shivpuri, M.P. India, Pin – 473665

[2]Department Of Electronics & Communication Engineering, Institute of Engineering. University, Shivpuri(M.P.)Thanra Village, Tehsil Kanera,NH-27,Dist.Shivpuri, M.P. India, Pin – 473665

*Corresponding Author Email Id: jadhavdimala@gmail.com

ABSTRACT:

This paper gives a brief review of the AI/ML algorithms to improve the process of VLSI designing and technology. As the analysis and development of techniques that might reduce design complexity brought on by expanding process variability and minimize the turnaround time of chip manufacturing are clearly going to be a problem for the integrated circuit (IC) industry in the nanometer regime. The traditional approaches used for these activities are mostly manual, which takes time and resources. Contrarily, very large scale integration (VLSI) design and testing can take advantage of a variety of new automated ways thanks to the distinctive learning strategies of artificial intelligence (AI). Utilizing automated learning algorithms, AI and machine learning (ML) algorithms reduce the time and effort required to comprehend and process data within and across different abstraction levels, improving IC yield and speeding up production turnaround. This article examines the automated AI/ML methods for VLSI design and production that were previously used. The synergy between AI/ML and VLSI technology not only accelerates the design process but also fosters innovation in developing next-generation electronic devices. In conclusion, the integration of AI/ML in VLSI design and technology represents a paradigm shift, offering substantial improvements in design automation, optimization, and reliability. As these technologies continue to evolve, their impact on VLSI design is expected to grow, driving further advancements in semiconductor technology and electronic design automation (EDA) tools. This abstract underscores the transformative potential of AI/ML in shaping the future of VLSI design and highlights the need for ongoing research and development in this interdisciplinary field.

Keywords: Artificial Intelligence (AI), Machine Learning (ML), VLSI Design, Design Automation, Optimization

ISBN Number: 978-93-95305-78-5

1. LITERATURE REVIEW

The application of Artificial Intelligence (AI) and Machine Learning (ML) in Very-Large-Scale Integration (VLSI) design has garnered substantial academic and industrial interest in recent years. This literature review surveys the key developments, methodologies, and applications of AI/ML in VLSI design, highlighting significant contributions and identifying current trends and future directions. Design Automation and Optimization: The traditional VLSI design process involves several stages, including logic synthesis, placement, routing, and verification, each of which can benefit from AI/ML interventions. Notably, Mirhoseini et al. (2020) demonstrated the efficacy of reinforcement learning in chip floorplanning, achieving superior results in terms of performance and power consumption compared to human experts. Similarly, Wang et al. (2018) explored the use of genetic algorithms for optimizing placement and routing, showcasing improvements in design efficiency and quality. Power and Performance Prediction: Accurate prediction of power consumption and performance metrics is crucial in VLSI design. Studies by Han et al. (2019) and Liu et al. (2021) utilized neural networks to predict power usage and thermal effects in integrated circuits. These approaches significantly enhanced prediction accuracy and enabled designers to make informed decisions during the design phase, thereby optimizing overall circuit performance. Fault Detection and Yield Improvement: Fault detection and yield enhancement are critical to ensuring the reliability of VLSI circuits. ML algorithms have been extensively researched for their ability to analyze manufacturing data and predict potential defects. For example, Liu et al. (2020) applied support vector machines to detect anomalies in semiconductor manufacturing, resulting in higher yield rates and reduced production costs. Another significant contribution by Tsai and Lu (2019) involved using convolutional neural networks (CNNs) for identifying defects in photomasks, a critical step in semiconductor fabrication. EDA Tool Enhancement: The integration of AI/ML into Electronic Design Automation (EDA) tools has led to more intelligent and autonomous design systems. Zeng et al. (2021) developed an ML-enhanced EDA framework that integrates various AI techniques to automate design tasks, thereby reducing design time and improving accuracy. These tools can adapt to new design challenges and continuously learn from design data, providing a competitive edge in the rapidly evolving semiconductor industry

2. INTODUCTION

Introduction In the world of microelectronics, CMOS technology has long dominated. On a single chip, the number of transistors manufactured has grown dramatically. The density and performance of these

ISBN Number: 978-93-95305-78-5

devices have increased due to the constant downscaling of transistors through many technical generations, which has greatly boosted the microelectronics industry's growth. Modern very-large-scale integration (VLSI) technology makes it possible to realize sophisticated digital systems on a single chip. As transistor size go smaller, the complexity of the semiconductor manufacturing process rises. Simple scaling inevitably comes to an end as we get closer to atomic dimensions. Even these devices are small, several aspects of their performance decline over time, such as leakage increasing gain decreasing and increased sensitivity to manufacturing process fluctuations. The circuit functioning is severely impacted by the sharp increase in manufacturing differences, which results in inconsistent performance in transistors of the same size. This affects the circuit's propagation delay, which behaves as a stochastic random variable, making timing closure procedures more difficult and significantly lowering chip yield. Affordable design at future technology nodes and advanced design techniques need to be adopted in the design flow for finer optimization in order to maintain the performance trend of VLSI systems handling the increasing challenges caused by increased process variability, design complexity, and chip integration. The effectiveness of electronic design automation (EDA) tools in overcoming design constraints determines how quickly a chip may be produced. The classic rule-based EDA approaches take a while to produce an ideal answer to the given design restrictions. A number of issues have found noteworthy solutions thanks to artificial intelligence (AI). The foundation of AI is human intellect, which is understood in a way that makes it simple for machines to duplicate it and carry out tasks of various levels of complexity. AI is a subset of machine learning (ML). Learning, reasoning, predicting, and perceiving are the objectives of AI/ML. Large amounts of data may be quickly and simply analyzed by AI/ML to find patterns and trends that help users make informed decisions. AI/ML algorithms are capable of processing multidimensional and multivariate data quickly. The fields of VLSI design and technology have seen substantial application of AI/ML techniques.

3. BASICS OF VLSI DESIGN FLOW

According to Fig.1, which depicts a generalized design flow that includes the front-end and backend of full-custom/semi-custom designs, a traditional digital IC design flow contains numerous hierarchical layers. The functionality, interface, and overall architecture of the digital circuit to be built are all described abstractly in the design specifications. Block diagrams that include the functional description, timing requirements, propagation delays, necessary package type, and design restrictions are among them. They also serve as a contract between the vendor and design engineer. The architectural design level

ISBN Number: 978-93-95305-78-5

determines the system's fundamental architecture, including the number of arithmetic logic units (ALUs), floating-point units, and processors with reduced instruction set computing (RISC) or complex instruction set computing (CISC). A micro architectural definition that includes the functional descriptions of subsystem components is the result of this level. A design's performance and power can be estimated by architects using these descriptions as a basis. The next step is behavioural design; it gives a functional description of the design, frequently written in Verilog HDL or VHDL. The behavioural level hides the implementation specifics by providing a high level description of the functionality. The RTL level of description, which is the following level, is where the timing information is verified and checked. A C/C++-based system specification can be automatically converted to HDL using a high-level synthesis (HLS) tool. The netlist, or gate-level description for the high-level behavioural description, is created by the logic synthesis tool. The time, area, and power requirements for the gate-level netlist are met by the logic synthesis tool. Testbench/simulation is used to carry out logic verification. At this point, formal verification and scan insertion using DFT (design for testability) are carried out to check the RTL mapping. Floor layout, placement, and routing are done after system partitioning, which is the act of breaking large, complicated systems into smaller modules. The floor planner's primary job is to calculate the amount of chip space needed to implement a typical cell or module design. It also works to increase design performance. The submodules, gates, and flip-flops are placed via the place and route tool before the CTS and reset routing. The routing of each block is then carried out. Layout verification is carried out after placement and routing to check whether the intended layout complies with the electrical/physical design guidelines and the source schematic. The chip enters the sign-off stage after the post-layout simulation, which involves the extraction and verification of parasitic resistance and capacitance. The finished product is transmitted to the semiconductor foundries for IC production as a GDS-II file. Precision is essential for the numerous sophisticated and difficult physical and chemical processes involved in IC production. From wafer preparation to reliability testing, it includes many steps. In a nutshell, wafers are made by growing and slicing silicon crystals. The wafers must be polished to an exceptionally high degree in order for VLSI devices to have incredibly small dimensions. The deposition and diffusion of various materials on the wafer are two of the many processes in the fabrication process.

ISBN Number: 978-93-95305-78-5

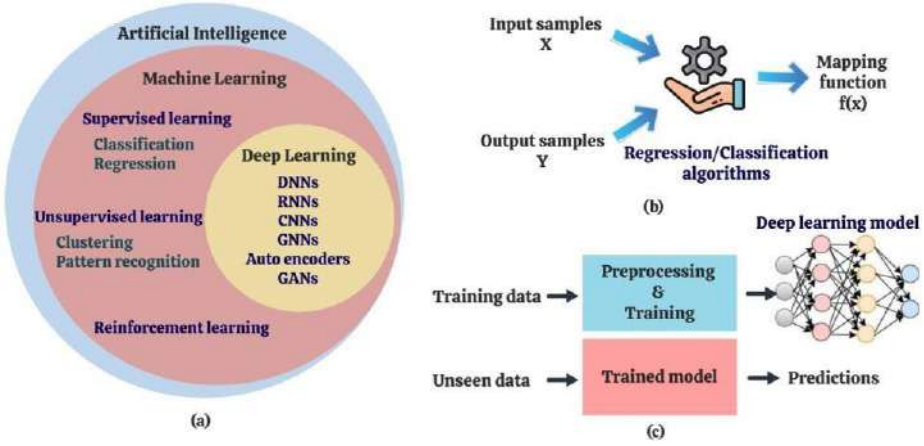

Figure 1: (a) Overview of Artificial Intelligence techniques (b) Learning function of classification/regression algorithms (c) Deep learning training and prediction

NOTE ON AI & ML ALGORITHMS

A machine may mimic human behaviour thanks to AI technology. The two primary AI subsets are machine learning and deep learning. With the aid of machine learning (ML), a computer may automatically learn from the data it has already collected. The most important subset of ML is deep learning (Fig.1). As fresh data are added, ML includes learning and self-correction. Structured and semi-structured data can be handled by ML, whereas structured, semi-structured, and unstructured data can be handled by AI. The three main categories of ML are reinforcement learning, unsupervised learning, and supervised learning. Supervised learning occurs when the output label is present for each piece in the input data. Unsupervised learning is carried out when the only input variables are present in the data. Semi-supervised learning is the process of learning from data that has labels attached to some of the pieces.

4. CATAGORIES OF AI ML

The two subcategories of supervised learning are regression and classification. Data analysis that uses classification derives models representing significant data classes. Classifiers are models that forecast discrete categorical class labels. Regression, as opposed to discrete class labels, is used to forecast missing or unavailable numerical data. A statistical method called regression analysis is frequently applied to the numerical prediction of continuously valued functions. Both numerical and class-label forecasts are referred to as "predictions" here. A learning function that predicts a mapping of Y = f (X), where Y is a collection of output variables for X input variables, can be seen in the classification/regression process. For estimating the related class label y of a given new tuple X, the mapping function is estimated. Support

ISBN Number: 978-93-95305-78-5

vector machines (SVMs), decision trees, random forests, ensemble learning, and linear, polynomial, and ridge regressions are examples of common regression and classification algorithms.

5. CONCLUSIVE REMARKS

A brief review of the VLSI design flow was presented in this paper. Deep learning, supervised/unsupervised/semi-supervised learning, NNs, MLP structures, and CNNs are a few examples of AI and ML approaches that offer chances to address the many issues and difficulties in the field of VLSI design. Artificial intelligence (AI) methods can lower the cost of testing a VLSI chip or subsystem. The design flow's various abstraction levels, from circuit design through chip production and testing, inevitably include a variety of models linking inputs to outputs. For instance, by applying AI heuristic search methods to locate an effective solution for rearranging the test cases, power consumption during testing can be decreased. On the chip, there are billions of integrated or future-integrated devices and components that exchange a huge quantity of data. With the help of AI/ML algorithms and the data gathered from various simulations and studies, it is possible to study the intricate I/O linkages between the components, processes, and different abstraction levels within each abstraction level. VLSI-CAD may make use of AI/ML solutions to optimise design flow. Future semiconductor difficulties may have ground-breaking answers provided by AI and ML.

REFERENCES

[1].Lin Rouzhou, “AI/ML Algorithms and Applications in VLSI Design and Technology, “International IT journal of research,Volume 1, Issue 1,October-December– 2023.

[2].Deekshita P.,and Dr.Pavithra G., “AI/ML/DL Algorithms and Applications in VLSI Design Technology Process Flow – A Brief Review,” International Journal of Engineering Technology and Management Sciences,Issue: 6 Volume No.6 October - November – 2022.

[3]. Deepthi Amuru, Harsha V. Vudumula, Amir Ahmadv “AI/ML Algorithms and Applications in VLSI Design and Technology” International Institute of Information Technology, Hyderabad – 2022.

[4]. M. Wolf, and J. Henkel, “Mlcad: A survey of research in machine learning for cad keynote paper,” IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, pp. 1–1, 2021in 2021

[5]. M.-Y. Su, W.-C. Lin, Y.-T. Kuo, C.-M. Li, E. J.-W. Fang, “Chip performance prediction using machine learning techniques,” International Symposium on VLSI Design, Automation, 2021.

ISBN Number: 978-93-95305-78-5
[6]. Mishchenko A., and S. Chatterjee, “Logic synthesis meets machine learning: Trading exactness for generalization,” IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, vol. 39, no. 12, pp. 5083– 5096, 2020.

[7].C.K.C. Lee, “Deep learning creativity in eda,” International Symposium on VLSI Design, Automation and Test (VLSI-DAT), pp. 1–1, 2020.

[8]. E. Alpaydin, “Introduction to machine learning”. IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, 2020.

[8]. P.A. Beerel and M. Pedram, “Opportunities for machine learning in electronic design automation,” IEEE International Symposium on Circuits and Systems (ISCAS), pp. 1–5, 2018.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

HUMAN RIGHTS AND GLOBAL JUSTICE-CHALLENGES AND SOLUTIONS

Dr Ramesh Kumar Singh
Assistant professor
Veer Kunwar Singh University, Ara Bihar
Posted at Maharaja Law College, Ara
singhrameshkumar148@gmail.com

Abstract

This study discusses human rights and global justice, structural inequalities that make it difficult to achieve these rights, and the fact that they apply to all. There exist multiple barriers to realization between those goals: economic disparity, entrenched discrimination, state sovereignty, and legal and governmental restrictions of international law. Through this perspective of global justice, civil, political, economic, social, and cultural rights are critically analyzed to respect human dignity and distribute resources equitably. The research recommends holistic remedies that include better international cooperation, civil society lobbying, economic restructuring, inclusive social policies, legal reforms, and harnessing the potential of new technologies such as blockchain and artificial intelligence for the monitoring and protection of rights. The genocide of Rwanda and the Syrian refugee crisis are two case studies through which it is possible to depict practical ramifications of those issues and the urgent requirement of prompt international solutions. Thus, the findings reveal that in the end teamwork will be necessary to mitigate the worst aspects of such abuse and to create more of a just and equitable society.

Keywords*: Human Rights, Global Justice, Challenges, Solutions, International Law, Global Governance.*

1. INTRODUCTION

Human rights and international justice constitute the very conceptual foundation in which the universal pursuit of equality, dignity, and justice for all human beings cuts across and disregards lines of nationality, ethnicity, or any form of social standing. It is concerned with the fundamental freedoms and the protections to which every person is entitled through their status as human. These rights include civil, political, economic, social, and cultural rights which guarantee people the right to live with dignity, take part in society, and be provided with resources needed. On the other hand, global justice seeks to eradicate structural injustices and promote fairness worldwide, ensuring that opportunities, resources, and protections are shared equitably and justly among all nations and peoples.

Global justice is not separable from human rights in a world where interaction increases each day. Since laying the foundation for a more equal and just international order requires the protection of human rights, it is central to the pursuit of global justice, despite the many obstacles this comes with. This is because of

ISBN Number: 978-93-95305-78-5

the convergence of social, cultural, political, and economic issues that conspire to impede the application of human rights globally in a fair and equitable manner. Issues that threaten human rights and global justice include state sovereignty, apathy, economic exploitation, prejudice, and lack of enforcement.

Despite these barriers, there are still viable approaches toward advancing global justice and strengthening human rights protection. Such solutions require a multi-pronged approach involving enhanced lobbying through civil society movements, corporate responsibility, global governance reforms, and greater international cooperation. Moreover, technology and international organizations can greatly assist in monitoring human rights abuses and bringing perpetrators to study.

1.1. Objectives of the Study

- To investigate the connection between global justice and human rights.
- To determine what obstacles, stand in the way of attaining fair global justice.
- To make suggestions for ways to remedy abuses of human rights and advance equity.

2. LITERATURE REVIEW

Van Ho, T. (2020) looked into corporate responsibility to respect human rights in "complex environments, as defined by itself," where it identified cases of gross violation of human rights ("IHRL" and "IHL" respectively), as well as serious breaches of international humanitarian law ("IHL"). The United Nations Guiding Principles on Business and Human Rights are widely referred to as the "UNGPs" or the "Guiding Principles." It is indeed the authoritative framework on the subject of business and human rights, known as "BHR." The company is responsible for protecting the rights of everyone involved, in all aspects. Companies were required to perform "human rights due diligence" to identify and address any actual or potential human rights issues. This was in their "duty to protect respect." Businesses were held to respect, as well as to make amends for any harm they could cause or contribute to.

Kanwel, S., Khan, M. I., & Asghar, U. (2024) simplified the problems faced and gave their solutions, in the extensive interaction of criminal justice with human rights. Human rights are cornerstones of democracy which is necessary for equity and justice in criminal justice. However, several factors acted as hindrances to the practice. They included prejudice, inhuman conditions in prisons, the misconduct of the police and pretrial custody misuse. The paper advanced diversity promotion, better training, legislative reform, and funding for alternatives to incarceration as the methods of addressing these problems. Stakeholders may have advanced a fairer and more effective criminal justice system as well as moved justice closer for all persons by making the principles of human rights their top priority.

ISBN Number: 978-93-95305-78-5

Mikalsen, K. (2017) talked about the role of state sovereignty in a just international system. Two competing ideas of international political justice—justice as impartiality and justice as non-domination—are the starting point. The former advocates an intergovernmental system of states with equal sovereignty, while the latter supports supranationalism and downplays the idea of equal sovereignty by substituting it with fundamental human rights. Because of their relative weaknesses, the sovereignty ideal of justice as non-domination remained exposed to forceful lines of counterarguments drawn upon by justice as impartiality. Using a branch of republican thought that Philip Pettit had labelled "Franco-German republicanism," Mikalsen provided stronger reason to argue that the equality of sovereignty is possible on behalf of the equality of states in contrast. Mikalsen specifically argued that sovereignty and human rights should have been considered of equal importance elements of the same normative conception and not as the key concepts of competing normative conceptions. respecting people's rights was in a seamless relationship with respecting the sovereign rights of states. Global justice was not only founded on equal sovereignty but it could not be said to further justice on a global scale without considering the equal sovereignty of states.

Atapattu, S. (2015) conducted an in-depth analysis of the human rights and climate change connection. This study encompasses the theoretical framework that governs human rights and the environment, the jurisprudential bases of human rights and the environment, and different approaches towards this, such as benchmarks, under which human rights approaches to climate change are discussed. In addition to reviewing the implications of international environmental law principles on human rights under the climate change regime, the study looked at how the framework of human rights may be applied to mitigation, adaptation, and adjudication. Other chapters examined how climate change would unevenly impact vulnerable populations such as women, indigenous peoples, and climate "refugees." The book then continued to examine if human rights legislation was suited to address these new challenges and a new category of persons created by climate change-the stateless persons that governments would dissolve and be displaced by climate change.

3. DEFINING HUMAN RIGHTS AND GLOBAL JUSTICE

3.1. Human Rights

Everyone, irrespective of nationality, ethnic group, or any such status, must have universal rights and basic freedoms to hold such status for dignity, liberty, and justice. Rights come in two main groups: civil and political on the one hand and economic, social, and cultural on the other.

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- Civil and Political Rights: These include life, liberty, personal security, speech, assembly, fair trial, and political participation. Such rights safeguard citizens from state excesses and provide for participation in society and governance.
- Economic, Social, and Cultural Rights: This ensures access to the most basic necessities-such as food, water, education, healthcare, and employment-into cultural involvement and social advantages, allowing individuals to lead dignified and fulfilling lives.

International human rights have found the foundation within the UDHR of 1948 through the UN. Everyone shall be considered born equal to all men and with all dignity as they add human rights a universal justification around the globe. Some broadening, as well as legal enhancement of the right at UDHR, includes some international treaties and conventions known as the ICCPR and ICESCR**.**

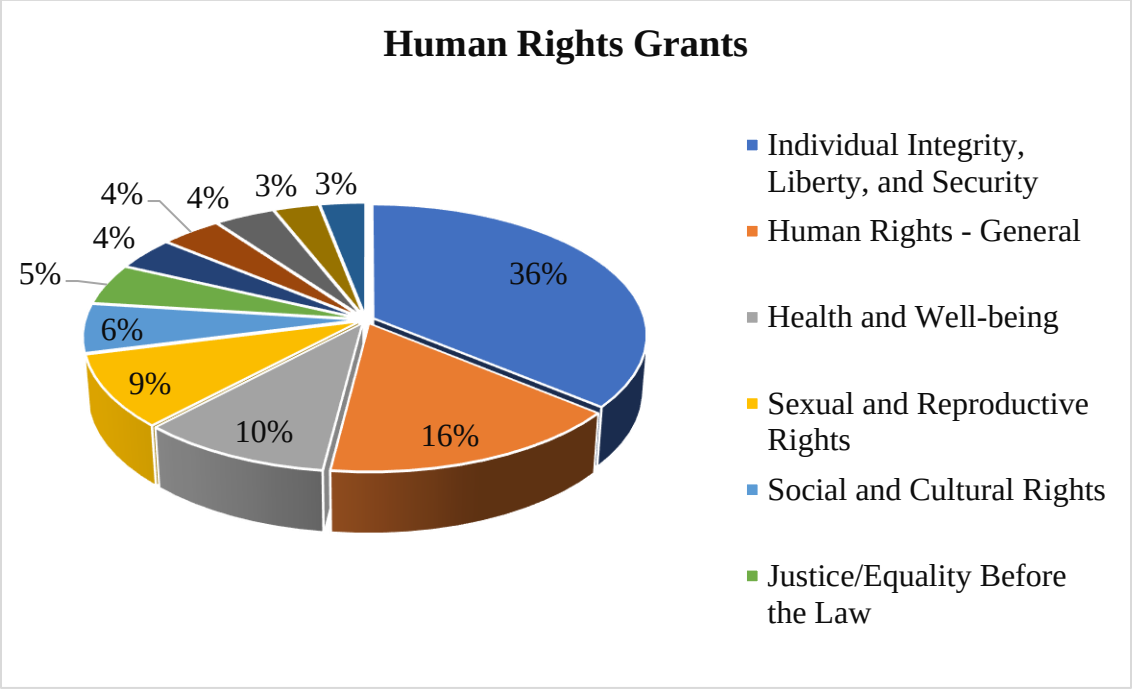

Figure 1: Human Rights Grants: What Do They Support?

3.2. Global Justice

The main aim of the notion of global justice is the worldwide scale of fairness in resource and opportunity allocation and safeguard provisions. It aims to address inequalities and disparities within and between countries. International cooperation is thus key to solving issues like poverty, environmental degradation, and human rights abuses, promoting economic equality, and giving moral treatment to everyone all over the world. It acknowledges that all are interdependent in the modern globalized world and seeks to create

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structures that ensure that everyone, irrespective of socioeconomic background, race, or nationality, receives the basics of a good living.

The information provided within the table gives an impression about the current situation that several rights have taken with regards to different nations and appraising global justice concerning liberty and rights of the citizens. The table is easily interpreted in terms of progress or failures with regard to upholding principles of global justice; in this case, based on the percentage of states which have progressed or declined in ensuring these rights within the population.

Table 1: Global Justice in Rights and Freedoms

Sub-factor	**% of Countries Declined**	**% of Countries Improved**
Equal Treatment	59%	41%
Right to Life and Security	65%	35%
Due Process of Law	69%	31%
Freedom of Expression	78%	22%
Freedom of Religion	76%	24%
Right to Privacy	61%	35%
Freedom of Association	81%	19%
Labor Rights	48%	52%

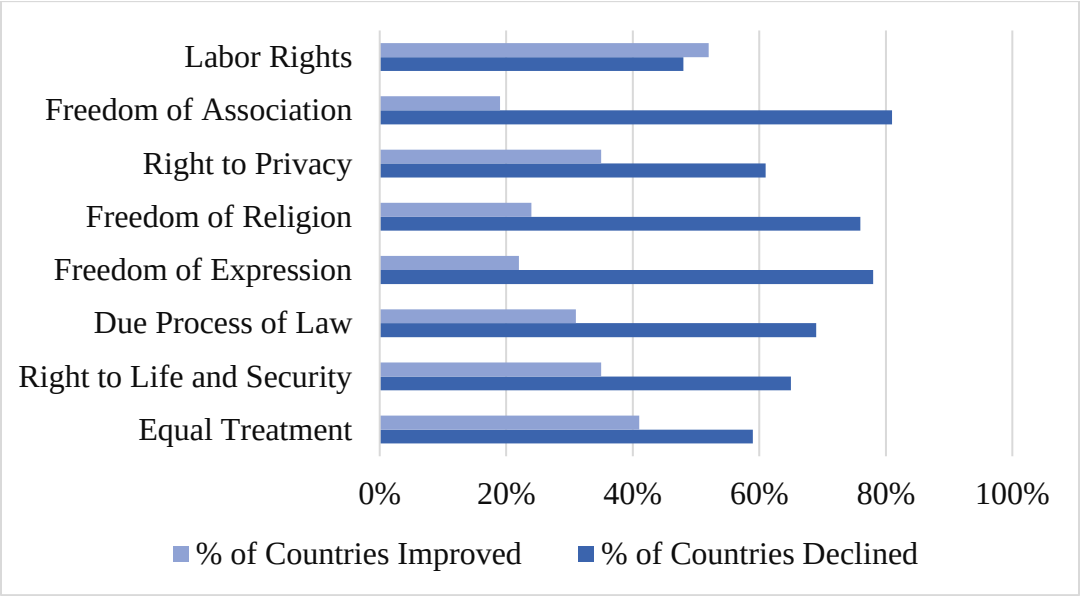

Figure 2: Global Justice in Rights and Freedoms

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Alarming patterns in the degradation of rights of some nations can be extracted from the information on the table above. The majority are nations experiencing the diminishment of freedom of speech, religious freedom, and right of association. Contrariwise, though that worldwide justice faces tough issues, improvements were realized for 52% of the nations on labour rights-places where there's hope. The rights to due process, equal treatment, and life and security also exhibit significant decreases, meaning many areas still fail to sustain these crucial elements of justice.

3.3. Relationship between the Global Justice and Human Rights

Global justice and human rights are closely related. Attaining global justice entails attaining human rights because it ensures that every individual is treated with dignity and has the opportunity to live a happy life. Global justice also seeks to eradicate systemic injustices that prevent people from exercising their human rights fully, especially in underprivileged and marginalized groups. The protection of individual rights is merely a part of attaining global justice, while another aspect would be the evolution of fairer international structures that allow equal access to resources, opportunities, and protections. In short, what sets these conditions in place to bring about human rights is global justice, and it is from human rights that moral as well as legal directions to this global justice originate. Indeed, both require an international commitment to human equality and justice as well as reverence for humanity.

4. CHALLENGES TO HUMAN RIGHTS AND GLOBAL JUSTICE

Political, economic, social, and legal factors pose a threat to human rights and global justice. Among the factors, external state behavior, global economic systems, social and cultural dynamics, as well as the limitations on international law and governance also contribute to the problem. However, many obstacles have to be overcome for the sake of fairness and equality to prevail worldwide.

1) Political Issues

State sovereignty versus international human rights law enforcement is a significant political issue for human rights. It allows countries to govern themselves without interference from others. This is the problem if they violate human rights. Nations that commit genocides or authoritarian regimes might claim sovereignty as a means of justifying international intervention. The R2P policy often fails to prevent political interests from blocking international action because powerful nations exercise their right to veto. The absence of political will also blocks international action since, no matter how democratic, most governments would always give primacy to national security and economic interests over human rights.

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Governments will not ignore or repress the other nation's human rights atrocities if these are strategically useful to them.

2) **Economic issues**

Economic inequality and poverty limit human rights and international justice. Poverty causes and is the effect of human rights violations in most nations, particularly those of the Global South. Systemic discrimination and maltreatment are promoted by the inequitable provision of healthcare, education, and housing. Economic arrangements globally favoring the world's elite put tremendous populations at risk. Multinational companies exploit inexpensive labor and act corruptly in poor countries, so corporate responsibility has become the paramount economic question. Environmental degradation, dangerous working conditions, and labor rights violations by these companies also affect local communities and violate human rights.

3) **Social and Cultural Issues**

Global Human rights and justice continue being faced by discrimination. There exist racial, ethnic, gender, and religious minorities subjected to systemic discrimination which prohibits them from enjoying equal rights and opportunities. Gender and political participation are barred due to various constraints imposed on women and girls. Sexual minorities face judicial and social discrimination in matters of freedom and security. Human rights are further compounded by cultural relativism and universalism. The concept of cultural relativism advocates for human rights to be particularistic, whereas universalism advocates for freedom from torture and equality to be enforced universally. This often breeds hostility towards international human rights standards in varied cultural situations.

4) **International Law and Global Governance**

International law lacks effectiveness in its enforcement mechanism, which threatens human rights. International human rights law may not be enforced fully and uniformly at times. While the UN and ICC can intervene in violations, they cannot compel governments to observe human rights norms. Super powers may escape accountability because of political influence in international structures. Selective enforcement disempowers global human rights. The global governance structure is in fragments, where many different bodies and treaties deal with various issues of human rights without coordination. The human rights violations, especially crossing borders, happen without having a coordinated approach. Due to fragmentation, it is difficult to have an all-encompassing response to abuse of human rights.

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5. SOLUTIONS TO HUMAN RIGHTS AND GLOBAL JUSTICE CHALLENGES

For resolving human rights and global justice issues, international cooperation with civil society action, change in economy, social justice activism, as well as some technical change is necessary for improving law enforcement, addressing global disparities, inclusion in societies and use of technical assistance to help assure accountability as well as transparency.

- ✓ **Law Reform and International Cooperation**

The third key human rights answer to strengthening international governance. Agencies like the UN find it difficult to implement human rights legislation, particularly when such issues involve the sovereignty of a state or authoritarian rule. These institutions must be reformed and strengthened for better enforcement powers. There is a potential that an efficient and binding global human rights tribunal might better make perpetrators accountable. It can punish genocide and war crimes more effectively than what systems exist today. In addition to strengthening international governance, there is a need for binding human rights accords. These accords will ensure that governments respect and observe human rights norms as well as ensure accountability to international law. Legally binding treaties can enhance compliance and reduce impunity for crimes against human rights in certain governments.

- ✓ **Civil Society Role**

Civil society is a significant feature of global human rights. Empowerment of vulnerable populations is, in general, spearheaded by NGOs, grass root movements, and organizations working for human rights. These groups raise awareness, mobilize, and mobilize for structural change. Advocacy may change history, as with the Anti-Apartheid Movement and Women's Rights Movement. Empowering grassroots movements who are usually the first to know and respond to human rights issues enhances the power of advocacy. Public education is also key. Society may promote rights and justice through human rights education in schools and through public awareness. Awareness-raising campaigns encourage people to be held accountable by governments and corporations, thus enhancing human rights.

- ✓ **Economy Solutions**

It requires economic solutions, most specifically global inequality. Such can be reduced and better lives for marginalized communities if achieved through fair trade, debt forgiveness, and sustainable development. These reduce poverty, economic unfairness, and structural human rights breaches of exploitation, bad education and health care. Corporations also must take responsibilities. Multinationals are often involved in human rights abuses, particularly when they engage in extractive industries with

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unsafe working conditions, labor exploitation, and environmental destruction. To keep corporations accountable for crimes on human rights, supply chain transparency and regulations for ethical business practices must be made.

- ✓ **Cultural and Social Solutions**

Social and cultural remedies enhance tolerance and inclusivity. Policies that ensure equity of races, genders, and religions must be established by the authorities. Marginalized groups can be incorporated into education and politics with affirmative action and diversity programs. Such measures are a way to combat discrimination and equality. Another significant socioeconomic answer is the promotion of cultural interchange. Cross-cultural discussion which is respectful can solve the dispute over cultural relativism and universal human rights. The promotion of universal human rights becomes easier with the help of respect towards different people's cultures. International cooperation and culture can help in the creation of a worldwide culture of peace and justice.

- ✓ **Technological and Digital Solutions**

Technology is fundamental to human rights in the digital age. Through data analytics and AI, one can monitor breaches in real time. AI may even be able to trace violence and discrimination so governments and NGOs can take immediate action. Blockchain will provide for openness and accountability because the record of human rights breaches is permanent and cannot be tampered with or erased. One of the very important modern human rights issues is the protection of digital rights. With the rise of the internet came cyber-surveillance, online censorship, and breaches of privacy. It is with these developments that digital rights need to be protected for the sake of free speech, information, and privacy. This can be through national and international legislation, protection against digital abuse, and promotion of internet and online access. The global adoption and effectiveness of solutions are shown in the following table:

Table 2: Solution Adoption and Effectiveness

Solutions	**Adoption Rate (%)**	**Effectiveness (%)**
ternational Cooperation & Law Reform	60%	75%
Civil Society Involvement (NGOs, Grassroots Movements)	85%	80%
Economic Solutions (Fair Trade, Debt Forgiveness)	65%	65%
Corporate Responsibility & Supply Chain Transparency	70%	70%
Social and Cultural Solutions (Inclusion, Affirmative Action)	80%	70%
ıltural Dialogue & Cross-Cultural Exchanges	65%	65%

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Technological and Digital Solutions (AI, Blockchain)	70%	85%
Digital Rights Protection	70%	75%

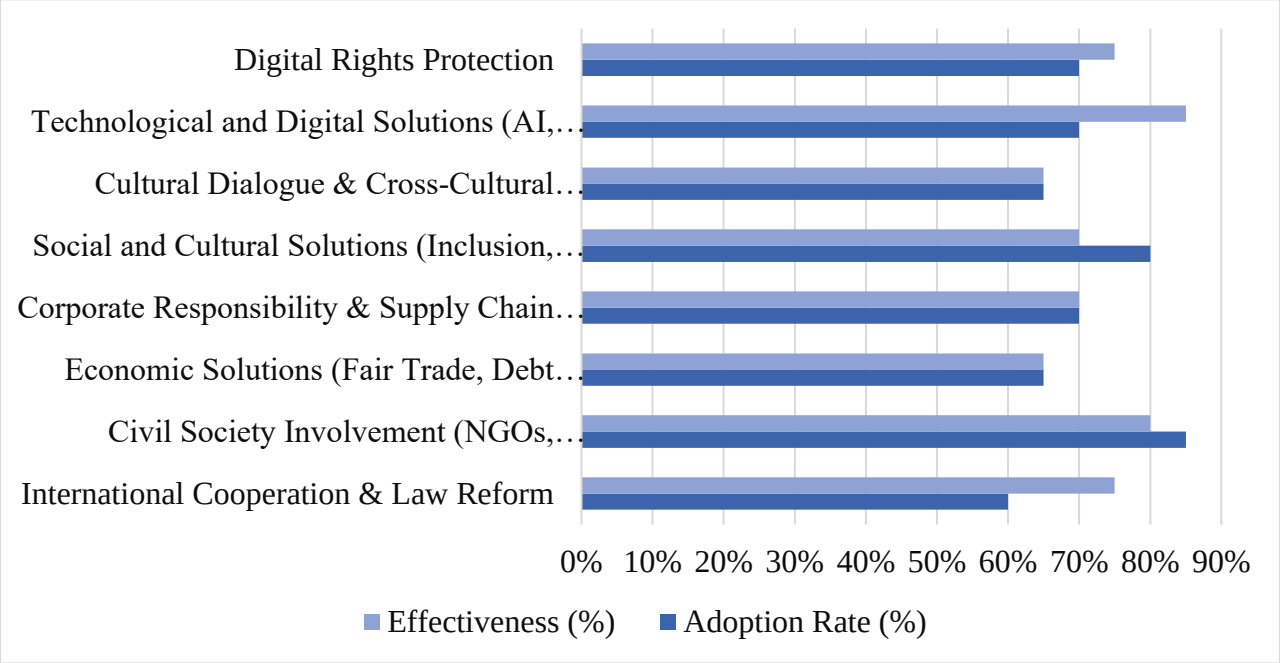

Figure 3: Solution Adoption and Effectiveness

6. CASE STUDIES OF HUMAN RIGHTS VIOLATIONS

Regional case studies describe human rights and global justice issues. These case studies reveal violations of human rights, the response of the international community, and long-term effects on the affected population and the international community.

1. Syrian Refugee Crisis

The 2011 Syrian civil war has triggered one of the largest humanitarian disasters in history. The atrocities include chemical warfare, mass displacement, and infrastructure destruction involving civilians. Millions of Syrians have been displaced, giving rise to one of the world's biggest refugee crises. Political intricacies have hindered the efforts for peacekeeping, despite global condemnation.

- **Key offenses** include indiscriminate bombs, chemical warfare, extrajudicial killings, torture, and forced displacement.
- **International reaction:** UN and NGO assistance, relocation of refugees, minimum involvement of military, and ineffective enforcement of international humanitarian law.
- **Long-term impacts:** regional instability, displacement, bad conditions of refugee's living, and political tension in host countries.

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2. Rwandan Genocide

The Hutu-led government killed 800,000 Tutsis and moderate Hutus in Rwanda in 1994. The international community could not intervene to stop the killing, despite early warnings and intelligence. Punishing the genocide perpetrators came after a long process of rebuilding at the International Criminal Tribunal for Rwanda.

- **Major Violations:** Genocide, mass killings, sexual violence, and torture.
- **Global Response:** Formed ICTR and structures for post-genocide reconciliation like gacaca courts. International intervention started coming too late to end the genocide.
- **Long-term effects** include psychological trauma, loss of confidence in international institutions, and other political and social problems within Rwanda and neighboring states.

3. The Myanmar Rohingya Crisis

For decades, governments and the military have been perfectionists of Rohingya Muslims. Not long ago, in 2017, a spree of savage crackdown killed many Rohingya Muslims, along with multiple cases of sexual abuse. The international community termed those actions ethnic cleansing, which Myanmar has declined to share with prosecution.

- **Most severe violations:** ethnic cleansing, forced displacement, deprivation of citizenship, and systemic violence.
- **International reaction:** Global condemnation, only slight involvement. Myanmar did not adhere to international judicial decisions on genocide cases in the UN's ICJ.
- **The long-term impacts** include more than 1 million refugees in Bangladesh, continued discrimination against Rohingya in Myanmar, and statelessness.

7. CONCLUSION

The study concludes that human rights and global justice are fundamentally interrelated and provide the basis on which a just and equal global society can be created. Although much progress has been made in the recognition and protection of human rights, much disparity and systemic barriers remain, which prevent their full realization. There are issues of economic inequality, social discrimination, and unequal access to justice. The study underlines the necessity of global cooperation, inclusive policymaking, and accountability mechanisms in order to bridge these gaps. The countries can work together toward a more just and inclusive world where human rights are respected and protected for all by addressing the root causes of inequality and equitable distribution of opportunities and resources.

ISBN Number: 978-93-95305-78-5

REFERENCES

1. *Adank, M. (2015). Inequality, Migration and Global Justice–Challenges in Social Work Practice.*
2. *Atapattu, S. (2015). Human rights approach to climate change: challenges and opportunities. Routledge.*
3. *Blitt, R. C. (2014). International Human Rights Law as a Global Foundation for Social Justice: Promise and Challenges. In Social Justice and the University: Globalization, Human Rights, and the Future of Democracy (pp. 67-95). London: Palgrave Macmillan UK.*
4. *Coccoli, J. (2017). The challenges of new technologies in the implementation of human rights: An analysis of some critical issues in the digital era. Peace Human Rights Governance, 1(Peace Human Rights Governance 1/2), 223-250.*
5. *Coughtry, S. (2017). The Role of the International Criminal Tribunal for the Former Yugoslavia in International Justice: Challenges, Triumphs, and Failures. California State University, Fullerton.*
6. *Davis, M. F. (2017). Design challenges for human rights cities. COLuM. HuM. RTs. L. REV., 49, 27.*
7. *Dudziak, S. (2005). Educating for justice: Challenges and openings in the context of globalisation 1. In Globalisation, global justice and social work (pp. 139-152). Routledge.*
8. *Gal-Or, N., & Schwelling, B. (2015). Global Cooperation in Transitional Justice: Challenges, Possibilities, and Limits. Global Dialogues, 6.*
9. *Kakra, V. (2021). Transitional Justice: Challenges and Solutions. Indian JL & Legal Rsch., 3, 1.*
10. *Kanwel, S., Khan, M. I., & Asghar, U. (2024). HUMAN RIGHTS AT THE CROSSROADS: NAVIGATING CRIMINAL JUSTICE CHALLENGES. PAKISTAN ISLAMICUS (An International Journal of Islamic & Social Sciences), 4(01), 139-149.*
11. *Luambano, T. R. (2018). Litigating human rights through the East African Court of Justice: overview and challenges. JL Pol'y & Globalization, 71, 76.*
12. *Mikalsen, K. (2017). Equal Sovereignty: On the Conditions of Global Justice. GLOBUS Research Paper, 3.*
13. *Soohoo, C. (2015). Human rights cities: challenges and possibilities. Global Urban Justice: The Rise of Human Rights Cities, Barbara Oomen, Martha F. Davis, Michele Grigolo, eds. (Cambridge University Press 2016).*
14. *Symonides, J. (Ed.). (2019). Human rights: New dimensions and challenges. Routledge.*
15. *Van Ho, T. (2020). Business and human rights in transitional justice: challenges for complex environments. In Research Handbook on Human Rights and Business (pp. 379-401). Edward Elgar Publishing.*

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

THE UNITED NATIONS SECURITY COUNCIL IN THE TWENTY FIRST CENTURY - A CRITICAL EVALUATION

Dr Ramesh Kumar Singh
Assistant professor
Veer Kunwar Singh University, Ara Bihar
Posted at Maharaja Law College, Ara
singhrameshkumar148@gmail.com

Abstract

The United Nations Security Council was established in 1945. Its structure, dominated by the five permanent members (P5), namely China, France, Russia, the United States, and the United Kingdom, has increasingly been criticized for not being able to adapt to the geopolitical and sociopolitical context of the twenty-first century. Because of the P5's veto power and antiquated representation, the Council is less successful at addressing contemporary challenges like cybersecurity breaches, climate change, and geopolitical conflicts. Instead, the system frequently puts national interests ahead of international peace. In order to objectively assess the UNSC's function in the modern period, this article looks at its problems, historical development, and pressing need for reform. It draws attention to the initiatives of advocacy organizations such as the G4, which are working to improve the Council's representation and inclusivity in order to better reflect the geopolitical realities of the modern world. The report emphasizes how urgently structural adjustments are required to guarantee that the UNSC continues to be a useful instrument for preserving world peace and security.

Keywords: *UNSC, Global Peace and Security, Veto Power, Reforms and Representation, Geopolitical Challenges.*

1. INTRODUCTION

The establishment of the UNSC in 1945 marked an important change in the balance of world power. The UNSC has ten elected, or non-permanent, members with rotating seats, but their impact is still quite small. The P5 maintains control over the other nations, frequently relegating them to a supporting position and limiting other UN members' capacity to significantly alter the structure and operations of the Council. The end effect is a system where the influence of more powerful governments reduces the voices of the majority. Due to the changing global political landscape of the twenty-first century, this significantly impairs the UNSC's capacity to address contemporary concerns. In order to create a more effective and

ISBN Number: 978-93-95305-78-5

responsive Council that can meet the current threats to global peace and security, the structural defect must be fixed.

Figure 1: UNSC

The worldwide system's tectonic plates have seen significant changes as a result of the advancements of the twenty-first century. The political and economic landscape is always changing, and the issues that threaten global security are becoming more complex. The development of technology, organized crime, climate change, and other societal challenges force us to reevaluate the kind of dangers that can undermine global security in the twenty-first century. War is no longer the only threat we confront.

An internationally recognized body, the UNSC was created to maintain world peace and avert international crises. But because of "the lack of unanimity of the permanent members," which undermines its structure, the Security Council regularly "fails to exercise its primary responsibility," as the P5 prioritize their own interests over the pursuit of world peace. Carswell raises questions about how change might be implemented, and the best means to do so would conflict with UNSC articles about the proper structure. Although sufficient representation is emphasized as a means of addressing socio-political changes, other types of change that are required to address contemporary challenges are sometimes left out of the reform that is being considered. As many nations and academics only strive for increased representation, the capacity to suggest policies and solutions is frequently overlooked.

At the moment, the Council permits the P5 to pursue their own goals. Being a member of the UNSC benefits both permanent and non-permanent governments, as some elected states have better access to powerful nations, according to The permanent members also benefit, albeit primarily from their veto

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power, which they frequently use to advance agendas that would best serve their nations and friends. Both of these academics tend to focus on how nations gain from membership in the Council, but they don't sufficiently address how these relationships and policies harm other nations; those directly impacted by vetoes or those in need of aid but unable to obtain it are voiceless.

2. LITERATURE REVIEW

Hardt, J. N. (2021)given an intensive triple analysis, adding to the corpus of research currently accessible on the relationship between climate change and security. Since its inception in 2007, the UNSC continuing discussion about the choice about whether to include climate change on its plan has continued to create. The creator starts by analyzing the dominant perspectives on the relationship between climate change and security, highlighting the 2020 joint announcement issued by ten UNSC members. Second, Hardt identifies the normal presumptions among UNSC part states in 2020 by fundamentally examining the difficulties surrounding diverse definitions of climate-security. The creator makes the contention that a consensus may be not too far off by comparing their opposing viewpoints. Third, the study assesses whether adding climate change to the UNSC plan will cause an extreme change inside the association and redefine security to more readily mirror the existential dangers of the Anthropocene. While the experimental basis of this research is based on essential sources from the 2020 UNSC deliberations, the hypothetical framework is based on fundamental security studies. Earth System Sciences insights in the world's ongoing status are combined with secondary writing on climate and security to give more perspective.

Tobey, W. H. (2018) gave a unique explanation of Resolution 1540's beginnings and goals. The author's experience, first-hand recollections, and conversations with former government officials—such as Stephen Hadley, John Bolton, and Robert Joseph—formed the basis of the study. Tobey aimed to provide understanding of the resolution's drafting process, its intended use, and the diplomacy involved in its passing. The study also looked at how these factors affected the final Security Council wording. By doing this, Tobey sought to place Resolution 1540 in the larger framework of other counter-WMD-terrorism and non-proliferation instruments and programs.

Adefisoye, T. O., & Adefisoye, I. D. (2019) examined the efforts of UNSC, which, in October 2000, passed Resolution 1325 fully intent on addressing the adverse consequences of vicious conflicts and wars on ladies and girls. The resolution sought to reposition ladies and girls in dynamic roles in peace and security, urging the involvement of UN part states in its execution. In response, the Nigerian government,

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through the Bureaucratic Ministry of Ladies Affairs and Social Turn of events, figured out the first Public Activity Plan (Rest) in 2013. Notwithstanding, despite being introduced twelve years after the resolution, the first Rest neglected to accomplish its essential plan goals. This disappointment was credited to unfortunate coordination among stakeholders, inadequate inter-organization joint effort, the exclusion of brutal conflicts and extremism, logistical challenges, and an absence of political will with respect to certain states and nearby governments to domesticate orientation related laws. These challenges hindered the success of the first Rest, leading to the introduction of the second Rest in May 2017. The study, thusly, investigated the challenges that hindered the execution of UNSCR 1325, especially in mobilizing ladies and girls to defeat customary barriers to their compelling cooperation in peacebuilding and security-related activities in Nigeria. Information for the study were gathered from both essential and secondary sources. The findings uncovered that socio-social factors, combined with biological issues within Nigeria's arrangement climate, had significantly impacted the execution of UNSCR 1325 on ladies, peace, and security. This undesirable pattern was supposed to persist unless deliberate efforts were made to address these challenges.

Zähringer, N. (2024) analyzed the role of the ICC and the UNSC in carrying out the Responsibility to Protect (RtoP) principle. This chapter discussed the current and past difficulties of coordinating international reactions to mass atrocities within the Responsibility to Protect framework; it was included in Africa's Engagement with the Responsibility to Protect in the 21st Century. Zähringer examined previous interactions between the UN Security Council and the International Criminal Court (ICC), looking into both potential conflicts and synergies caused by the two bodies' competing missions and agendas. In particular, she focused on the setting of Africa, where the implementation of RtoP has been most severely challenged, to highlight the changing discourse on the global responsibility to avoid and respond to humanitarian catastrophes. The author provided a critical analysis of previous RtoP interventions, drawing attention to both the UNSC's and the ICC's accomplishments and failures in their coordination. The work of Zähringer exposed the difficulties of coordinating the efforts of international political and legal organizations to safeguard marginalized communities and provided a critical analysis of the ways in which historical events have influenced contemporary practices. In addition, the study highlighted the shortcomings of the current system of global governance and provided suggestions for how RtoP could be made more effective through improved coordination, so that political institutions and legal instruments could work together to protect human rights around the world.

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3. HISTORICAL EVOLUTION AND STRUCTURE OF THE UNSC

3.1. Overview of the UNSC's formation

In 1945, in the result of the devastation caused by The Second Great War, the United Nations Security Council was established as a foundational part of the recently framed United Nations. The anticipation of future conflicts and the maintenance of global stability were its principal reasons for being. While encompassing a more extensive scope of global interest, the framework of the United powers Security Council was designed to strike an overall influence among the victorious Partnered powers.

3.2. Permanent and non-permanent members

The United States of America, Russia, China, France, and the United Kingdom make up the five permanent members (P5) of the United Nations Security Council. The other ten members are elected for terms of two years each and are not permanent. The permanent members exert considerable influence due to their veto power, while the non-permanent members contribute regional perspectives and expertise.

Non- Permanent Members: The five-person permanent membership of the United Nations Security Council is complemented by the rotating roster of nonpermanent members who represent different regions. One possibility is that the nonpermanent members will be involved in the security briefing. For the first two decades, the Security Council was comprised of six countries: Poland, Egypt, Brazil, Mexico, and Brazil. Ten further nonpermanent members were admitted in 1965.

The United Nations General Assembly elects these ten non-permanent members to two-year terms beginning on January 1st, with five new members being replaced annually. Because approval for a seat is contingent upon receiving at least two-thirds of the total votes cast for that seat, a tie may result if two candidates are almost evenly matched. After a record-breaking 154 rounds of voting in 1979, the Cuban and Colombian governments finally broke the impasse by withdrawing their candidates and accepting Mexico as a middle ground. The process took three months. A member who resigns from office cannot be re-elected by a simple majority vote.

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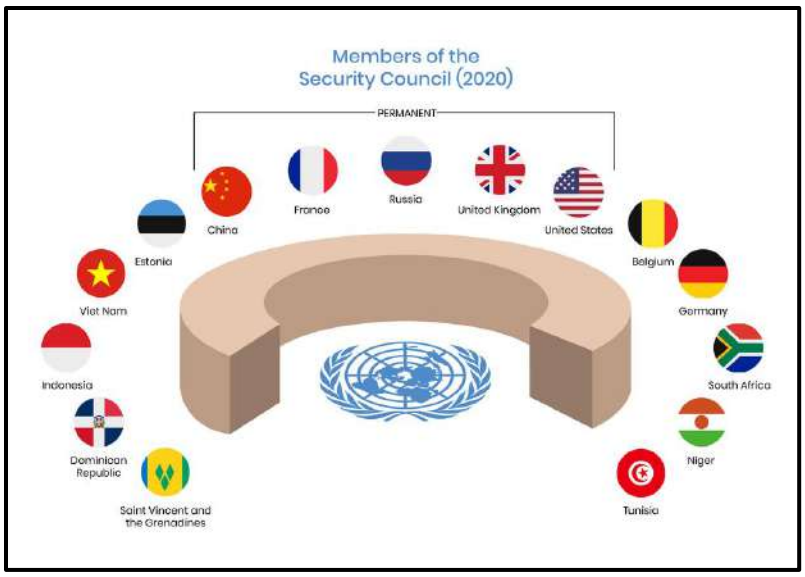

Figure 2: Non-Permanent member in UNSC

Veto power

The United Nations Charter stipulates that in order for any substantive matter to be approved, at least nine out of ten voting members of the Security Council must be in favor. No matter how many votes are needed, a permanent component with a "veto" can stop a vote from passing. Although a veto is rarely exercised through abstention, all five permanent members of the UN must vote in order to modify the UN Charter. No one can attempt to avoid discussing procedural issues by claiming the veto honor. The permanent members are plainly impacted by a few of the non-binding decisions. Rather than impacting fundamental international security issues, the majority of vetoes have blocked secretary general nominees or partial admissions to membership.

The veto nations—the United States, the United Kingdom, China, France, and the Soviet Union—did everything in their power to stop the United Nations from coming into being, despite the fact that many smaller countries were against the veto power during the UN's early discussions. According to Francis O. Wilcox, an advisor to the US delegation at a 1945 meeting, the Big Five leaders at San Francisco made it glaringly clear that there was only one option: the Charter with the veto or none at all.

There were 269 vetoes used by the Security Council by 2012. During that time, the veto was used by 89 countries: France 18, China 9, the Soviet Union or Russia 128 (instead of 32 by the UK), and the US. During the initial ten years of the Security Council, the Soviet Union and Russia utilized two-thirds of the vetoes. Thirteen US resolutions were vetoed by Russia(7) and China (5). That amount was not met by the use of the veto by the United Kingdom and France. A decision to withdraw French forces from Syria and

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Lebanon, which were occupied by France, was vetoed by Soviet Commissar Andrei Vishinsky in February 1946. In peace and non-war related topics, permanent members were granted the power to use the veto. A number of years were squandered since the Soviet Union vetoed the dates that were supposed to go to Transjordan, Laos, Libya, Nepal, Portugal, South Vietnam, and Cambodia. In order to avoid a Security Council statement regarding the Suez Crisis of 1956, France and Britain used the veto. In 1970, the United States first rejected any action taken by the General Assembly against Southern Rhodesia. To protect its interests in Korea and Panama and to prevent anti-Israeli resolutions, the United States used its veto power 27 times between 1985 and 1990. As early as 1996, it blocked Boutros-Ghali's reappointment.

Permanent members: The five members of the Security Council who are designated as permanent members are able to veto any resolution that addresses substantive matters. This implies that a permanent member can veto the adoption of a resolution, but they cannot stop or end debate on such a resolution.

Figure 3: Permanent Member of UNSC

3.3.Functions and powers under the UN Charter

According to the United Nations Charter, the United Nations Security Council has the power to approve peacekeeping missions, impose sanctions, and give its endorsement to the use of power in request to preserve or restore international peace and security. Furthermore, it plays a significant part in mediating disagreements and recommending solutions to the Overall Assembly.

Background and creation

4. RELEVANCE AND EFFECTIVENESS IN THE 21ST CENTURY

4.1.Role in maintaining international peace and security

As the 21st century has progressed, the United Nations Security Council has continued to face urgent global concerns, such as the crises in Syria, Yemen, and Ukraine. It has been of great assistance in reducing

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the amount of violence and fostering stability through its role in the deployment of peacekeeping forces and its endorsement of resolutions.

4.2. Success stories and landmark resolutions

The UNSC has helped resolve global crises and promote peace and security through major resolutions and initiatives. Peacekeeping missions have been authorized to stabilize conflict zones, protect people, and aid post-conflict reconstruction. In the Balkans, Africa, and the Middle East, UNSC peacekeeping efforts have prevented further escalation and promoted peace processes. In addition, the UNSC has used economic and military penalties on rogue states, non-state actors, and terrorist organizations to maintain global order. These actions target aggression, human rights abuses, and WMD proliferation. In 2000, UNSC Resolution 1325 focused on women in peace and security and is a landmark. This resolution advanced global human rights, gender equality, and women's empowerment in conflict resolution and peacebuilding objectives. Resolution 1325 established the foundation for policies and activities to ensure women's full involvement in peace processes and the preservation of their rights in conflict circumstances by acknowledging their vital role in peace promotion. These achievements show the UNSC's centrality in creating global norms, addressing conflict's core causes, and promoting inclusive peace and security.

5. THE PAST, PRESENT, AND FUTURE OF SECURITY COUNCIL REFORM

The UNSC is essential to world peace and security, as discussed. However, 21st-century emergent challenges raise questions about the Council's current design and structure. Critics point to its outmoded composition, poor representation, and the five permanent members' oppressive veto power. Diplomatic stalemates result from the UNSC's inability to dynamically reflect global power shifts and new moral authority. Russia's veto-backed invasion of Ukraine in February 2022 and the US' unapproved invasion of Iraq in 2003 have both frustrated the Council. Ukrainian President Volodymyr Zelenskyy expressed issues about the Council's ability to provide security in April 2022 after these occurrences, which violate the UN Charter and international law, went unresolved. Stalled and failed negotiations necessitate reform. The 1963 reform transformed the UN Security Council. The UNSC's General Assembly membership increased as additional decolonized countries joined, starting with six non-permanent states. This spike signaled the need for more global decision-making engagement. Non-Aligned Movement, led by decolonized countries, campaigned for reform, prompting the 1963 General Assembly resolution. This resolution added ten non-permanent seats and competitive elections for geographical divisions. The

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revision allowed for more creative and imaginative chamber use and multilateral action without diverting power from the P5.

The 1963 reform improved the UNSC, but additional revisions are difficult. Diversity of member state interests and perspectives and P5 veto authority create complexity. Any permanent member can reject resolutions notwithstanding majority support from member nations, hindering reform attempts. The P5's consensus requirement hinders decision-making, hindering the UNSC's adoption of global changes and reform requests. However, major UNSC reforms demonstrate its ability to adapt to international community requirements.

UNSC reforms are championed by advocacy groups including the G4, Brazil, Germany, India, and Japan. These states propose permanent and non-permanent seat additions to reflect geopolitical realities and regional representation. The G4 wants equal representation in Africa, Asia, Europe, and Latin America to strengthen the UNSC. The G4 hopes to strengthen its proposals and steer discussions toward a more balanced and representative Council with support from some permanent members, such as the UK and France, and regional powers like the BRICS group.

Clearly, UN Security Council structural reform is needed. Despite disagreements and P5 unwillingness to give up veto authority, reform is gaining pace. Advocates like the G4 keep working to enhance diversity. The necessity for reform is acknowledged by ongoing talks and diplomatic attempts. Sustained negotiation, collaborative diplomacy, and national will can create a reformed Security Council that can address future multidimensional challenges.

6. CHALLENGES AND CRITICISMS FACING THE UNSC

Geopolitical tensions, power dynamics, and structural flaws are the main causes of the UNSC many problems and critiques. The conflicting interests of superpowers can cause paralysis in a time of increased international tensions, and the P5 members' rivalry regularly prevent agreement on how to successfully handle crises. Concerns regarding the fairness and inclusion of the decision-making process are raised by the P5's veto power, which allows individual countries to thwart decisions even when they have the support of the majority. The geopolitical realities of the twenty-first century are also not reflected in the composition of the UNSC, as new powers like Brazil, South Africa, and India are calling for changes to better represent the changing global order, such as permanent membership and increased inclusivity.

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7. CONCLUSION

The UNSC is essential to maintaining international peace, but it confronts several difficulties in the twenty-first century because of its antiquated design, unequal representation, and the abuse of its permanent members' veto power. Because the P5 cannot agree, the UNSC has had difficulty responding to modern challenges like cyberwarfare, climate change, and political disputes, despite important achievements like peacekeeping missions and historic resolutions. Advocated by countries such as the G4, the urgent appeal for reform reflects a worldwide desire for more fair representation and greater inclusivity. In order for the UNSC to continue being a valid and efficient organization for preserving global peace and security, it must adapt to new power dynamics as the world order changes. Even if structural reforms are difficult, they are essential to improve the Council's legitimacy and capacity to handle the intricate problems that the world community will face in the future.

Future of the United Nations Security Council

UNSC future depends on its capacity to adjust to new worldwide dangers like pandemics, wars brought on by climate change, and cybersecurity breaches. The UNSC must adapt its tactics to proactively handle these unconventional issues if it hopes to stay relevant. To ensure that multilateralism flourishes and member state collaboration is reinforced, the UNSC must find a balance between defending national interests and maintaining international peace. The UNSC's ability to strike this fine balance and promote both respect for national sovereignty and a dedication to global stability will determine how effective it is.

REFERENCES

1. Adefisoye, T. O., & Adefisoye, I. D. (2019). Nigeria and the implementation of the United Nations Security Council Resolution 1325 on women, peace and security. *Journal of Public Administration and Development Alternatives (JPADA)*, *4*(1), 16-29.
2. Binder, M. and Heupel, M. (2020) ‘Rising powers, UN Security Council reform, and the failure of rhetorical coercion’, Global Policy, 11(S3), pp. 93–103.
3. Bryndum-Buchholz, A., Tittensor, D. P., Blanchard, J. L., Cheung, W. W., Coll, M., Galbraith, E. D., ... & Lotze, H. K. (2019). Twenty-first-century climate change impacts on marine animal biomass and ecosystem structure across ocean basins. *Global change biology*, *25*(2), 459-472.
4. Carswell, J. (2013). The United Nations Security Council: A Critical History. Routledge.

ISBN Number: 978-93-95305-78-5

5. Dayal, A., & Dunton, C. (2023). UNSC Reform: Historical Context and Contemporary Challenges. Journal of Global Governance, 8(2), 123-140.

6. Dunton, C. and Dayal, A. (2023) The U.N. Security Council was designed for deadlock can it change?, United States Institute of Peace. Available at:

7. Foray, J. L. (2021). The Republic at the Table, with Decolonisation on the Agenda: The United Nations Security Council and the Question of Indonesian Representation, 1946–1947. *Itinerario*, *45*(1), 124-151.

8. Hardt, J. N. (2021). The United Nations Security Council at the forefront of (climate) change? Confusion, stalemate, ignorance. *Politics and Governance*, *9*, 5-15.

9. Hurd, I. (2002) 'Legitimacy, power, and the symbolic life of the UN Security Council', Global Governance: A Review of Multilateralism and International Organizations, 8(1), pp. 35–51.

10. Mingst, K. A., Karns, M. P., & Lyon, A. J. (2022). *The United Nations in the 21st century*. Routledge.

11. Patrick S., Mbete S., Spektor M., Guihong Z., Novosseloff A., Heusgen C., et al (2023) UN Security Council Reform: What the World Thinks. Available at:

12. Reis, C. T. (2022). REFORM OF THE UNITED NATIONS SECURITY COUNCIL.

13. Tobey, W. H. (2018). A History of United Nations Security Council Resolution 1540. *Preventing the Proliferation of WMDs: Measuring the Success of UN Security Council Resolution 1540*, 13-32.

14. Weiss, T. G. (2009). What's Wrong with the United Nations and How to Fix It. Polity Press.

15. Zähringer, N. (2024). Implementing the Responsibility to Protect (RtoP): Coordinating Approaches Between the United Nations Security Council and the International Criminal Court. In *Africa's Engagement with the Responsibility to Protect in the 21st Century* (pp. 219-233). Singapore: Springer Nature Singapore.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

NSF Fellows' Perspectives on Incentives, Research Misconduct, and Scientific Integrity in STEM Academia

Dr. Diwakar Chaudhary, Assistant Professor, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh
Ms. Rashi Bhati, Assistant Professor, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh
Ms. Ishita Goswami, MBA Student, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh

There is increased concern about perverse incentives, quantitative performance metrics, and hyper-competition for funding and faculty positions in US academia. Recipients of the prestigious National Science Foundation Graduate Research Fellowships (n = 244) from Civil and Environmental Engineering (45.5%) and Computer Science and Engineering (54.5%) were anonymously surveyed to create a baseline snapshot of their perceptions, behaviors and experiences. NSF Fellows ranked scientifi advancement as the top metric for evaluating academics followed by publishing in high-impact journals, social impact of research, and publication/citation counts. The self-reported rate of academic cheating was 16.7% and of research misconduct was 3.7%. Thirty-one percent of fellows reported direct knowledge of graduate peers cheating, and 11.9% had knowledge of research misconduct by colleagues. Only 30.7% said they would report suspected misconduct. A majority of fellows (55.3%) felt that mandatory ethics trainings left them unprepared for dealing with ethical issues. Fellows stated academic freedom, fl ible schedules and opportunity to mentor students were the most positive aspects of academia, whereas pressures for funding, publication, and tenure were cited as the most negative aspects. These data may be useful in considering how to better prepare STEM graduate trainees for academic careers.

Introduction

U.S. scientific enterprise grew exponentially in the post-World War II era with large f i nancial investments from the federal government. Several high-pro le cases of alleged research misconduct in the 1980s forced Congress to push for legislative oversight, ombuds o ces at funding institutions, and university protocols to address unethical behavior[1–3]. In the twenty- rst century, there are concerns that the rising importance of pos- sible perverse incentives (i.e., emphasizing quantitative performance metrics, funding, high impact journal publications and prestige) in STEM academia might undermine the quality of research performed, maintenance of high ethical standards and productive use of taxpayer dollars[4–6]. For example, it is hypothesized that reward-

ISBN Number: 978-93-95305-78-5

ing researchers for higher publication or citation counts can lead to "natural selection" of substandard science and reduced emphasis on quality hypotheses and research questions[7–9]. Further, as journal retractions rise[10], it remains unclear the extent to which science is self-correcting, and this trend has been variously attributed to pressures to publish and garner funding, misconduct policies, academic culture and investigator career stage[11,12]. Maintaining scienti c integrity is deemed "vital" for the US' national interest[13], but there is relatively little data on this subject from targeted surveys of high-performing US researchers.

In this article, we report results from an anonymous, online survey of U.S. National Science Foundation (NSF) Graduate Research Fellowship recipients (herea er, "NSF Fellows" or "Fellows") on their perceptions of STEM and academia. e survey posed questions on cheating, research misconduct, formal integrity training and ethi- cal environments, as well as the overall positives and negatives of academia[5,14,15]. NSF's de nition of research misconduct, i.e., the "willful fabrication, falsi cation, plagiarism, and other questionable practices," was displayed before survey respondents answered questions on the topic[16]. e survey was administered in February–May 2019 before the COVID-19 global pandemic and targeted Fellows from Civil and Environmental Engineering (CEE) or Computer Science and Engineering (CSE). ese were selected as two broad STEM disciplines that have transformed society but currently face concerns about ethics[17–19] and high competition for faculty positions[20].

[1]Department of Civil and Environmental Engineering, Virginia Tech, 1145 Perry St., 418 Durham Hall, Blacksburg, VA 24061, USA. [2]The Water Institute at UNC, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC 27516, USA.

Methods

study was approved by Virginia Tech's Institutional Review Board (IRB #17-677) and administered online via Qualtrics (www.qualtrics.com) between February 18–May 02, 2019. e names, baccalaureate institutions, and proposed elds of study of individuals rst receiving their NSF Graduate Research Fellowships during 2002–2007 and 2012–2017 in CSE and CEE disciplines (n = 1662) were downloaded from www.nsfgrfp.org. Active email addresses could be retrieved for 1078 fellows through online searches, who were each sent one recruitment and one reminder email containing a unique survey link. All Fellows read an electronic informed consent form before agreeing to participate. Fellows completing the survey received US$25 Amazon.com electronic gi cards through

ISBN Number: 978-93-95305-78-5

a department Amazon account not tied to the study investigators. Given the sensitive nature of some questions, Fellows were assured anonymity through Qualtrics' "Anonymize Response" setting, which decouples survey responses from respondent email addresses. Incomplete survey responses were not included in the nal dataset and analyses.

All data were analyzed and graphed in Minitab 19.2020.1, Microso Excel 2016, QDA Miner Lite 2.0.6, and Datawrapper (www.datawrapper.de). Summary statistics tables and cross-tabulations were generated in Minitab. Fisher's exact test of independence and Pearson's Chi-Square test were used to analyze cheating and misconduct responses by NSF Fellows' gender, cohort year, discipline and academic stage. A p-value below 0.05 was used to establish statistical signi cance for assigned variables. e responses could be classi ed by discipline for 218 of 244 (89.3%) Fellows based on primary undergraduate major, dates respondents began lling out the survey (recruitment emails were sent to CEE and CSE email lists during di erent weeks) and responses to open-ended questions mentioning discipline. All methods, including the coding and categorization of qualitative responses to open-ended questions, were conducted in accordance with relevant guidelines and methods for qualitative data analysis[21] in Excel and QDA Miner Lite. Speci cally, survey responses were assigned categories, and these catego- ries were systematically reorganized and merged into larger and more representative themes in later iterations. A subset of Fellows' responses was also extracted and reproduced as-is in text to properly contextualize the themes.

Results

Survey demographics. e overall response rate for this survey was 22.6%, based on 1078 Fellows who received recruitment emails (Tables S1 and S2) containing unique links to the survey (Text S1). While survey email delivery rates were comparable for CSE And CEE disciplines (62–66.5%), the response rates were higher in CEE (30.2%) over CSE (18.7%). It is unclear why the response rates di er. As one survey eligibility criterion was that every respondent should have received formal ethics training, this may explain the somewhat low overall participation rates. e respondent pool (n= 244) was relatively evenly distributed between the CSE (54.5%; n = 133) and CEE (45.5%; n = 111) disciplines, and between female (50.8%, n = 124) and male (48.4%, n = 118) genders. Eighty-one percent (n= 198) were awarded their fellowships in 2012–2017 and the rest (18.9%; n = 46) in 2002–2007 (Table 1). Ninety-four percent (94.3%; n = 230) nished their undergraduate studies with one major, while 5.7% (n= 14) had 2–3 majors, with 32.8% (n= 80) majoring in

ISBN Number: 978-93-95305-78-5

Computer Science, and 32.4% (n = 79) majoring in Civil Engineering, Environmental Engineering or Environmental Science. Fi y-six per- cent (56.1%; n = 137) were enrolled in graduate school when they took the survey, while the remaining 43.9% (n = 107) had graduated. A majority of NSF Fellows were employed in academia as graduate students, postdocs or untenured faculty (50.8%) and tenured/tenure-track professors (20.1%).

Research evaluation criteria and academia pros vs. cons. A majority of Fellows agreed that research ideally is or should be about truth-seeking (87.3%; n = 213) and service to humanity (67.6%; n = 165) (Fig. 1A). In contrast, when asked about self-advancement only 24.3% (n = 59) felt that should be a primary objective while 67.5% stated it should sometimes be an objective. Only 8.2% (n = 20) said research should not be about self- advancement. On a Likert scale, NSF Fellows arranged six criteria they used to evaluate their peers from most (1) to least important (6) and the results (Fig. 1B) in order of decreasing importance was (1) [highest ranked] scien- ti c advancement of their eld ($\mu = 1.81$, $\sigma = 1.23$), (2) publishing in prestigious journals ($\mu = 2.95$, $\sigma = 1.21$), (3) social impact of their work ($\mu = 3.00$, $\sigma = 1.6$), (4) publication and citation count ($\mu = 3.43$, $\sigma = 1.38$), (5) h-index ($\mu = 4.83$, $\sigma = 1.21$), and (6) total funding procured ($\mu = 4.98$, $\sigma = 1.12$). About 8 out of 10 Fellows (82.8%; n = 202) said they used the same metrics to evaluate their own academic careers (Fig. 1C).

In response to open-ended questions asking Fellows to list the most positive aspects of academic life (Table 2), the following were ranked in order of decreasing importance: (1) academic freedom (59%; n = 144), (2) exible schedule (33.6%; n = 82), (3) opportunity to mentor students (29.1%; n = 71), (4) intellectually stimulating work

(22.1%; n = 54), (5) teaching courses (21.3%; n = 52), and (6) autonomy over their careers (13.5%; n = 33). e top cited negative aspects (Table 2) were (1) time spent in constantly writing grants (27.9%; n = 68) or excessive workload or long hours (27.9%; n= 68), (3) high stress or pressures (24.6%; n= 60), (4) low salary (24.2%; n= 59), (5) pressure to publish (22.1%; n = 54), 6) poor work-life balance (19.7%; n = 24) and (7) hyper-competition (18.4%; n = 45).

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Category	Response	Count (%)
Subject area (sub-disciplines in Table S2)	Civil and Environmental Engineering	111 (45.5)
	Computer Science and Engineering	133 (54.5)
GRFP Cohort year	2002–2007	46 (18.9)
	2012–2017	198 (81.1)
Gender	Male	118 (48.4)
	Female	124 (50.8)
	Others: "Female (Trans woman)", "Non-	2 (0.8)
Undergraduate major(s)*	Civil Engineering or Environmental	80
	Computer Science	79
	Electrical or Computer Engineering	25
	Mathematics	14
	Mechanical Engineering	8
	Chemical or Mining or Metallurgical	6
	Others	47
Respondent status (in Spring 2019)	MS student	4 (1.6)
	PhD student (post-MS)	60 (24.6)
	PhD student (direct)	73 (29.9)
	Total students	137 (56.1)
	Working post-MS	6 (2.5)
	Working post-PhD	101 (41.4)
	Total working	107 (43.9)
Current area of employment	Academia (Graduate Student/Postdoc/	124 (50.8)
	Academia (Tenure-track/Tenured)	49 (20.1)
	Industry/Consulting/Startup/Entrepreneur	42 (17.2)
	Nonpro t/Government	16 (6.6)
	Research Laboratory	11 (4.5)
	Others *("unemployed"—CEE; "unsure"—CSE)*	2 (1.6)
Considering or pursuing a research career?	Yes	195 (79.9)
	No	49 (20.1)

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Table 1. Demographics. Summary of NSF Fellow respondents on this survey. *Total # of undergraduate majors reported exceeds total # of NSF fellows (244), because 14 fellows reported at least two majors (one fellow reported three).

Academic dishonesty. Sixteen percent of Fellows (16%, n= 39) self-reported cheating in graduate school (male = 16.9%; female = 14.5%). e 2002–2007 cohort reported an 8.7% incidence whereas the 2012–2017 cohort reported a 17.7% incidence. Finally, the cheating rate for CEE (23.8%) was signi cantly higher than that for CSE (11.1%) (Table 3 and S3). irty-one percent (31.1%; n= 76) reported having seen their graduate peers cheat (male = 29.7%; female = 33.8%). e rates of NSF Fellows' knowledge of graduate peers cheating among the 2002–2007 cohort (19.6%) was insigni cantly lower than the 2012–2017 cohort (33.8%), whereas that for CEE Fellows (39.6%) was signi cantly higher than CSE Fellows (23.1%).

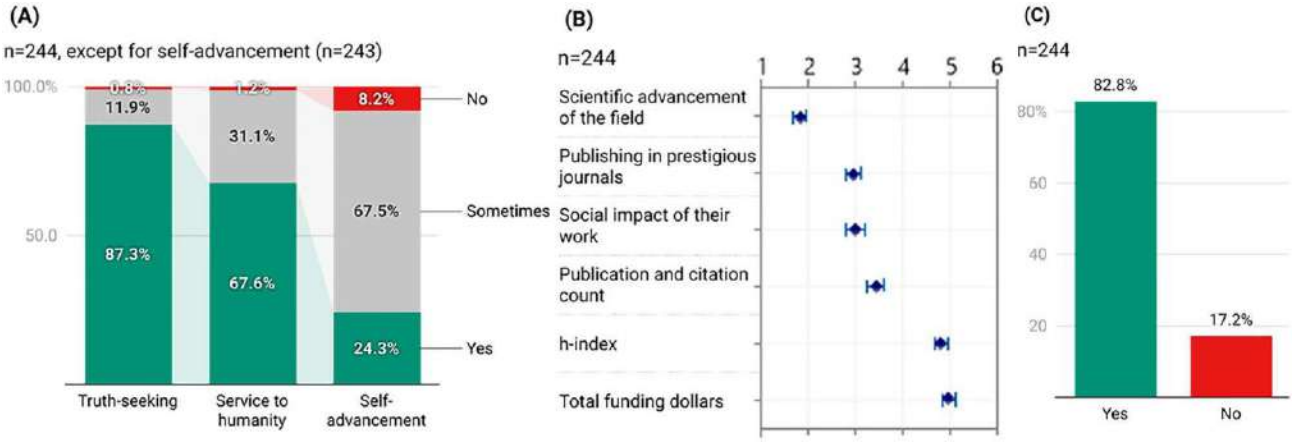

Figure 1. Science and scientists. (A) NSF Fellows who believe research is or should be about truth-seeking, service to humanity, or self-advancement. (B) Criteria Fellows use to evaluate academic peers (ranked in decreasing order of importance). (C) Whether Fellows applied the same criteria for themselves?

Pros (Rank)	Count	Cons (Rank)	Count
Academic freedom (1)	144	Constant writing of grants (1)	68
Flexible schedule (2)	82	Excessive workload or long	68
Mentoring students (3)	71	High stress and pressure (2)	60
Intellectually stimulating	54	Low pay (3)	59
Teaching (5)	52	Pressure to publish (4)	54

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Autonomy (6)	33	Poor work-life balance (5)	48
Intellectual environment or	30	Hyper-competition (6)	45
Bene t society or make a di	27	Extreme pressure to get	36
Job security (9)	26	Institutional politics (8)	19
Create new knowledge (10)	20	Limited job prospects or	16
Prestige or respect (10)	20	Excessive bureaucracy (10)	12

Table 2. Top 10 pros and cons of STEM academia. Ranked in decreasing order by count and percentage.

Over half (62.3%; n = 152) noted that the level of cheating made them rethink their career choice and the people their eld was attracting. e top three most common types of cheating Fellows witnessed their gradu- ate school peers engage in (Fig. 2A) were copying assignments (81.6%), plagiarizing (47.4%), and using online solutions (36.8%). One in ve (21.3%; n = 52) individuals acknowledged that academic environments could be made su ciently perverse due to poor class design, hypercompetitive grading or unfair homework practices, that made cheating justi ed or acceptable (Table 3). Additionally, 23.4% fellows (n = 57) reported witnessing graduate classes and situations where perverse environments where they felt cheating was necessary or even justi ed. Despite the above, nearly 9 in 10 fellows (88.9%; n = 217) agreed with the declaration that maintaining their integrity outweighed incentives to cheat (Table 3). Based on their graduate school experiences, 71.7% fel- lows (n = 175) had a somewhat or very favorable perception of current research integrity practices, while only 9% (n = 22) viewed the policies as somewhat or very unfavorable (Fig. 2B).

e top two reasons Fellows o ered for committing academic cheating or considered a motivation for their peers cheating (Table 4) were good grades (e.g., "afraid of bad grades—ashamed of having done so!") and hav- ing less time (e.g., "felt too busy, had to cut corners to get everything done"). In one department, it was asserted that cheating was the norm (i.e., "it [was] unusual if you DON'T have the homework solutions ahead of time"). In another, "getting at least the A or B grade [was] required to continue in the program." e drive to stay com- petitive (e.g., "I felt that it was a gray area and that I wanted to have a leg up on my classmates"), the advanced nature of graduate-level classes, and preference to do research over classwork (e.g., "classes are a waste of time, would rather do research"), were less prominent but still notable factors (Table 4) motivating Fellows and their graduate peers to

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cheat. Altruism (e.g., "I was enjoying working with friends and wanted to help them") was also mentioned.

Fellows used negative personality descriptors (e.g., "mismanagement," "laziness," or "knew they could get away with it") to describe their peers' cheating at least 11 times but such terms were never used to described their own cheating except to acknowledge disinterest in coursework (n= 3). A distinction was sometimes drawn for circumstances where cheating was perceived as defensible (e.g., "convenient, necessary to proceed forward, and ethically neutral in the long run," "we were not supposed to use textbooks in class and I thought that was ridiculous," or "only cheated on homework, never on tests").

Research misconduct: awareness, participation and future propensity to commit or report. Only 36.5% (n = 89) of respondents had ever heard of cases of research misconduct (sub-groups: male = 39%, female = 33.9%; 2002–07 cohort = 37%; 2012–17 cohort = 36.4%; CSE 40.2%; CEE = 30.7%). ere was no signi cant association between Fellows' reporting any knowledge of misconduct cases vis-à-vis their gender, fellowship cohort year or discipline (Tables 2 and S2). A signi cant association was found between Fel- lows' academic stage and their likelihood of ever having heard of research misconduct cases (Table S4); over half of tenured/tenure-track professors (51%) reported knowledge compared to less than one-third of graduate students or non-tenure track professionals (28.4%). Twelve percent (11.9%; n= 29) had rst-hand knowledge of misconduct by colleagues in their research group, department or eld (median case knowledge count= 2; range = 1–10) (sub-groups: male = 15.3%; female = 8.9%; 2002–07 cohort = 10.9%; 2012–17 cohort = 12.1%; CSE = 14.5%; CEE = 9.9%. ere was no signi cant association between direct knowledge of misconduct among Fellows and their gender, fellowship cohort year or discipline (Fig. 2C and Tables 2 and S2). Four percent (n = 9) confessed to participating in research misconduct (sub-groups: male = 4.2%; female = 3.2%; 2002–2007 cohort = 2.2%; 2012–2017 cohort = 4%; CSE= 5.1%; CEE= 1. ere was no signi cant association between Fel- lows' likelihood of committing misconduct and their gender, fellowship cohort year or discipline (Tables 2 and S2) and examples ranged from mild (e.g., non-contributing researchers listed as co-authors) to egregious (i.e., statistical manipulation and data fabrication) (Table S8). Interestingly, 7.4% Fellows (n = 18) were not sure if some of their actions quali ed as research misconduct (Table 3).

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About six percent of Fellows (6.1%; n = 15) believed that < 2% of all researchers succumb to pressures and commit misconduct at least once in their career (Fig. 2D), whereas 61.4% (n = 150) Fellows felt the proportion

No	Summarized prompt or question	Choice	All respondents N (%) 244 (100)	By gender				By award year		
				Male n (%) 118 (100)	Female n (%) 124 (100)	Other n (%) 02 (100)	p-value (M vs. F only)	2002–2007 n (%) 46 (100)	2012–2017 n (%) 198 (100)	p-value
Perceptions and practice of academic cheating in graduate school										
1	I have seen fellow students cheat in graduate classes	Yes	76 (31.1)	35 (29.7)	41 (33.1)	0 (0)	> 0.05**	9 (19.6)	67 (33.8)	> 0.05**
		No	168 (68.9)	83 (70.3)	83 (66.9)	2 (100)		37 (80.4)	131 (66.2)	
2	I have personally cheated in college and/or graduate school	Yes	39 (16)	20 (16.9)	18 (14.5)	1 (50)	> 0.05**	4 (8.7)	35 (17.7)	> 0.05**
		No	205 (84)	98 (83.1)	106 (85.5)	1 (50)		42 (91.3)	163 (82.3)	
3	Maintaining my integrity outweighs incentives to not cheat in class	Yes	217 (88.9)	104 (88.1)	111 (89.5)	2 (100)	> 0.05**	40 (87)	177 (89.4)	> 0.05**
		No	27 (11.1)	14 (11.9)	13 (10.5)	0 (0)		6 (13)	21 (10.6)	
4	I have seen class environments and situations, where cheating was arguably necessary or justi ed	Yes	57 (23.4)	31 (26.3)	25 (20.2)	1 (50)	> 0.05**	8 (17.4)	49 (24.7)	> 0.05**
		No	187 (76.6)	87 (73.7)	99 (79.8)	1 (50)		38 (82.6)	149 (75.3)	
5	It is possible to create environments^ in classrooms where cheating is justi ed or acceptable	Yes	152 (62.3)	78 (66.1)	73 (58.9)	1 (50)	> 0.05**	20 (43.5)	132 (66.7)	**0.0042 ** **
		No	92 (37.7)	40 (33.9)	51 (41.1)	1 (50)		26 (56.5)	66 (33.3)	
6	e level of cheating I wit-nessed or engaged in made me think twice about my career choice or the type of people my profession was attracting	Yes	52 (21.3)	24 (20.3)	27 (21.8)	1 (50)	> 0.05**	5 (10.9)	47 (23.7)	> 0.05**
		No	192 (78.7)	94 (79.7)	97 (78.2)	1 (50)		41 (89.1)	151 (76.3)	
Awareness, direct knowledge of and personal involvement in research misconduct in last 5 years										
7	I have heard of research mis- conduct in my eld	Yes	89 (36.5)	46 (39)	42 (33.9)	1 (50)	> 0.05**	17 (37)	72 (36.4)	> 0.05**
		No	155 (63.5)	72 (61)	82 (66.1)	1 (50)		29 (63)	126 (63.6)	
8	I have direct knowledge of research misconduct in my research group, department or eld	Yes	29 (11.9)	18 (15.3)	11 (8.9)	0 (0)	> 0.05**	5 (10.9)	24 (12.1)	> 0.05**
		No	215 (88.1)	100 (84.7)	113 (91.1)	2 (100)		41 (89.1)	174 (87.9)	
	I have personally	Yes	9 (3.7)	5 (4.2)	4 (3.2)	0 (0)		1 (2.2)	8 (4)	

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9	participated in research involving miscon- duct, even if I did not commit them myself	No	217 (88.9)	105 (89)	110 (88.7)	2 (100)	> 0.05 ***	44 (95.7)	173 (87.4)	> 0.05 ***
		Not sure	18 (7.4)	8 (6.8)	10 (8.1)	0 (0)		1 (2.2)	17 (8.6)	
Propensity to commit or report misconduct										
10	If I felt pressured by my academic advisor or mentor to engage in misconduct#, I would do it	Yes	18 (7.4)	9 (7.6)	9 (7.3)	0 (0)	> 0.05 ***	2 (4.4)	16 (8)	> 0.05 ***
		No	139 (57)	69 (58.5)	70 56.5)	0 (0)		31 (67.4)	108 (54.6)	
		I don't know	87 (35.6)	40 (33.9)	45 (36.3)	2 (100)		13 (28.3)	74 (37.4)	
11	If fabricating and/or falsify- ing data helped increase my chances to get research funding, scholarship money or publication in a high impact journal, I would do it	Yes	1 (0.4)	1 (0.9)	0 (0)	0 (0)	–	0 (0)	1 (0.5)	–
		No	217 (88.9)	100 (84.7)	115 (92.7)	2 (100)		42 (91.3)	175 (88.4)	
		I don't know	26 (10.7)	17 (14.4)	9 (7.3)	0 (0)		4 (8.7)	22 (11.1)	
12	If I suspected a researcher of engaging in misconduct, I would report it	Yes	75 (30.7)	34 (28.8)	41 (33.1)	0 (0)	**0.0309 *** X^2 = 6.956**	15 (32.6)	60 (30.3)	> 0.05 ***
		No	21 (8.6)	16 (13.6)	5 (4)	0 (0)		1 (2.2)	20 (10.1)	
		I don't know	148 (60.7)	68 (57.6)	78 (62.9)	2 (100)		30 (65.2)	118 (59.6)	
13	Do you feel empowered to raise questions about wrong- doing (however big or small) in your research group?	Yes	190 (77.9)	97 (82.2)	92 (74.2)	1 (50)	> 0.05**	38 (82.6)	152 (76.8)	> 0.05**
		No	54 (22.1)	21 (17.8)	32 (25.8)	1 (50)		8 (17.4)	46 (23.2)	
14	Is "doing the right thing" even though it might negatively impact your career or how you are viewed by peers, something you feel strongly about?	Yes	218 (89.4)	100 (84.7)	116 (93.6)	2 (100)	> 0.05 ***	44 (95.7)	174 (87.9)	–
		No	13 (5.3)	10 (8.5)	3 (2.4)	0 (0)		2 (4.4)	11 (5.6)	
		I don't care	13 (5.3)	8 (6.8)	5 (4)	0 (0)		0 (0)	13 (6.6)	

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Table 3. Academic cheating and research misconduct. NSF Fellows' perceptions and practice of academic cheating in graduate school (Q1–6), awareness, direct knowledge of and personal involvement in research misconduct in last ve years (Q7–9), and propensity to commit or report misconduct (Q10–14). Percentages may not add up to 100 because of rounding. ^e.g., poor design of classes, hypercompetitive grading, unfair homework practices. #Examples given in prompt: "everyone is doing it this way", "it is okay to throw out bad data", or publishing results before you are personally con dent. **Fisher's Exact Test; ***Chi-Square Test.

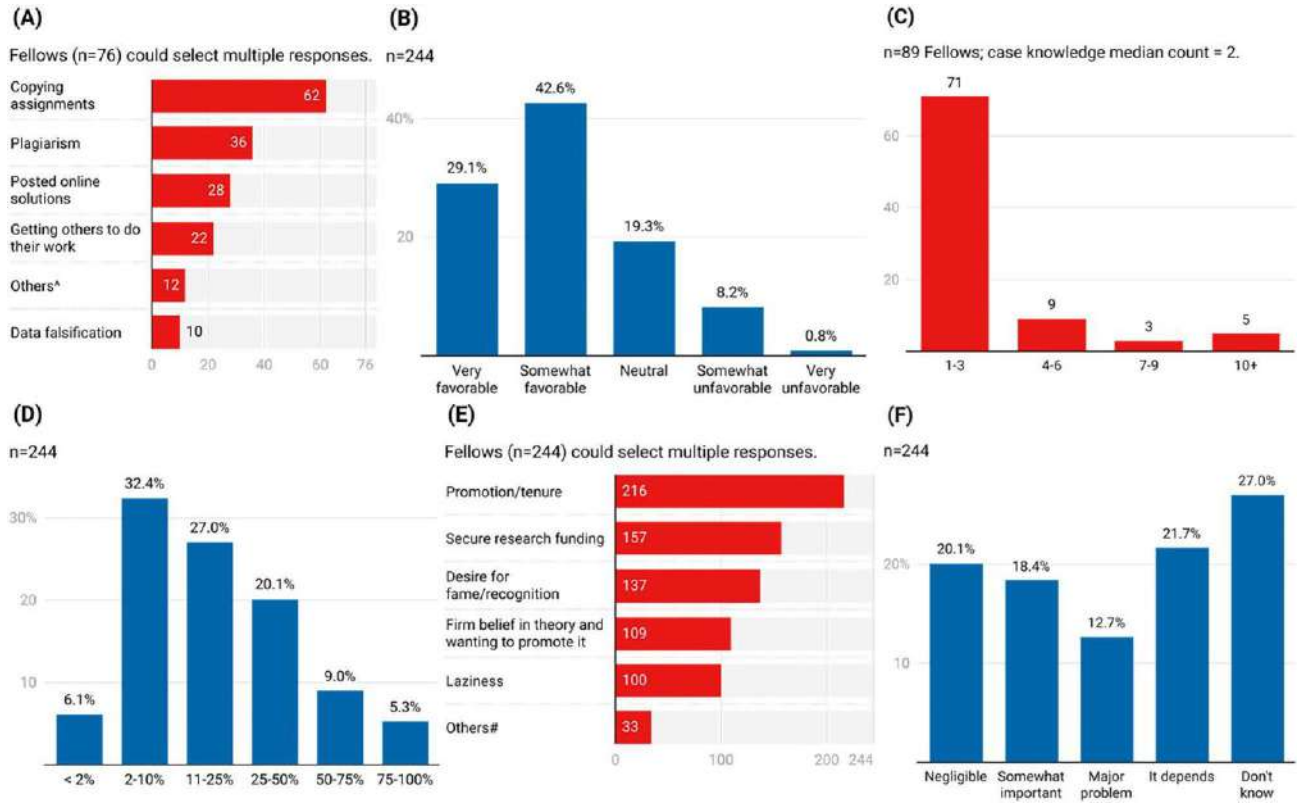

Figure 2. Academic cheating and research misconduct. (A) Types of cheating witnessed by NSF Fellows among graduate school peers. (B) Perceptions of research integrity practices based on graduate school experiences. (C) Histogram of research misconduct case counts Fellows reported direct knowledge of in their elds (original responses listed in Table S6). (D) Perceived proportion of researchers who succumb to pressures and commit misconduct at least once in their career. (E) Factors that contribute to misconduct or fraud. (F) Impact of uncovered fraud on their eld. ^,#Responses under "Others" listed in Tables S4 and S6, respectively.

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(A) Motivations for graduate school peers cheating, per Fellows (n = 76)		(B) Motivations for Fellows themselves cheating (n = 39)	
Motivation	Count (%)	Motivation	Count (%)
Avoid bad grades/failing or get good grades	33 (43.4%)	Time pressure (or heavy workload)	15 (38.5%)
Time pressure (or mismanagement)	21 (27.6%)	Avoid bad grades/failing or get good grades	6 (15.4%)
Disinterest (or laziness)	11 (14.5%)	Stay competitive, high-performing or ahead	5 (12.8%)
Course was too advanced	9 (11.8%)	Accepted way of completing assignments	4 (10.3%)
Preferred research over coursework	8 (10.5%)	Professor did not teach well	3 (7.7%)
Stay competitive, high-performing or ahead	5 (6.6%)	Preferred research over coursework	3 (7.7%)
Faced language barriers as international students	4 (5.3%)	Course was too advanced	2 (5.1%)
Under stress	4 (5.3%)	Desperation or avoid embarrassment	2 (5.1%)
Ignorant on what constitutes cheating	3 (3.9%)	Disinterest	2 (5.1%)
Came from a di erent academic culture as international students	2 (2.6%)	Ensure I understood the material	2 (5.1%)
		Help friends	2 (5.1%)
Others (1 count each): Stay in the US; Make up for personal de ciencies; Struggling with mental health problems; Ensure they understood the material; Will not get caught	5 (6.6%)	Others (1 count each): Ambiguous expectations around group work; Assignments not representative of knowledge; Class lectures irrelevant to homework; Convenience; Exam sourced from online sources; Ridiculous standards	6 (15.4%)

Table 4. Motivation for academic cheating in graduate school. NSF Fellows' (A) perceived motivations for graduate peers cheating and (B) motivations for themselves cheating in college and graduate school. Ranked in decreasing order by count.

was > 10% of all researchers; 5.3% (n = 13) estimated 75–100% researchers commit misconduct at least once. Almost nine out of ten (89%; n= 216) Fellows selected promotion and tenure pressures (Fig. 2E) as the most likely cause for misconduct, followed by funding hyper-competition (64%; n= 157), desire for fame (56%; n= 137), rm belief in one's theory (45%; n = 109), and laziness (41%; n = 100). One Fellow reported that if the tenure system were changed, "this problem [of misconduct] would be xed." Only 12.7% Fellows (n = 31) felt that uncovered fraud had a major impact on the progress of their eld, while nearly half picked "It depends" (21.7%) or that they did not know (27%) (Fig. 2F).

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While 88.9% Fellows (n = 217) said they would not engage in misconduct (i.e., fabricate or falsify data) to gain funding, win scholarships or publish in high-impact journals, another 10.7% (n = 26) Fellows were unsure, and one NSF Fellow (0.4%) said they would (Table 3). If pressured to engage in research misconduct by an advisor 7.4% Fellows (n = 18) said they would do so, 37.5% (n = 87) were unsure and 56.9% (n = 139) said they would not. Only thirty-one percent (30.7%; n = 75) Fellows said they would report another researcher if they suspected misconduct, whereas 60.7% (n = 148) were not sure, and 8.6% (n = 21) said they would not. A signi cant associa- tion was found between the likelihood of Fellows' reporting misconduct and their gender, with more men saying they would not report relative to women (Table 3).

Research misconduct: penalties for scientists found guilty. *Guilty of distorting the scienti c re- cord.* e top three recommended punishments were public retractions and corrections of the scienti c re- cord, ring or revoking of faculty tenure (e.g., " re them like any other normal job would do to them"), and a permanent public record of the misconduct (Table 5). Recordkeeping suggestions included (a) databases (i.e., "public index of the guilty") with researcher names and ORCID (or, Open Researcher and Contributor ID) and

(b) universal tags next to all published articles (i.e., "a red ag" signifying the author was "found guilty" of mis- conduct). A loss of reputation, Fellows reasoned, would negatively impact publishing and reduce grant success as punishment.

However, there was debate on what constituted distortion of the scienti c record. Cherry-picking or report- ing only positive results was seen as a "much grayer area," and "(unfortunately) standard practice in many elds, so it's not clear that there should be a harsh consequence." One Fellow wrote how "almost every research paper is distorting the results to an extent, because everyone's making a sales pitch." In contrast, an Earth Sciences Fellow was "surprised" this survey contained questions on research misconduct as this was not an issue at all in their eld. Yet another Fellow had witnessed misconduct to the point it was "detrimental to [their] faith in the results of published research across scienti c elds" and they le academia post-PhD for industry. Some concerns were also voiced on the unintended consequences of retractions due to misconduct by the PIs on the careers of their graduate students.

Guilty of misconduct that wasted taxpayer money. e three recommended punishments for misconduct were = revoking of grant money, permanent ban from receiving government funding, and losing tenure

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or job (Table 5). However, Fellows were uncertain as to what constitutes "wasting" taxpayer money. Since research does not always work and "plenty of ethical scienti c conduct wastes taxpayer dollars," who will decide "what is a waste of taxpayer dollar <s>." One Fellow argued "most research areas are a waste," while another noted, "every project has at least some people who think it's a waste of money." One Fellow's perspective on punishing academics for misconduct focused on "if there was willful distortion of science," which could apply to falsifying data or misrepresenting results to gain funding or committing such acts a er receiving grant money. ere was also the worry that the "wasting taxpayer dollars" argument could be "politicized in potentially harmful ways."

No	(A) Distort the scienti c record	#	(B) Waste taxpayer dollars	#	(C) Harm the public	#
1	Public retraction and correction of the scienti c record	85	Revoke funding or awards	50	Bring legal charges or conduct criminal investiga- tion	118
2	Revoke tenure or re them	61	Ban them from receiving government funding	46	Revoke tenure or re them	59
3	Permanent public record of misconduct	36	Revoke tenure or re them	31	Jail time	29
4	Depends	29	Depends	28	Depends	27
5	Ban them from publishing	29	Public retraction and correction of the scienti c record	23	Public retraction and correction of the scienti c record	23
6	Punishment and disciplinary action by university or professional organizations	19	Flag them and increase scrutiny for future funding and publications	22	Ban them from academia and conducting research	16

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7	Ban them from receiving government funding	19	Fine them	20	Ban them from receiving government funding	15
8	Conduct review of all past publications and research	17	Ban them from receiving government funding (some: temporarily)	20	Fine them	13
9	Revoke funding or awards	16	Bring legal charges or conduct criminal investiga- tion	19	Not sure	12
10	Ban them from academia and conducting research	16	Not sure	18	Revoke funding or awards	10

Table 5. What should happen to researchers found guilty of scienti c misconduct that (a) distort the scienti c record, (b) waste taxpayer dollars, or (c) harm the public? Top 10 responses, ranked in decreasing order by count.

In contrast, other Fellows opined that beyond a certain criterion, wasting money on fraudulent work should be "illegal" and that "misconduct is misconduct and penalty should not be di erent depending on funding source". Others stated that " ere should only be legal consequence if they broke the law," like embezzlement, and wasting of taxpayer money should be treated as "pretty much like any fraud, gra , or corruption crime" and punishment should be "commensurate with whatever penalties there are for politicians."

Some perspectives focused on the researcher's department or university and their obligation to return the funding because the nancial waste occurred on their watch and their failure to monitor faculty (" is would make them advocates for good research practices. And their tenure processes are part of this problem"). While one Fellow felt that barring such researchers from getting public grants and preventing them from running a lab seemed "cruel," another stated, "if I could get my way, I'd also sue them for my tax money back." Fellows also voiced the view that researchers should be made to "pay it back," by forfeiture all remaining funds (except salaries of existing employees and graduate students), community service, or repayment of everything out of pocket.

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Guilty of misconduct that harmed the public. Nearly half of Fellows (48.4%, n= 118) recommended legal charges be brought or a criminal investigation initiated against those guilty of harming the public (Table 5). Revoking of tenure or ring and jail time were the next two most cited penalties. While one Fellow argued that even if a researcher conducted their work unethically, they should not be "held liable for unforeseen repercus- sions" but investigated purely for misconduct, whereas another felt they should be red since falsi ed research, for example, in their area of climate change and infrastructure could lead to poor policies harming the public. One Fellow claimed that the public could only be hurt by policymakers, as they decide "what to do with science results and to measure the impact of those decisions, not scientists." is is interesting because other Fellows cited the fraudulent and retracted "vaccines cause autism" study[22,23], and the horri c 40-year experimentation by government physicians on Black men in the Tuskegee syphilis study[24,25] as exemplar cases of distortion of truth and deliberate public harm by scientists deserving of criminal prosecution and jail time.

Integrity training and ethical role models. In response to open-ended questions asking to describe their formal integrity trainings, NSF Fellows recalled attending various combinations of online tutorials (62.7%; n = 153) (e.g., Responsible Conduct of Research training from Collaborative Institutional Training Institute [CITI]), university courses at the undergraduate or graduate levels (37.7%; n= 92), and workshops (18%; n= 44) (e.g., graduate school orientation), and mandated by funding agencies or home institutions (27.5%; n= 67) (Fig. 3A). While 44.7% (n = 109) said the trainings le them "more prepared" to deal with ethical issues in gradu- ate school and beyond, over half (54.1%; n= 132) reported the trainings had no e ect (Fig. 3B). Fellows believed that ethical scientists and engineers should uphold high standards of research integrity (53.3%; n= 130), report

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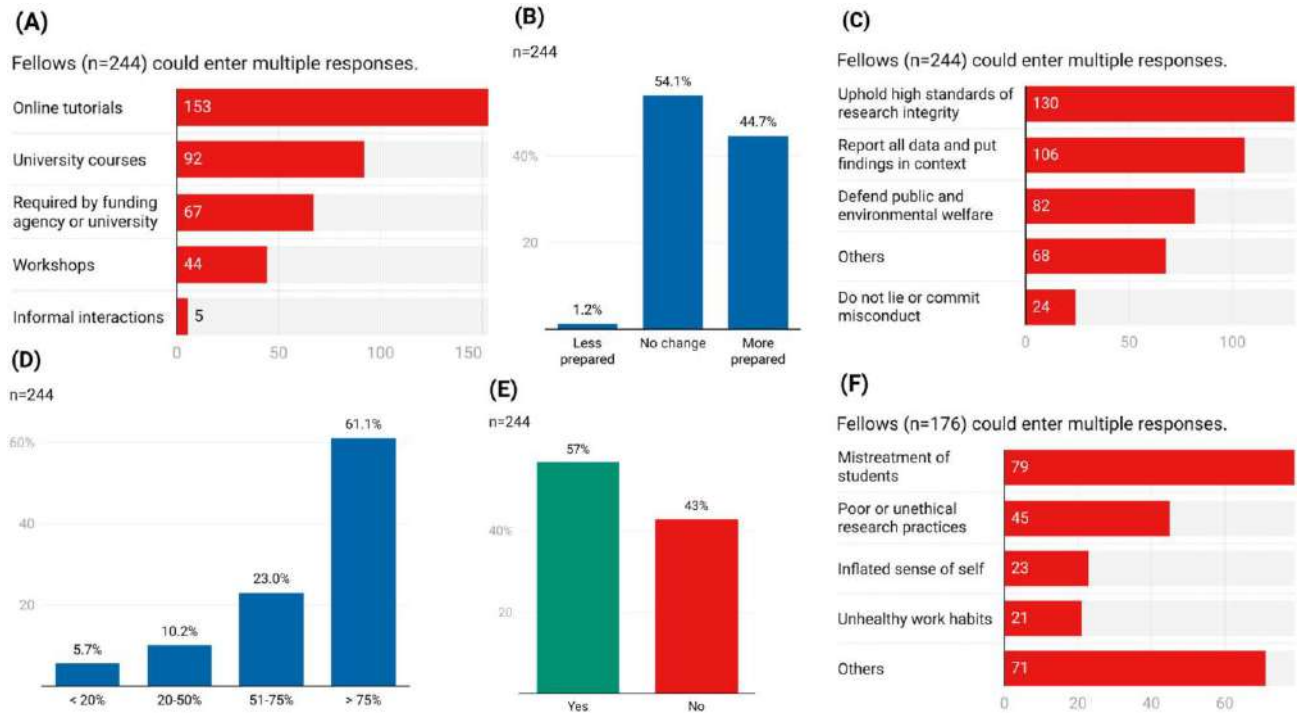

Figure 3. Ethics training and ethical behavior. (A) Types of formal ethics training NSF Fellows received. (B) Whether these trainings le Fellows prepared to handle ethical issues in graduate school and beyond. (C) What does being an ethical scientist or engineer mean to Fellows? (D) Percentage of Fellows' graduate school professors who were good role models. (E) Fellows who considered if potential PhD advisors were good role models when choosing graduate schools. (F) Top reasons, if any, why Fellows' advisors were not good role models.

all data and put ndings in context (43.4%; n= 106), defend the public or environmental welfare (33.6%; n= 82), and do not lie or commit misconduct (9.8%; n= 24) (Fig. 3C). Other favored character traits (n= 68) included: treat everyone fairly and with respect (n = 12), collaborate or share credit with others (n = 12), and prioritize real scienti c progress over mediocre work (n = 9).

Eight-four percent (84.1%; n = 205) Fellows reported that over half of their graduate school professors were good role models, while 5.7% (n = 14) Fellows felt only < 20% of their professors met that standard (Fig. 3D). Over half of the Fellows (57%; n= 139) took into consideration whether potential advisors were good role models when choosing graduate schools (Fig. 3E). e top reasons (n = 176) Fellows' actual PhD advisors did not turn out to be good role models (Fig. 3F) were (a) mistreatment of students (n = 79; e.g., "Misled students about uni- versity policy to delay graduation so they would publish more papers" and "highly critical of graduate student work in a manner that didn't foster that

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student's training"), (b) poor or unethical research practices (n = 45; e.g., "publishing data of poor quality", "using creative statistics", "worked far outside his expertise and didn't know he was ignoring existing work" and "not aware of IRB standards and did not conform to them [putting] graduate students in a tough spot"), (c) an in ated sense of self (n = 23; e.g., "textbook narcissist"), and d) unhealthy work habits (n = 21; e.g., "workaholics and emotionally abusive (but still ethical)"). Less common examples (n = 71) cited: concerned solely about publication count or funding dollars (n = 12), bad or uncaring teaching/mentoring, (n = 12) and being discriminatory (n = 11), primarily sexist (n = 8; e.g., "treated me di erently for being female").

Lying on this survey. Six (2.5%; n = 6) Fellows confessed to lying in their survey responses, while 40.2% (n = 98) of the remaining group acknowledged they were tempted to lie in response to our survey questions (Tables 6 and Table S3).

Discussion

Our national survey compiled academic perceptions and experiences of 244 recipients of the NSF graduate research fellowship that "recognizes and supports outstanding graduate students in NSF-supported STEM dis- ciplines" and has a competitive 15–16% acceptance rate[26,27]. It provides the rst ever snapshot of perceptions about academic cheating and research misconduct amongst this high-performing group of researchers. is work summarizes NSF Fellows' assessments of dominant academic incentives, motivations potentially guiding unethical behavior, and desired professional and legal penalties for serious o enses. e ndings cast doubt on the quality and e ectiveness of scienti c integrity trainings being o ered nationwide to engineering graduate students in promoting ethical awareness and behavior. Finally, the survey captures perceptions about the benefits and detriments of an academic career.

Academic dishonesty, research misconduct and ethics trainings. e 16% cheating rate among NSF Fellows is less than half of that estimated from large, national undergraduate and graduate student surveys[15,28,29]. is discrepancy might be partly explained by the fact that the de nition of what constitutes as "cheating" among students is shrinking and the growing rationalization of such behaviors as being sometimes acceptable[15,30–32]. NSF Fellows may also represent a subset of graduate students, who are less likely to cheat in the

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first place. Moreover, the comparable rates of cheating among men and women[15] as well as the top reasons for engaging in it—grades and time—are also consistent with prior studies[30,33].

Research misconduct rates (3.7% for self-reported and 11.9% for direct knowledge of colleagues) are of magnitude similar to those estimated in the most recent global meta-analysis (2.9% and 15.5%, respec- tively), which relied on 42 surveys (n = 23,228 net participants from 18 countries) conducted over the past three decades[34].

Factors that Fellows believe majorly contribute to scienti c misconduct t the Fraud Triangle hypothesis for white-collar crime, where external pressures (e.g., for promotion/tenure, funding hyper-competition), opportu- nity (e.g., desire for fame and recognition), and rationalization (e.g., rm belief in pet theories) result in "a secret violation from a position of trust to commit unethical behavior"[35–37]. Several Fellows echoed recent calls in the literature to prosecute severe research misconduct as a white-collar crime, make investigation reports public and list guilty perpetrators on internet databases to promote transparency and discourage misconduct[38–42]. Personal- ity traits like desire for fame/recognition, narcissism and sociopathy were mentioned as possible factors behind misconduct (Fig. 2E and Table S7). While past research has shown that scoring high on narcissism, psychopa- thy, and certain Big Five traits (e.g., high extraversion with high IQ) can promote lying, fraud and forgery, or contagion e ects spreading to other researchers[43,44], these results require further investigation among scientists. While a feared consequence of not punishing dishonest behavior among students is that they could later become "cheating professors"[45], no systematic studies have directly tested this relationship to our knowledge. However, ~ 20% of Fellows who confessed to academic dishonesty also admitted to or were unsure if they had

			I was tempted to lie		Total
			Yes	No	
I lied	Yes	6			6 (2.5%)
	No	0	98	140	238 (97.5%)
Total		6 (2.5%)	98 (40.2%)	140 (57.3%)	244 (100%)

Table 6. Dishonesty in this survey. Crosstab of NSF Fellows tempted to lie and confessed to actually lying on this survey.

committed research misconduct (Table S9). Interestingly, while CEE Fellows reported cheating and saw their peers cheat at twice the rate of their CSE counterparts, those in CSE acknowledged higher participation in misconduct and had higher knowledge of colleagues' misconduct than the former. e

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emphasis on the First Canon ("to hold paramount the health, safety and welfare of the public") in the training of CEE Fellows could explain why CEE Fellows perceive themselves as committing misconduct at lower rates than CSE Fellows, but the high self-reported cheating rate among CEE Fellows, while lower than national averages for graduate students[28], needs further evaluation.

Less than 1 in 3 Fellows believed scienti c misconduct to be a somewhat or major problem, compared to nearly half of Americans, who view it as a moderate to very big problem[46]. NSF only started mandating scienti c integrity or "Responsible Conduct of Research" training programs starting in 2010[47,48]; over 2200 institutions now o er web-based trainings through the Collaborative Institutional Training Initiative alone[49]. While their e ectiveness in reducing scienti c misconduct has not yet been evaluated[50], it is concerning that the trainings reportedly made no di erence in ~ 54% Fellows' ability to handle ethical dilemmas and 7% were unsure if they had ever committed misconduct.

Over one-tenth of Fellows explicitly viewed misconduct on a spectrum ranging from honest mistakes to will- ful fraud, and believed that professional and legal sanctions (i.e., article corrections and retractions, ring and revoking of tenure and criminal trials) (Table 5) should be commensurate to the severity and frequency of the misconduct. While the scienti c community bears collective responsibility to discourage, detect and sanction research misconduct[1], many academics and institutions do not think such incidents merit serious consideration or investigation[51–54].

Our survey found NSF Fellows to be astonishingly uninformed as nearly two-thirds had never heard of misconduct cases in their eld and this was true for both the older (2002–2007; 63%) and younger (2012–2017; 63.6%) cohorts as well as CSE (59.8%) and CEE (69.3%) Fellows. Chubin contended that the ultimate respon- sibility to uncover misconduct rests on individual scientists[55], and indeed, whistleblowers have been the most common way prominent research fraud cases came to light[56]. However, less than one in three Fellows said they would report misconduct and more than half were not sure if they would do anything. is is probably not surprising given that academics usually have no incentive beyond curiosity, self-interest or a sense of duty to investigate research misconduct[57,58]. Moreover, the repercussions of exposing unethical behavior are potentially catastrophic for whistleblowers, as journal articles, grant applications and awards are anonymously reviewed by peers[59] and severe mental health problems can result from academic shunning and

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retaliation[60]. On the other hand, if "universities shoulder a major responsibility for exercising control over scholarship misconduct" based on who they hire and promote and how they respond to misconduct allegations[1], the incentives for departments and universities where unethical professors bring in large amounts of funding can create con icts of interest and should be considered.

While various policies and protocols have been suggested to reduce cheating and research misconduct (e.g.[41]), e orts should consider both individual motivations and academic pressures[15,61,62]. Pressure to get promotion/ tenure was top-ranked by Fellows as possible motivation behind unethical behavior, which is consistent with recent ndings on researcher career stage being a predictive factor for journal retractions that mostly result from scienti c misconduct[11,63,64]. Integrity training should likely include real world and eld-speci c case studies and instruction rooted in human nature and organizational psychology, like the TRAGEDIES (i.e., Temptation, Rationalization, Ambition, Group and authority pressure, Entitlement, Deception, Incrementalism, Embarrass- ment, Stupid systems) and Public-inspired Science models[65,66], and not driven by compliance alone.

Dominant academic incentives and ethical research climate. e most emphasized positives of academic careers, i.e., academic freedom, exible schedule and mentoring opportunities, could explain why 56% of graduate students[67] and 80% of postdoctoral scholars[68] still considered academia their career destination of choice, despite an extremely crowded job market and shortening academic career spans[20,69,70]. e intense pressures tied to research grants, publishing, and tenure described by Fellows are also some top reasons given by faculty and graduate students leaving universities following the COVID-19 pandemic[71]. Focus on metrics can also lead to (a) more importance being paid to incremental science instead of novel, transformative topics[72], (b) misrepresentation and possible distortion of research ndings in publications[73], (c) discounting of scienti c con- tributions by early-career researchers with uctuating productivity in their initial years making them "more vul- nerable to early termination"[74], (d) preferential retention of young faculty whose productivity may be partially tied to being employed at more-prestigious institutions[75], and (e) failure to fully capture "research impact" in tenure and promotion practices by not including socially and scienti cally relevant outcomes, including trans- formative community-based research[76]. Moreover, the quantitative metrics arms race may lock researchers on to a "hedonistic treadmill," where ever higher article counts and

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funding dollars need to be pursued to sustain an academic career per Goodhart's Law and possibly maintain one's self-worth[5,77].

Fostering ethical cultures i.e., work environments that are supportive of research integrity, is one of 14 core responsibilities of Principal Investigators[78], but over 1 in 5 Fellows felt they could not discuss wrongdoing in their research groups. Academic advisors arguably in uence the academic ethical principles of graduate advisees to a disproportionate degree because if pressured by their advisor to commit misconduct, 2 in 5 fellows either said they would do so or were unsure. "Positive mentorship" has been deemed the "most important factor in completing a STEM degree"[17] and exhibiting truly ethical leadership by PhD advisors (Fig. 3C) could also help graduate students spot academic temptations, manage ethical dilemmas and avoid questionable practices, thereby contributing to aspired positive and productive research cultures[79].

Our study has signi cant limitations. Since women made up 43% (17,577/40,850) of all US doctoral degree recipients in science and engineering in 2021[80] and the fact that women PhD graduates are over-represented in some STEM elds (e.g., Environmental Engineering [53.2%], Biology [53.8%], and Health and Medical Sciences [71.4%]) and under-represented in others (e.g., Civil and Environmental Engineering [33.3%], Civil Engineering [29.4%], Engineering overall [25.5%], Computer Science and Engineering [20.9–23.6%])[81,82], responses from our survey cohort (50.8% female) may not be fully representative of STEM academia. e cheating and research misconduct rates are likely underestimates, as is expected with responses to questions of sensitive nature, even in anonymous surveys like ours[5,15]. NSF Fellows are also a group least subject to nancial pressures during graduate school due to NSF funding and, therefore, perhaps more likely to accurately describe dominant incentives and external pressures, which may be worse for the typical graduate student. Future research on these topics should survey more representative U.S. academic populations akin to that in e Netherlands[83] and United Kingdom[84].

Survey dataset could be analyzed using cross correlation matrices for possible inter-relationships between respondents' attitudes and self-reporting of cheating, misconduct and ethics training compliance, their beliefs on penalties for those found guilty and, more generally, pros and cons of academia. Beyond tracking incidence, research can be designed in conjunction with educational psychologists, moral psychologists, neuroscientists, behavioral economists and legal scholars to: (a)

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design ethics training and interventions that reduce occurrence of academic dishonesty and research misconduct, (b) isolate institutional and eld-speci c factors that impact motivation and likelihood of misconduct, (c) study the relationship between individual personality traits vis-à-vis academic cheating and misconduct, and (d) formalize and re ne con icts of interest, penalties and reparation processes for misconduct. Finally, this survey instrument (Text S1) could also be condensed, standardized and administered every 10 years to temporally track trends among NSF Fellows and, more generally, NSF-funded scientists.

References

1. Braxton, J. M. *Perspectives on Scholarly Misconduct in the Sciences*. (Ohio State University Press, 1999).
2. Bush, V. Science, the endless frontier. *Science, the Endless Frontier* (Princeton University Press, 1945).
3. Franzen, S. *University Responsibility for the Adjudication of Research Misconduct*. (Springer, 2021).
4. Anderson, M. S., Ronning, E. A., De Vries, R. & Martinson, B. C. e perverse e ects of competition on scientists' work and relationships. *Sci. Eng. Ethics* **13**, 437–461 (2007).
5. Edwards, M. A. & Roy, S. Academic research in the 21st century: Maintaining scienti c integrity in a climate of perverse incentives and hypercompetition. *Environ. Eng. Sci*. **34**, 51–61 (2017).
6. Lindner, M. D., Torralba, K. D. & Khan, N. A. Scienti c productivity: An exploratory study of metrics and incentives. *PLoS ONE*
13, e0195321 (2018).
7. Packalen, M. & Bhattacharya, J. NIH funding and the pursuit of edge science. *Proc. Natl. Acad. Sci. USA* **117**, 12011–12016 (2020).
8. Smaldino, P. Better methods can't make up for mediocre theory. *Nature* **575**, 9–10 (2019).
9. Smaldino, P. E. & McElreath, R. e natural selection of bad science. *R. S. Open Sci.* **3**, 160384 (2016).
10. Oransky, I. Retractions are increasing, but not enough. *Nature* **608**, 9 (2022).
11. Fanelli, D., Costas, R. & Larivière, V. Misconduct policies, academic culture and career stage, not gender or pressures to publish, a ect scienti c integrity. *PLoS ONE* **10**, e0127556 (2015).
12. Holtfreter, K., Reisig, M. D., Pratt, T. C. & Mays, R. D. e perceived causes of research misconduct among faculty members in the natural, social, and applied sciences. *Stud. High. Educ.* **45**,

2162–2174 (2020).

13. White House OSTP. *Protecting the Integrity of Government Science. White House O ce of Science and Technology Policy* https://www.whitehouse.gov/wp-content/uploads/2022/01/01-22-Protecting_the_Integrity_of_Government_Science.pdf (2022).
14. Fanelli, D. How many scientists fabricate and falsify research? A systematic review and meta-analysis of survey data. *PLoS ONE* **4**, e5738 (2009).
15. McCabe, D. L., Butter eld, K. D. & Trevino, L. K. *Cheating in College: Why Students Do It and What Educators Can Do About It* (JHU Press, 2012).
16. National Science Foundation. *Dear Colleague Letter February 4 2020*. https://oig.nsf.gov/sites/default/ les/document/2022-10/ DearColleague_new.pdf (2020).
17. National Academies of Sciences Engineering, and Medicine. *Environmental engineering for the 21st century: Addressing grand challenges*. (National Academies Press, 2019).
18. National Academies of Sciences Engineering, and Medicine. *Fostering Responsible Computing Research: Foundations and Practices*. (National Academies Press, 2022).
19. Roldan-Hernandez, L., Boehm, A. B. & Mihelcic, J. R. Parachute environmental science and engineering. *Environ. Sci. Technol.* **54**, 14773–14774 (2020).
20. Larson, R. C., Gha arzadegan, N. & Xue, Y. Too many PhD graduates or too few academic job openings: e basic reproductive number R0 in academia. *Syst. Res. Behav. Sci.* **31**, 745–750 (2014).
21. Bazeley, P. *Qualitative Data Analysis: Practical Strategies*. (SAGE, 2013).
22. Wake eld, A. J. *et al.* RETRACTED: Ileal-lymphoid-nodular hyperplasia, non-speci c colitis, and pervasive developmental disorder in children. *Lancet* **351**, 637–641 (1998).
23. Hviid, A., Hansen, J. V., Frisch, M. & Melbye, M. Measles, mumps, rubella vaccination and autism: A nationwide cohort study. *Ann. Intern. Med.* **170**, 513–520 (2019).
24. Edwards, M. A., Yang, C. & Roy, S. Who dares to speak up?. *Am. Sci.* **109**, 238–243 (2021).
25. Washington, H. A. *Medical Apartheid: e Dark History of Medical Experimentation on Black Americans*

from Colonial Times to the Present (Doubleday Books, 2006).

26. Hahm, J., Hill, C. L. & Norman, N. *Graduate Research Fellowship Program* 54.
27. National Science Foundation. About GRFP. *NSF Graduate Research Fellowships Program (GRFP)* https://www.nsfgrfp.org/conta ct/about-grfp/.
28. Danilyuk, J. Academic Cheating Statistics: is Is What You Ought to Know. *Unicheck Blog for Education Junkies* https://unicheck. com/blog/academic-cheating-statistics (2019).
29. ICAI. *Facts and Statistics*. https://academicintegrity.org/resources/facts-and-statistics (n.d.).
30. Carpenter, D. D., Harding, T. S., Finelli, C. J., Montgomery, S. M. & Passow, H. J. Engineering students' perceptions of and attitudes towards cheating. *J. Eng. Educ.* **95**, 181–194 (2006).
31. Rettinger, D. A. & Kramer, Y. Situational and personal causes of student cheating. *Res. High. Educ.* **50**, 293–313 (2009).
32. *Young, J. L. High-tech cheating abounds, and professors bear some blame. e Chronicle of Higher Education* http://www.chron icle.com/article/high-tech-cheating-abounds-and-professors-bear-some-blame/ (2010).
33. Sheard, J., Markham, S. & Dick, M. Investigating di erences in cheating behaviours of IT undergraduate and graduate students:
e maturity and motivation factors. *High. Educ. Res. Dev.* **22**, 91–108 (2003).
34. Xie, Y., Wang, K. & Kong, Y. Prevalence of research misconduct and questionable research practices: A systematic review and meta-analysis. *Sci. Eng. Ethics* **27**, 41 (2021).
35. Ariail, D. & Crumbley, D. Fraud triangle and ethical leadership perspectives on detecting and preventing academic research misconduct. *J. Forensic Investig. Account.* **8**, 480–500 (2016).
36. Cressey, D. *Other People's Money*. (Patterson Smith Publishing Corporation, 1973).
37. Kassem, R. & Higson, A. e new fraud triangle model. *J. Emerg. Trends Econ. Manag. Sci.* **3**, 191–195 (2012).
38. Dal-Ré, R., Bouter, L. M., Cuijpers, P., Gluud, C. & Holm, S. Should research misconduct be criminalized?. *Research Ethics* **16**, 1–12 (2020).

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

GOING SHORT AND DIGITAL: CONSUMER PERSPECTIVES ON THE DIGITALIZATION OF SHORT FOOD SUPPLY CHAINS

Dr. Diwakar Chaudhary, Assistant Professor, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh
Ms. Rashi Bhati, Assistant Professor, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh
Ms. Khushbu Goyal, MBA Student, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh

Abstract: Agricultural digitalization and short food supply chains (SFSCs) are considered to be different avenues for transitioning to more sustainable agrifood systems. Can these avenues be put together, or are they parallel and, hence, not compatible? The answer to that question largely depends on the potential effects of digitalization on SFSCs. Going digital is a transformative process, accompanied by desirable and undesirable economic, social, environmental, and cultural impacts on short supply schemes. In this cross-sectional quantitative study, based on data from 211 individuals who frequently buy from SFSCs, we examined how consumers evaluate these impacts. We also investigated how participants' perceptions of these impacts influence their acceptance of agricul- tural digitalization and their willingness to buy food products from digitalized SFSCs. Our results revealed that consumers view digitalization as a source of positive environmental but adverse social, cultural, and economic impacts on short supply schemes. In addition, we found that acceptance of digitalization and willingness to buy from digitalized SFSCs received moderate-to-low scores. Two regressions showed that buyers' perceptions of the social impacts that follow digitalization shape both acceptance and willingness. These findings uncovered consumers' skepticism toward digitalization, suggesting that their commitment to short supply chains and the values that these schemes represent cultivate the belief that digitalization can negatively transform SFSCs, leading to an unwelcome industrialization.

1. Introduction

The emergence and rapid growth of advanced, digital (or smart) technologies and the first enthusiastic arguments on their potential to revolutionize agrifood production and supply [1–3] spurred high interest in how digitalization can transform agriculture. Combining cross-cutting and geolocation tools, and taking advantage of real-time data collection and processing applications [4,5], digital technologies are viewed as tools that can facilitate the transition to a more sustainable future by producing beneficial economic, social, and environmental impacts, while also reshaping farm and market culture in posi- tive

ISBN Number: 978-93-95305-78-5

ways. However, scholars express some concerns about the potential externalities of digitalization, putting in doubt the economic viability of digitalized farms and exposing several socio-ethical, environmental, and cultural risks associated with the digital transition of agriculture [6–11].

Notably, the scholarly and policy discussion on the pros and cons or the actual and expected impacts of digitalization emphasizes the capacity of digital technologies to change current agriculture without fully elaborating on whether and how digital technologies will transform sub-systems that operate in tandem with prevalent (conventional) farm production and supply paradigms [12–14]. Although they have several complementarities [15], alternative food production/distribution models and digitalized agriculture are often viewed as opposite poles of an agricultural production continuum. In this vein, as Klerkx et al. [16] suggest, there is a need for more research to uncover how alternative niches, more sustainable than the dominant paradigm, can be supported and affected by digitalization.

In the present work, we took a step in this direction, devoting our attention to short food supply chains (SFSCs), which represent alternatives to the mainstream food production and distribution models (operational definitions of SFSCs and digitalization are provided in Table 1 and discussed in the following sections). Selling through short supply conduits is a practice that is gaining momentum, especially in the European Union, where, according to the European Parliamentary Research Service [17], about 15% of farmers choose direct- to-consumer channels to distribute their products. Scholars argue that digitalization can improve food production and marketing in SFSCs [18,19]. However, little research has investigated how producers and buyers view the digitalization of SFSCs and its impacts on these chains. In this study, we aimed to examine how consumers assess the impacts of digitalization on these chains, and to understand whether these perceptions affect consumers' acceptance of agricultural digitalization and their willingness to buy food products from digitalized SFSCs.

2. Short Food Supply Chains: Definition, Properties, and Challenges

Gaining momentum during the first decade of the 2000s, SFSCs initially became a topic of interest for social scientists. This first wave of study gave prominence to the alternativeness of short supply schemes compared to the more "industrialized" mainstream food distribution channels. For Marsden et al. [20], SFSCs are schemes that shorten long supply networks, ensure a better connection between farmers and consumers, and allow the exchange of information on food origin and quality. Renting et al. [21] also focused on the relational component of SFSCs, emphasizing that, contrary to their "longer" equivalents,

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short supply conduits link food producers, processors (if any and if different than the producer of the primary products), and consumers.

As research on SFSCs continued to evolve, new elements entered the concept. Among them, proximity is the most pivotal feature of any SFSC. Geographical proximity, which refers to the physical distance between the places of production and consumption, is reduced compared to conventional supply chain schemes. Some efforts have been made to specify the maximum distance between the farm and the point of consumption, but scholars have not yet reached a consensus [22]. Distance is, by default, a relational measure, and it is practically challenging to assess what is "long" or "short," or what "local" means in food production. For example, in the USA, a product is considered local when it travels less than 275 miles from its place of production to the point of consumption [23]. However, for some countries, such a distance is considered long. For example, 275 miles is longer thanthe distance from the westernmost to the easternmost cities of Belgium. Hence, it can be argued that, in SFSCs, the distance is kept to a minimum, as determined by understanding a "region" with no strictly defined borders but definable characteristics.

Apart from geographical features, organizational and social proximity are critical ele- ments of SFSCs. The first type refers to the arrangement between farmers and consumers. Short supply schemes lack intermediaries or involve only a limited number of middle nodes. Interestingly, researchers hold different perceptions of the number of intermediaries that can be engaged in an SFSC. A commonly cited definition describes SFSCs as schemes in which no or only an extra node can intervene between producers and consumers [24]. Galli and Brunori [25] are more elastic in their conceptualization of SFSCs, stating that the number of extra nodes "equals zero or very few (often one, but no more than two)". Others also agree that, to be counted as short, a supply chain should involve a minimal number of middle actors [26,27], without specifying how many nodes can be included in a "short" chain.

Notably, beyond the number of actors involved in SFSCs, it is essential to focus on their characteristics and properties. Since SFSCs are alternatives to conventional food distribution channels, intermediate actors should carry characteristics of this alternativeness and safeguard the locality of the products marketed through these channels. This attribute means that, ideally, they should belong to the same area as the farmers and consumers, thus returning a part of the social value produced through the operation of SFSCs to the community by, for instance, offering employment opportunities to other community members and contributing to the sustainability of local food.

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In other words, the actors engaged in short supply schemes should promote local cooperation and the economic development of the areas in which they operate [28]. This characteristic refers to the social proximity between the economic actors participating in SFSCs and is often underrepresented in the literature, where the emphasis is put on the socially proximate relations between farmers and consumers and the consequent development of trust, reciprocity [29], and social capital [30].

In summing up the dimensions of SFSCs mentioned above, we can argue that SFSCs are food distribution and marketing schemes that operate within the framework of a specific area or community, facilitate the development of trust and social capital between their nodes, and allow the exchange of food-related information between farmers and consumers. These market arrangements can be direct (i.e., based on the direct selling of local food products from farmers to consumers) or intermediated (when regional actors intervene to facilitate the distribution or processing of products, contributing extra value to the community with their activity).

Such chains produce economic, social, and environmental value, thus contributing to the sustainability of food systems [31] and promoting rural development [32]. Nevertheless, SFSCs face several challenges due to the particular conditions under which they operate. As small-scale farmers, producers selling their products in SFSCs often lack technological capacity [33] and economic resources [34]. In addition, the shortage of workforce [35] and the demanding nature of multicultivation further reduce the operational efficiency of farms and increase the workload for farmers [36].

At the market level, farmers face intra-SFSC (with producers who use similar dis- tribution practices) and inter-supply chain competition (with market actors operating in conventional supply chains). Although the relevant literature often emphasizes the in- teractions between farmers and their customers, SFSCs still encompass a commodified component [37], which is decisive for succeeding in the market. Hence, issues like the continuous availability and variety of products or their quality determine the market per- formance of a farm. However, lacking essential resources, farmers are often not capable of ensuring the quantity and quality of their production. On the other hand, the high level of perishability associated with the products usually sold in SFSCs (vegetables, fruits, dairy products) [38] makes programming the production and distribution processes a difficult yet critical endeavor.

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3. Digitalization of Agriculture: A Brief Overview

3.1. Agricultural Digitalization Defined

Digitalization is a widely used term that carries different meanings. Relevant defini- tions emphasize varying attributes of digitalization, from the process of the production [39] and use [40] of digital solutions to the transformative capacity of digital technologies [41] and their ability to restructure social life [42], consequently leading to new economic and social realities [43].

Agricultural digitalization can also be seen through the angle of the development, adoption, and exploitation of technology [44,45], or under the lens of its disruptive and transformative nature [46,47]. Combining these views, we can define it as the process of developing digital agricultural technologies that do not belong to the evolutionary line of farm machinery and integrating them into farming activity to produce new forms of value. This procedure initiates transformative changes in the social fabric of agrifood systems and is accompanied by several risks.

This operational definition summarizes the key points previously presented in the literature. Agricultural digitalization is about developing, adopting, and using technolo- gies with different attributes from analog equivalents, since they collect, process, store, analyze, and transmit digital data. Although legacy technologies (technologies in use that were created under a different design spirit [48] and, in some instances, were considered revolutionary when they emerged) continue to "do the work" for farmers, new tools like sensors, farmbots, unmanned aerial vehicles, and various advancements like the Internet of Things, cloud computing, and artificial intelligence promise to solve problems and address needs that remain pressing.

3.2. What Do We Know About the Impacts of Agricultural Digitalization?

As noted in the previous section, digitalization entails a transformative and disrup- tive nature. As digital technologies supersede their legacy antecedents, they generate new ways of working and managing a farm. Current digital applications like sensing technologies and digital fences allow for the remote execution of farm operations [49,50], while artificial intelligence-supported farm robotic systems can undertake the picking [51], weed control, and spraying of crops [52]. Data provided by smart technologies increase farmers' management capacity [9] and reduce improvisation and experience-based choice in favor of more rational and well-informed decision-making [53]. Hence, at the farm level, these technologies can reduce the time needed to perform farm tasks [54] and, therefore, the workload for farmers and farm workers [55], while offering opportunities for more intelligent and insight-based farm management [56].

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However, technology-spurred transformations are not always positive [57]. Looking at the social layer of digitalization, the introduction of digital technologies in farming enhances farm productivity [58–60] and improves products' quality [61], with obvious subsequent positive outcomes in the fight against food insecurity and the efforts to supply consumers with highly nutritious food. Nevertheless, some technologies put low-skilled farm workers at risk of exclusion [62], while disconnecting producers from their farm culture [7] and negatively affecting their wellbeing. For instance, a study in Norway indicated that adopters of digital technologies (automated milking systems) express high stress levels [63]. Barrett and Rose [64] also observed that, in Eastern England, farmers associate the adoption of digital technologies with high levels of stress due to information overload and the need to remain continuously connected to technology and the farm. Beyond psychological issues, digitalization can also indirectly affect physical health. For instance, the procedures and materials used in the technology development phase might increase human toxicity, negatively impacting human health [65].

In addition, digitalization can have several positive and negative environmental, economic, and cultural impacts. Concerning environmental impacts, digitalization can help increase resource efficiency [54] and reduce the use of fertilizers and irrigation water [66]. However, negative externalities related to the production of digital technologies have also been uncovered [67], while the shift to a more technology-driven mode of production may lead to the dominance of mono-cultivation, with adverse outcomes for biodiversity [7].

Economic impacts refer to the increase in yields and the simultaneous reduction in production costs [68], which can lead to a growth in income for farmers in the long term [69]. However, the high cost of technologies [70] and possible associated expenses (e.g., for replacing or renovating farm facilities to develop proper infrastructure for digitalizing a farm) can be a heavy burden, especially for small-scale farmers. Notably, a potential cost pass-through practice—frequently used in the markets—will have negative economic effects on food prices and, thus, might reduce poor consumers' access to some food products.

Finally, digitalization can transform farm culture in contrasting ways. By shaping new (digital) agricultural innovation systems [71], digitalization connects farmers with new market players, technology developers and providers, and innovation brokers who take various roles (see [72] for a detailed stakeholder analysis). These actors convey new ethics, patterns of interaction, and ways of thinking, thus gradually changing the prevailing cultural norms in the agrifood system [46,73]. Interacting with these new entrants in the agrifood nexus, farmers might develop a new entrepreneurial culture and

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willingness to follow a more entrepreneurial path [74], while digital technologies are tools that support entrepreneurial decisions [75] and open up new entrepreneurial directions [76]. On the other hand, there are concerns associated with adopters' over-reliance on technology [11,77] and the potential technofication of agriculture [78], which could alienate farmers from a culture that has been developed over generations and reduce their sense of responsibility to their land and customers [7].

4. How Do Consumers View Digitalization of Agriculture?

Interestingly, consumers are the least represented group in the literature on the impacts of agricultural digitalization. Hence, little is known about their thoughts on the digitaliza- tion of farms and the food produced by exploiting digital technologies. Some sentiment analyses indicate a rise in the public discussion about digital agricultural technologies [79] and a possibly growing positive stance of social media users toward the digitalization of farm production [80]. However, studies using consumer samples are still scarce.

Among the few exceptions, Spykman et al. [81] found that consumers are generally optimistic about the effects of specific digital technologies (spot spraying) on the environ- ment. Nevertheless, about one-fourth of the participants in their study agreed that digital technologies can alienate farmers from their farms and farm animals. Others [82] concluded that German citizens have a relatively positive attitude towards the impacts of digital agri- cultural technologies on farmers' wellbeing and the environment, while also revealing that the surveyed persons had a moderate belief that digital technologies disconnect farmers from their animals and land. In another German study, Wilmes et al. [83] discovered that consumers' willingness to buy from digitalized farms decreases as digitalization intensifies. In a focus group study [84], Dutch, Finnish, and French consumers expressed mixed perceptions of the aftermath of digitalizing animal farms. Although digital technologies are viewed as tools that enable transparency across supply chains, increase food safety, enhance productivity, and improve farmers' wellbeing, concerns over potential risks related to the "robotization" of farming and the technological waste that the overuse of technology generates were also mentioned by the participants. Stampa et al. [85] reached similar conclusions, confirming the existence of mixed consumer perceptions of digitally enabled farm production methods and the products emerging through digital farming.

However, the research conducted to date has focused only to a limited extent on alternative agrifood production and distribution schemes. Wilmes and colleagues [83], ex- amining consumers' attitudes toward digitalized organic farms, found that they were more positive than for larger, conventional farms.

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Concerning local food consumers, however, Broad et al. [86] concluded that buyers view the food produced through the use of highly advanced technologies as less natural than that produced with the exploitation of more conventional farm machinery. One of our previous studies [33] explains this perception through the lens of symbolic compatibility, indicating that consumers consider digitaliza- tion to be a threat to the distinct and alternative nature of SFSCs. In the present study, we expand on this literature by shedding light on consumers' perceptions of digitalization's impacts on these chains.

5. The Present Study

In this study, we aimed to assess consumers' perceptions of the impacts that digital- ization (e.g., the introduction of technologies like spraying and seeding drones, robotics, or sensor networks) will have on SFSCs, while also examining whether and how these perceptions affect (i) the level to which consumers endorse the digitalization of SFSCs and

(ii) their willingness to buy through digitalized SFSCs. We adapted instruments developed in a previous work to evaluate perceptions of economic, social, environmental, and cultural impacts [33]. Then, we compared the scores obtained for the four categories of impacts to arrive at conclusions regarding their importance for consumers.

Furthermore, to understand how these perceptions affect consumers' acceptance of the digitalization of SFSCs and their willingness to buy from digitalized SFSCs, we built two hierarchical regression models using the constructs mentioned above as response variables. At step 1 of the models, we entered the perceived importance of SFSCs and consumers' general perceptions of digitalization. Perceived importance is a widely used concept in consumer behavior research. Similar to involvement, it refers to the perceived relevance of a product or service for a person, as well as the importance that a consumer ascribes to it [87]. In our case, it describes the importance and personal significance attributed to SFSCs by their customers. The rationale behind using perceived importance as a control variable lies in its potential effects on the response variables. Attributing high relevance to SFSCs might reduce the willingness to engage in a different (digitalized) form of these chains. The second variable—general perception of digitalization—reflects individuals' beliefs about risks and trust towards introducing digital technologies in agriculture, which, as research confirms [81,88], might affect their behavior as consumers. Hence, this perception possibly affects both the degree to which consumers endorse the digitalization of SFSCs and their willingness to buy from digitalized SFSCs. In the second step of our regressions, we added the four variables referring to the impacts of digitalization on SFSCs.

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6. Methods

6.1. Participants and Procedure

In this study, we followed a cross-sectional quantitative research design. Our data came from 211 Greek consumers (56.9% women; mean age = 41.55, S.D. = 15.18; 56.4% university educated). To recruit potential study participants, we visited farmers' markets and on-farm stores in the Thessaloniki (Greece) region. Data were collected through face- to-face questionnaire completion. In Appendix A, we present the part of the questionnaire that contains the instruments used in our analysis.

Consumers had to answer two introductory questions to be included in the sample. The first one concerned the frequency of purchases from SFSCs. The second question asked whether participants knew what digital technologies are. To ensure that the participants were aware of these technologies, we added an open-ended question in the introductory part of the questionnaire, requesting subjects to mention the digital agricultural technologies that they know. Only persons who buy food products through short supply channels more than once a month, answered positively to the second question, and could offer correct examples of digital technologies were counted as study participants. In their open answer, all participants referred to "hard" digital technologies, like unmanned aerial vehicles for spraying and monitoring crops, or sensor networks.

6.2. Measures

To measure the constructs of interest, we used a series of scales. We developed four instruments to evaluate participants' perceptions of the economic (example item: "digitalization will help farmers increase their income"), social (example item: "digitalization will increase the quantities of produced food products, thus assisting in fighting food insecurity"), environmental, (example item: "digitalization will lead to energy waste for the production and operation of digital technologies"—reverse worded), and cultural impacts of digitalization on SFSCs (example item: "digitalization will disconnect farming from its fundamental principles and values"—reverse worded). Each scale consisted of four items answered on a five-point Likert scale. After recoding negatively worded items, we confirmed the unidimensionality of all scales through principal axis factor analyses (eigenvalues ranged from 2.30 to 2.92). Cronbach's alphas received values that exceeded 0.79. A new variable was calculated for each scale by averaging relevant items.

We also assessed two parameters that can shape consumers' willingness to buy through digitalized SFSCs: The first was their general perception of agricultural digitalization, which refers to consumers' trust in

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digital technologies, their concerns about the future effects of technologies, and their belief that these technologies will revolutionize agriculture and improve farmers' wellbeing. Items were assessed using a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). An example item was "I fully trust digital agricultural technologies". The second construct describes the perceived importance of SFSCs for consumers, which reflects the importance that they attribute to short supply schemes. The instrument that we developed included five items measured on a seven- point scale. An example item was: "SFSCs are consistent with my personal values", with response options anchored by "definitely not" (1) to "definitely yes" (7). The factor analysis procedures revealed that the two scales load on single factors (eigenvalues: 3.51 and 3.91, Cronbach's alphas: 0.89 and 0.95, respectively). We computed a score for each scale as the mean of its items.

To measure participants' willingness to buy food products from digitalized SFSCs, we administered a five-point scale from 1 (not at all) to 5 (very much). The question posed to the respondents was "To what extent are you willing to buy food products from short food supply chains in which farmers use digital technologies?" Finally, to evaluate the degree to which consumers agree with the digitalization of the farms from which they buy food products, we used a single item answered on the same five-point scale.

6.3. Data Analysis Techniques

To analyze data, we used descriptive and inferential statistics (paired-samples t- tests, Pearson's correlations, and Mann–Whitney U tests). We also built two hierarchical regression models (as detailed in Section 5) to test whether consumers' beliefs about the impacts of digitalization on SFSCs influence their willingness to buy food products through digitalized short supply schemes and their acceptance of the digitalization of SFSCs. To calculate the statistical power of our regression, we used Soper's formula [89]. For an effect size of 0.15 and a probability level of 0.05, the power was 0.997.

7. Results

7.1. Primary Analysis

The descriptive statistics of the study variables (Table 2) indicate that consumers are only slightly willing to buy food products from short supply schemes in which producers use digital technologies. Moreover, they express a moderate acceptance of the digitalization of SFSCs. The analysis confirmed that, as expected, acceptance of the digitalization of SFSCs positively correlates with willingness to buy from digitalized short supply schemes.

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Table 2. Descriptive statistics and intercorrelations (Pearson's r) for the study variables.

Variable **Mean Score (S.D.)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Economic impacts of digitalization (1) 2.41 (0.75)	-							
Social impacts of digitalization (2) 2.69 (0.85)	0.62 **	-						
Environmental impacts of digitalization (3) 3.21 (0.84)	0.55 **	0.60 **	-					
Cultural impacts of digitalization (4) 2.44 (0.73)	0.62 **	0.58 **	0.64 **	-				
General perception of agricultural digitalization (5) 2.91 (0.95)	0.60 **	0.67 **	0.62 **	0.59 **	-			
Perceived importance of SFSCs (6) 4.54 (2.06)	0.04	0.01	−0.06	0.11	0.01	-		

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Acceptance of the digitalization of SFSCs (7) 2.91 (1.16)	0.53 **	0.61 **	0.59 **	0.61 **	0.61 **	0.17 *	-	
Willingness to buy from digitalized SFSCs (8) 2.65 (1.14)	0.47 **	0.52 **	0.43 **	0.57 **	0.57 **	−0.10	0.66 **	-

* $p < 0.1$, ** $p < 0.01$.

The correlations among the four constructs used to assess the participants' percep- tions of the impacts associated with digitalization were, in all cases, high and positive. Nevertheless, it is worth mentioning that the mean score for the environmental impacts of digitalization was the only one that reached a value greater than 3.00, indicating the participants' belief that introducing digital technologies in SFSCs will lead to environmental benefits. Conversely, the mean scores for the remaining three categories of impacts were lower than 3.00.

Paired-samples t-tests revealed that the mean score for the environmental impacts was significantly higher than those for the economic ($t = 15.15$, $p < 0.001$), social ($t = 9.92$, $p < 0.001$), and cultural impacts ($t = 16.44$, $p < 0.001$). In addition, social impacts had a significantly higher mean score than cultural ($t = 4.93$, $p < 0.001$) and economic ($t = 5.83$, $p < 0.001$) effects of digitalization. The difference between the two latter variables was insignificant ($t = 0.853$, $p = 0.394$).

Gender did not affect the variables referring to impacts, as uncovered through the independent-samples t-tests. The absolute values of the mean differences between women and men consumers ranged from 0.04 to 0.18 ($t < 1.76$ in all cases). Age was associated only with the perceptions of social impacts, with a negative r coefficient ($r = -0.16$, $p = 0.018$), revealing that older consumers have a more cautious view of the potential social exter- nalities of digitalization. The level of education was not correlated with any of the four categories of impacts (r values ranged from 0.02 for social impacts to 0.12 for cultural impacts, corresponding to p values higher than 0.05).

Notably, willingness to buy from digitalized SFSCs was correlated with all four vari- ables referring to categories of impacts and the perception of digitalization. Nevertheless, we did not observe significant associations between willingness and participants' age ($r = -0.09$, $p = 0.184$) or gender ($U = 5130.5$, p

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= 0.439). Acceptance of the digitalization of SFSCs exhibited significant correlations with all four categories of impacts, while it was unaffected by gender (U = 525.5, p = 0.335). Nevertheless, it was significantly and negatively correlated with age (r = 0.22, p = 0.001), showing that the level of acceptance decreases in older consumers. Consumers' educational level did not correlate with their willingness to buy from digitalized SFSCs (r = −0.07, p = 0.287) or their acceptance of digitalized SFSCs (r = −0.02, p = 0.742).

7.2. Regression Analyses

Our regression analysis for willingness to buy from digitalized SFSCs showed that, among the variables belonging to the first block, only perception of digitalization was significant for the initial and the final model. In the final model (Table 3), the standardized beta coefficient for the variable yielded a value of 0.35 ($p < 0.001$). Regarding the examined impacts, we discovered that only those referring to the social externalities influence con- sumers' willingness to buy food products through digitalized SFSCs ($\beta = 0.20$, $p = 0.016$). The positive sign of the βcoefficient reveals that willingness to buy increases when social impacts are considered to be positive.

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Table 3. Hierarchical regression analysis for willingness to buy: standardized coefficients of the final model.

	ΔR^2	ΔF	β
Step 1	0.34	52.20	
Perceived importance of SFSCs			0.10
General perception of agricultural digitalization	0.35		
Step 2	0.04	3.66	
Economic impacts of digitalization			0.11
Social impacts of digitalization			0.20 *
Environmental impacts of digitalization	0.04		
Cultural impacts of digitalization			−0.01

* $0.01 < p \leq 0.05$, ** $p \leq 0.01$.

When we used acceptance of the digitalization of SFSCs as the dependent variable (Table 4), the perceived importance of SFSCs and the general perception of digitalization were significant at the first step, retaining their significance in the final model. Interestingly, the beta value for the importance of SFSCs received a negative beta coefficient, suggesting a negative relation (β= −0.15, p = 0.003). Perceptions of the social (β= 0.26, p = 0.001) and environmental impacts of digitalization (β= 0.20, p = 0.006) contributed significant variance to the model, suggesting that consumers who view digitalization as a way of promoting positive social changes and reducing the environmental footprint of SFSCs endorse the introduction of digital technologies to short supply schemes to a greater extent.

Table 4. Hierarchical regression analysis for acceptance of digitalization: standardized coefficients of the final model.

	ΔR^2	ΔF	β
Step 1	0.39	65.58 **	
Perceived significance of SFSCs			−0.15 **

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General perception of agricultural digitalization 0.26

** Step 2 0.10 10.08 **

Economic impacts of digitalization 0.12

Social impacts of digitalization 0.26

**

Environmental impacts of digitalization 0.20

** Cultural impacts of digitalization −0.0

4

** $p \leq 0.01$.

8. Discussion and Conclusions

The relevant literature suggests that both SFSCs and digitalization are paths that can lead to more sustainable agrifood systems [90–93]. SFSCs can directly or indirectly con- tribute to attaining Sustainable Development Goals by generating societal, environmental, and economic benefits [94], as does digitalization by supporting the achievement of goals like ending poverty and hunger, combating climate change, or ensuring the health and wellbeing of farmers, workers, and consumers [95]. However, an unanswered question is whether these two sustainability promises can meet each other. In this work, we aimed to provide some preliminary insights into the topic by examining how consumers evaluate the impacts of digitalization on SFSCs and how their perceptions of these impacts affect acceptance of digitalized SFSCs and their willingness to buy through such distribution channels. In so doing, our study makes two contributions to the agricultural digitalization literature and SFSCs research. First, contrary to most research conducted so far, it examines the impacts of digitalization on a niche operating in parallel with the dominant production and marketing paradigms. Second, although most scholarly efforts in this area analyze the perceptions of farmers or experts, in the present work we shifted our attention to consumers, thus offering some more evidence on a recently developed sub-field of study [33,81–84].

Following a vivid stream of research inquiring into the effects of digitalization on agriculture [7,9,11,14], we divided impacts into four categories: economic, social, environ- mental, and cultural. Our analysis revealed that the environmental impacts of digitalization were assessed as slightly positive, while the mean scores for the remaining categories received a relatively negative evaluation. In addition, the results showed a moderate consumer agreement with the digitalization of SFSCs. These findings suggest that SFSCs' consumers are somewhat skeptical toward the potential impacts of digitalization on short supply

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schemes, despite the rhetoric of public policy actors and popular media surrounding the (positive) transformative potential of digital technologies [64,96].

Although our work did not examine the antecedents of this attitude, the differences between our findings and those of studies dealing with dominant food production meth- ods [81,82,84] can be ascribed to the ways in which consumers view SFSCs, the farming model these chains represent, and the popular imagery associated with the production pro- cess behind them. Food shoppers might create an idealized view of SFSCs, thus attributing to them properties that deviate from conventional mainstream food distribution channels. Indeed, research indicates that consumers believe that the products marketed through SFSCs are healthier, fresher, and have a higher quality and lower levels of chemical residues than those distributed through mainstream channels [27,97,98]. Although our aim here was not to confirm the validity of these perceptions, this (possibly romanticized) conception of SFSCs makes most technologies seem incompatible with the critical traits of short food supply schemes [33]. As Bazzani and Canavari [99] argue, SFSCs represent a shift from the "industrialized" to a "domestic" production and marketing scheme. In this sense, digitalizing might equal industrializing short supply chains, an unwelcome evolution for most consumers, as reflected in their limited willingness to buy from digitalized SFSCs.

Another interesting finding was that consumers' perceptions of the possible social impacts of digitalization influence both their acceptance of digitalized SFSCs and their willingness to buy from such chains. Even though the implications of digitalizing the agrifood sector on social sustainability have received only marginal attention in the relevant public debate [100], the social dimension of digitalization had significant associations with the response variables used in our regression models. Simply put, going digital is viewed as a source of potentially negative social impacts for short supply schemes. That perception reduces consumers' acceptance of digitalized SFSCs and their willingness to purchase food products from farmers who use digital technologies. To understand the roots of this relation, one needs to rethink the potent social dimension of SFSCs. Such supply chains are based on a different social structure than their longer, more commercialized equivalents, with strong and trust-laden social ties between producers and consumers [29,101], who are driven to participate in these schemes by motives such as altruism and willingness to support each other [102–104]. Consumers view digitalization as an evolution that threatens the social structure (and sustainability) of these chains, therefore altering SFSCs' essential and desirable social characteristics.

On the other hand, consumers' assessment of the potential environmental impacts of digitalization was found to be associated with the degree to which they accept the digitalization of short supply schemes.

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However, our analysis demonstrated that this is unrelated to their willingness to buy from digitalized SFSCs. This intriguing finding suggests that the difference between accepting digitalization and buying food produced through the exploitation of digital technologies can be vast. Acceptance, a broadly used construct in scholarly work, refers to the endorsement of using digital technologies in farming. The emphasis in scientific [105], policy [13], and public discourses [64,106] on the environmental benefits of agricultural digitalization is possibly what leads consumers to agree with the use of digital artifacts in farming activity.

Nevertheless, when it comes to decisions with more obvious cost/benefit implications (i.e., buying food produced through the use of digital technologies), consumers might attribute limited importance to the environmental impacts of digitalization. The links between acceptance of digitalization and willingness to buy from digitalized farms await further research. Parameters like consumers' ethical or safety concerns, environmental motives, or the symbolic qualities that they attribute to digital technologies potentially intervene in the relationship between acceptance of digitalization and intentions to buy food produced in digitalized farms. Untangling this issue represents a challenge that we leave open for future researchers.

Finally, an observation worthy of comment refers to the significance of the perception of digitalization and the importance that consumers ascribe to short supply schemes for shaping acceptance of digitalized SFSCs. Regarding the former, it seems that the low level of trust in digital technologies and concerns over their possible negative impacts are deci- sive in shaping consumers' stance toward digitalized SFSCs. Beyond personal subjective judgments about the value of digital technologies, the neutral-to-negative perception found in our sample could be due to the poor level of digitalization in Greece [107] and the problematic or even non responsible practices performed by some actors who participate in the digital agriculture ecosystem in the country [47]. However, more work is needed to trace the origins of Greek consumers' negative perceptions of digitalization. With regard to the perceived importance of SFSCs, its significant and negative association with the acceptance of SFSCs' digitalization reveals a solid personal commitment of customers to these food production and distribution channels, which is translated into an unwillingness to approve a different, more technology-driven form of SFSC.

A couple of potential limitations for this study deserve mention. First, this work offers insights into consumers' views of SFSCs operating in only one Greek region. Across coun- tries, SFSCs are characterized by different levels of maturity [108] and relations between participating actors [109], while consumers' views of these chains also vary [26]. In addition, the pace and width of digitalization are

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dissimilar between countries or regions, possibly affecting public perceptions of digital technologies. Hence, more research is needed to assess the generalizability of our results in different social and cultural contexts. Moreover, upcoming work could examine how different groups of consumers (e.g., rural versus urban residents, or people with special dietary habits) perceive digitalization with larger samples and/or exploiting different analytical methods (e.g., cluster analyses, quantile regressions). Second, beyond perceptions of the impacts that digitalization may have on SFSCs, there are several factors—external (like the degree to which social and policy actors promote or oppose digital technologies) or internal (such as consumers' ethical concerns or their beliefs about the personal benefits and risks associated with the consumption of food produced with the use of digital technologies at the farm level)—that may affect consumers' acceptance of and willingness to buy from digitalized SFSCs. Future research might examine which—if any—of these factors contribute to forming positive or negative consumer attitudes toward digitalized SFSCs.

Furthermore, we should note that digitalization may take different shapes, ranging from its softest (e.g., exploiting tools like digital platforms and simple monitoring tools) to its hardest forms (exploiting, for instance, hi-tech digital artifacts, farmbots, artificial intelligence-supported decision-making tools, etc.). Investigating how consumers perceive these soft and hard manifestations of digitalization can provide fruitful insights in the field. Finally, although our research focuses on short food supply systems, one can hardly claim that SFSCs' customers are different from those purchasing food products through other mainstream or "alternative" food distribution conduits, since consumers use several parallel channels to buy their food. How do consumers view the digitalization of conventional agrifood production and supply schemes? Are there any differences in how consumers consider the digitalization of conventional and alternative food networks? Do they endorse using digital technologies in other niches operating within agrifood systems, such as agroecology or nature farming? This study leaves these questions unanswered. Therefore, we invite future researchers to build upon our work and design studies to provide a more detailed picture of consumers' attitudes toward digitalizing the various co-existing agricultural models.

References

1. Raut, D.R.; Masane, G.V.; Naphade, R.A.; Verulkar, N.M. Smart farming: Present and future. Int. J. Electron. Commun. Soft Comput. Sci. Eng. **2017**, 25–30.

2. Walter, A.; Finger, R.; Huber, R.; Buchmann, N. Smart farming is key to developing sustainable agriculture. Proc. Natl. Acad. Sci. USA **2017**, 114, 6148–6150.

3. Tripicchio, P.; Satler, M.; Dabisias, G.; Ruffaldi, E.; Avizzano, C.A. Towards smart farming and

sustainable agriculture with drones. In Proceedings of the 2015 International Conference on Intelligent Environments, Prague, Czech Republic, 15–17 July 2015; IEEE: New York City, NY, USA, 2015; pp. 140–143.

4. Idoje, G.; Dagiuklas, T.; Iqbal, M. Survey for smart farming technologies: Challenges and issues. Comput. Electr. Eng. **2021**, 92, 107104.

5. van Es, H.; Woodard, J. Innovation in agriculture and food systems in the digital age. In The Global Innovation Index 2017: Innovation Feeding the World; Dutta, S., Lanvin, B., Wunsch-Vincent, S., Eds.; Cornell University: Ithaca, NY, USA; INSEAD: Fontainebleau, France; WIPO: Geneva, Switzerland, 2017; pp. 97–104.

6. Lieder, S.; Schröter-Schlaack, C. Smart farming technologies in arable farming: Towards a holistic assessment of opportunities and risks. Sustainability 2021, 13, 6783. [CrossRef]

7. Lioutas, E.D.; Charatsari, C.; De Rosa, M. Digitalization of agriculture: A way to solve the food problem or a trolley dilemma? Technol. Soc. 2021, 67, 101744. [CrossRef]

8. Soma, T.; Nuckchady, B. Communicating the benefits and risks of digital agriculture technologies: Perspectives on the future of digital agricultural education and training. Front. Commun. 2021, 6, 762201. [CrossRef]

9. Eastwood, C.; Ayre, M.; Nettle, R.; Rue, B.D. Making sense in the cloud: Farm advisory services in a smart farming future NJAS-Wagening. J. Life Sci. **2019**, 90, 100298. [CrossRef]

10. Van der Burg, S.; Bogaardt, M.J.; Wolfert, S. Ethics of smart farming: Current questions and directions for responsible innovation towards the future. NJAS-Wagening. J. Life Sci. **2019**, 90, 100289. [CrossRef]

11. Regan, Á. 'Smart farming'in Ireland: A risk perception study with key governance actors. NJAS-Wagening. J. Life Sci. **2019**, 90, 100292.

12. Da Silveira, F.; Lermen, F.H.; Amaral, F.G. An overview of agriculture 4.0 development: Systematic review of descriptions, technologies, barriers, advantages, and disadvantages. Comput. Electr. Agric. **2021**, 189, 106405. [CrossRef]

13. Lajoie-O'Malley, A.; Bronson, K.; van der Burg, S.; Klerkx, L. The future (s) of digital agriculture and sustainable food systems: An analysis of high-level policy documents. Ecosyst. Serv. **2020**, 45, 101183. [CrossRef]

14. Bronson, K. Looking through a responsible innovation lens at uneven en-gagements with digital farming. NJAS-Wagening. J. Life Sci. **2019**, 90, 100294.

15. Klerkx, L.; Rose, D. Dealing with the game-changing technologies of Ag-riculture 4.0: How do

we manage diversity and responsibility in food system transition pathways? Glob. Food Secur. **2020**, 24, 100347. [CrossRef]

16. Klerkx, L.; Jakku, E.; Labarthe, P. A review of social science on digital ag-riculture, smart farming and agriculture 4.0: New contributions and a future research agenda. NJAS-Wagening. J. Life Sci. **2019**, 90, 100315.

17. Augère-Granier, M.-L. Short Food Supply Chains and Local Food Systems in the EU; European Parliamentary Research Service (EPRS): Brussels, Belgium, 2016.

18. Parrag, V.; Fricz Szegedyné, Á.; Sebők, A. Application of digital solutions to improve the operation of short food supply chains.
Int. J. Food Stud. **2022**, 11, SI151–SI160. [CrossRef]

19. Todorovic, V.; Maslaric, M.; Bojic, S.; Jokic, M.; Mircetic, D.; Nikolicic, S. Solutions for More Sustainable Distribution in the Short Food Supply Chains. Sustainability **2018**, 10, 3481. [CrossRef]

20. Marsden, T.K.; Banks, J.; Bristow, G. Food supply chain approaches: Exploring their role in rural development. Sociol. Rural. **2000**,
40, 424–438. [CrossRef]

21. Renting, H.; Marsden, T.K.; Banks, J. Understanding alternative food Networks: Exploring the role of short food supply chains in rural development. Environ. Plan. A **2003**, 35, 393–411. [CrossRef]

22. Rucabado-Palomar, T.; Cuéllar-Padilla, M. Short food supply chains for local food: A difficult path. Renew. Agric. Food Syst. **2020**,
35, 182–191. [CrossRef]

23. US Government. Food Safety Modernization Act. 2011. Available online: https://www.govinfo.gov/content/pkg/PLAW-11 1publ353/pdf/PLAW-111publ353.pdf (accessed on 21 September 2024).

24. Chiffoleau, Y. Les circuits courts de commercialization en agriculture: Di-versité et enjeux pour le développement durable. In Les Circuits Courts Alimentaires: Bien Manger Dans les Territoires; Maréchal, G., Ed.; Educagri Editions: Paris, France, 2008; pp. 21–30.

25. Galli, F.; Brunori, G. Short food supply chains as drivers of sustainable development. In Evidence document. Document developed in the framework of the FP7 project FOODLINKS (GA No. 265287); Laboratorio di studi rurali Sismondi: Pisa, Italy, 2013; ISBN 978-88-90896-01-9.

26. Vittersø, G.; Torjusen, H.; Laitala, K.; Tocco, B.; Biasini, B.; Csillag, P.; de Labarre, M.D.; Lecoeur, J.-L.; Maj, A.; Majewski, E.; et al. Short food supply chains and their contributions to sustainability:

Participants' views and perceptions from 12 European cases. Sustainability **2019**, 11, 4800. [CrossRef]

27. Kneafsey, M.; Venn, L.; Schmutz, U.; Balázs, B.; Trenchard, L.; Eyden-Wood, T.; Bos, E.; Sutton, G.; Blackett, M. Short Food Supply Chains and Local Food Systems in the EU. A State of Play of their Socio-Economic Characteristics; Santini, F., y Paloma, S.G., Eds.; European Commission, Joint Research Centre Scientific and Policy Reports: Luxembourg, 2013.

28. European Commission. Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on Support for Rural Development by the European Agricultural Fund for Rural Development (EAFRD) and Repealing Council Regulation (EC), No 1698/2005. 2013. Available online: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013: 347:0487:0548:en:PDF (accessed on 22 September 2024).

29. Gori, F.; Castellini, A. Alternative food networks and short food supply chains: A systematic literature review based on a case study approach. Sustainability **2023**, 15, 8140. [CrossRef]

30. Freeman, R.; Phillipson, J.; Gorton, M.; Tocco, B. Social capital and short food supply chains: Evidence from fisheries local action groups. Sociol. Rural. **2024**, 64, 510–528. [CrossRef]

31. Charatsari, C.; Lioutas, E.D.; Michailidis, A.; Aidonis, D.; De Rosa, M.; Partalidou, M.; Achillas, C.; Nastis, S.; Camanzi, L. Facets of value emerging through the operation of short food supply chains. NJAS-Wagening. J. Life Sci. **2023**, 95, 2236961. [CrossRef]

32. Mundler, P.; Laughrea, S. The contributions of short food supply chains to territorial development: A study of three Quebec territories. J. Rural Stud. **2016**, 45, 218–229. [CrossRef]

34. Lioutas, E.D.; Charatsari, C. Smart farming and short food supply chains: Are they compatible? Land Use Policy 2020, 94, 104541. [CrossRef]

35. Pasqualotto, C.; de Menezes, D.C. Drivers and barriers for the adoption to the circular economy by organic food producers in short chains. Rev. De Gestão E Secr. 2023, 14, 20441–20479. [CrossRef]

36. Sebok, A.; Varsanyi, K.; Kujani, K.; Xhakollari, V.; Fricz, A.S.; Castellini, A.; Di Gioia, D.; Gaggia, F.; Cannavari, M. Value propositions for improving the competitiveness of short food supply chains built on technological and non-technological innovations. Int. J. Food Stud. 2022, 11, 161–181. [CrossRef]

37. Dupré, L.; Lamine, C.; Navarrete, M. Short food supply chains, long working days: Active work and the construction of professional satisfaction in French diversified organic market gardening. Sociol. Rural. 2017, 57, 396–414. [CrossRef]

ISBN Number: 978-93-95305-78-5

38. Matacena, R.; Corvo, P. Practices of food sovereignty in Italy and England: Short food supply chains and the promise of de-commodification. Sociol. Rural. 2020, 60, 414–437. [CrossRef]

39. Lami, O.; Mesías, F.J.; Horrillo, A. A qualitative study on the development of short supply channels in the Spanish agri-food sector: Producers' perspectives and expectations. J. Agric. Food Res. 2023, 14, 100894. [CrossRef]

40. Voitsekh, V.O. Retrospective analysis of the word "digitalization". Bus. Econ. Sustain. Leadersh. Innov. 2022, 9, 4–9.

41. Srai, J.S.; Lorentz, H. (2019). Developing design principles for the digitalization of purchasing and supply management. J. Purch. Supply Manag. 2019, 25, 78–98. [CrossRef]

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

THE ENDURANCE OF COGNITIVE BIASES IN FINANCIAL DECISION-MAKING ACROSS ECONOMIC GROUPS

Mr. Piyush Kumar,
Assistant Professor, Department of Management,
Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh
Ms. Himani Chaudhary,
Assistant Professor,
Banarsidas Chandiwala Institute of Professional Studies, New Delhi
Mr. Swatm Rajyahan,
MBA Student, Department of Management,
Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh

While economic inequality continues to rise within countries, efforts to address it have been largely ineffective, particularly those involving behavioral approaches. It is often implied but not tested that choice patterns among low-income individuals may be a factor impeding behavioral interventions aimed at improving upward economic mobility. To test this, we assessed rates of ten cognitive biases across nearly 5000 participants from 27 countries. Our analyses were primarily focused on 1458 individuals that were either low-income adults or individuals who grew up in disadvantaged households but had above-average fi well-being as adults, known as positive deviants.

Using discrete and complex models, we fix evidence of no differences within or between groups or countries. We therefore conclude that choices impeded by cognitive biases alone cannot explain why some individuals do not experience upward economic mobility. Policies must combine both behavioral and structural interventions to improve financial well-being across populations.

Economic inequality is a direct and global barrier to upward mobility and positive socioeconomic outcomes, perpetuating negative e ects for individual and population health, well-being, and sustainability[1]. In broad terms, economic mobility is a measurement of substantive change in nancial well-being status, such as going from middle-class to wealthy or poverty to low-income. In this paper, economic mobility is understood beyond simply income, but through comparative nancial security, such as wealth, debt, employment opportunity, and ability to withstand economic shocks.

Within countries, economic inequality continues to rise, made worse by the COVID-19 pandemic, disrupting decades of improvement in which inequality between countries had declined[2]. ere are myriad established links between economic inequality and decision-making, such as how individuals from disadvantaged communities are more prone to higher rates of impulsivity[3] and temporal discounting[4]. Individual factors

ISBN Number: 978-93-95305-78-5

such as existing wealth and education are known to in uence nancial decision-making[5]. However, while it is widely studied that such

nancial behaviors may be in uenced by cognitive biases (e.g., familiarity heuristics[6,7], optimism[8], proximity[8]), there is an absence of de nitive evidence whether individual decision-making ability is directly associated with upward economic mobility on a population level. ere is a general view that poverty leads to attentional focus on scarcity demands, which ampli es biases such as risk aversion[9]. However, others[10–12] argue that low-income individuals are not substantively di erent in decision-making[13], but instead face narrower margins[14] and greater impact from their immediate environment. ere is also evidence to suggest that even making generally good nancial decisions can have di erentiated outcomes for low-income individuals due to large transactional costs against relatively small investment gains[15]. Inequality is also associated with lower self-belief in achieving socio-economic success, diminishing the motivation to engage in behaviors associated with long-term socioeconomic growth[1].

Behavioral interventions have attempted to reduce inequalities by informing individuals of the decisions associated with better socioeconomic outcomes. For instance, the Swedish government's opt-out pension plan for workers facilitated better pension investment strategies[16]. Similarly, across several studies from di erent countries, Reñosa et al.[17] found that vaccination hesitancy was lower following simple behavioral nudges that made information more salient or were linked to incentives. In Kenya, unconditional cash transfers (UCTs) promoted better socioeconomic outcomes by enabling the coverage of immediate costs and the investment of any excess funds (e.g. in durable assets or business activities)[18].

Unfortunately, despite some positive e ects, behavioral approaches to reducing economic inequality have been largely ine ective at making substantive impacts. is may be due to measures focused on the modal person without considering marginalized groups. Consider three examples: rst, the U.S. Earned Income Tax Credit aims to help low- to moderate-income workers reduce their tax burden, yet is under-subscribed by those that stand to bene t the most. When state agencies and non-pro t organizations attempted established behavioral nudges to promote the utilization of and access to credits among the lowest-income families, e ects were null and even linked to distrust among targeted groups[19]. Similarly, a large UCT experimental trial in the U.S. was followed by worsened subjective nancial and psychological outcomes, rather than indicating positive bene ts amongst recipients[20]. A conditional cash transfer program in Indonesia failed

ISBN Number: 978-93-95305-78-5

to support the needs of the lowest-income bene ciaries due to inadequate distribution of funds[21]. e incongruent e ects between economic classes of such programs are a strong indication of need for new approaches.

"Positive deviance" is a framework which studies individuals from disadvantaged circumstances that experience notably better outcomes or routinely make more optimal choices than similarly disadvantaged peers[22]. Positive deviance approaches focus on understanding observed behaviors of individuals, thus lending practical policy suggestions[23]. As general interventions for improving nancial well-being may inadvertently back re among underprivileged groups[24], considering the patterns of positive deviants may aid in developing programs with more successful impact.

While positive deviance has been identi ed around the world[25–28] no substantive work across countries and economic contexts exists to determine its viability as a frame for research or policy design. To ensure reliability, replicability, and generalizability prior to proposing a new construct for explaining behavior, there is consider- able value in taking a multi-country, large-sample approach[29]. is both limits methodological biases based on sample or language[30] and presents more globalized contours of psychological and behavioral constructs[12].

Secondary analysis of data from 60 countries[12] shows that rates of positive deviance are highly varied (Fig. 1), indicating a number of potential environmental and/or individual factors may contribute to population-level mobility. While most work on such economic matters will understandably focus on incomes, employment, edu- cation, and other systemic factors, how individuals make decisions under scarcity will also help develop more e ective policies (in response to those failed attempts described). One low-cost way to test potential di erences in decision-making on a large scale is through cognitive biases known to in uence (and harm) decision-making, particularly nancial choices[31]. Assessing cognitive biases across multiple countries helps assess if patterns of preferences re ect speci c environments and if choice pat- terns are highly similar but barriers impede consistent outcomes. If biases emerge consistently and vary between

ISBN Number: 978-93-95305-78-5

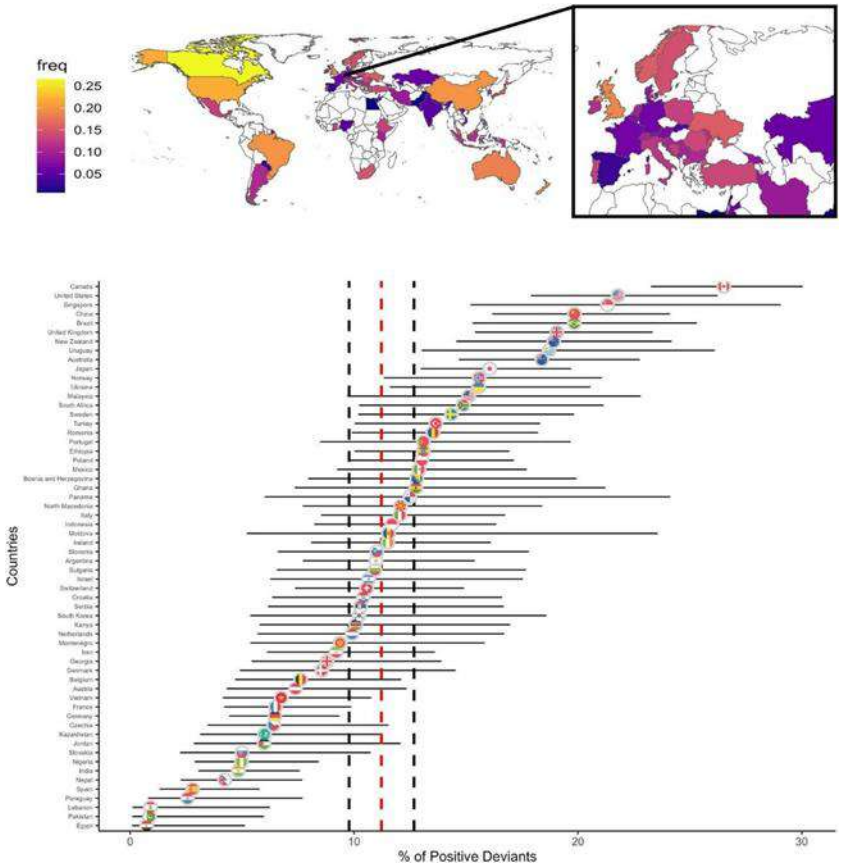

Figure 1. Frequency of positive deviance across country samples with a cross section on Europe, as taken from Ruggeri et al.[12]. Map generated with natural earth.

Positive deviants and those who remain low-income, upward economic movement may be heavily explained by choices. If no such patterns emerge, it strongly suggests that barriers and absence of resources or opportunities are the most critical indicators of outcomes rather than unique choice patterns. Focusing our assessment on a global sample provides a robust insight compared to presenting ndings from a single location and making assumptions about large applicability. With this approach, meaningful results may address economic inequali- ties in di erent settings.

e aim of this study was to test whether cognitive biases were observed at di erent rates between positive deviants and those who remain in disadvantaged circumstances as adults. Because of varying economic systems, we attempted to engage participants from around the world to produce a more robust rst attempt at this research approach, rather than only those in similar environments. is was important in terms of added value of this research because most biases used here have primarily been tested and validated in contexts considered to meet the WEIRD (Western, Educated, Industrialized, Rich, Democratic) classi cation.

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We expected to identify small to moderate di erences in cognitive biases between positive deviants and low-income adults, looking at both the full sample as well as analyzing within each country. We also anticipated heterogeneity in di erences in proportions of cognitive biases between countries. As this was the rst such approach on the topic, some aspects were highly exploratory and we planned to report general patterns even if in the opposite direction than anticipated (i.e., if there were certain biases more common among positive deviants). Ultimately, the primary research question was to understand if some individuals may overcome extremely disadvantaged nancial circumstances in part due to resistance against cognitive biases that may impede optimal decision-making. If so, it may explain why some behavioral interventions aimed at reducing inequality have been unsuccessful. However, if no substantive di erences exist, it would give strong evidence against the idea that individuals remain poor through choices alone. It would also indicate a more robust understanding of human behavior is necessary to develop e ective policies for meaningful impact across populations.

Results

To test our pre-registered hypotheses (osf.io/wj9yn), we ran binomial logistic regressions to predict di erences in the presence of individual cognitive biases between positive deviants and low-income individuals (we mostly ignore comparisons with high-income individuals for this research, though data are available for such use). Bayesian meta-analyses were used to assess overall presentation of cognitive biases to account for potential heterogeneity within countries. Pooled Bayesian meta-analysis checked for di erences among positive deviants across countries.

Across ten cognitive biases, rates observed ranged from 28.2% (temporal discounting) to 70% (ambiguity bias). On average, participants exhibited 3.23 (*SD* = 1) cognitive biases. As indicated in Fig. 2, individual biases were not highly correlated within individuals, which is why we treated them in discrete analysis rather than creating an index.

0.4
0.2
0
-0.2

Rates of cognitive biases between income groups.

Chi-squared tests showed no signi cant di er- ences between the rates of any of the eight cognitive biases demonstrated by low-income individuals or positive deviants, as indicated in Fig. 3A,B (see also Supplementary Material, Table S8). Next, we conducted binomial logistic regressions to predict the presence of cognitive bias based on income group and country of residence. Prediction coe cients were not signi cant in any of ten logistic regressions; positive deviants were equally likely to exhibit cognitive bias compared to low-income individuals (see Table 1). As a robustness check, we also ran complementary Bayesian logistic regressions, whose results are consistent with these. We conclude that

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this additional analysis provides further evidence that rates of cognitive biases do not seem to di er between positive deviants and low-income adults. A table reporting credible intervals from all Bayesian logistic regressions can be found in the Supplementary Materials (Table S6).

To examine the optimal choice patterns between low-income and positive deviants, we calculated the mean di erence between the overplacement score and number of presented biases. One-way ANOVA showed no signi cant di erence; ($F(2) = 0.281$, $P = 0.755$). We conducted additional ANOVAs for each country and found no signi cant di erences between the three groups.

Because there were no substantive di erences between groups, there are no additional insights to report on our second hypothesis anticipating positive deviants would show more optimal choice patterns (see Sup- plementary Material).

Rates of cognitive biases between countries.

Our third hypothesis expected di erences in biases between countries in a way that might highlight how speci c systems interacted with choice patterns. For exam-

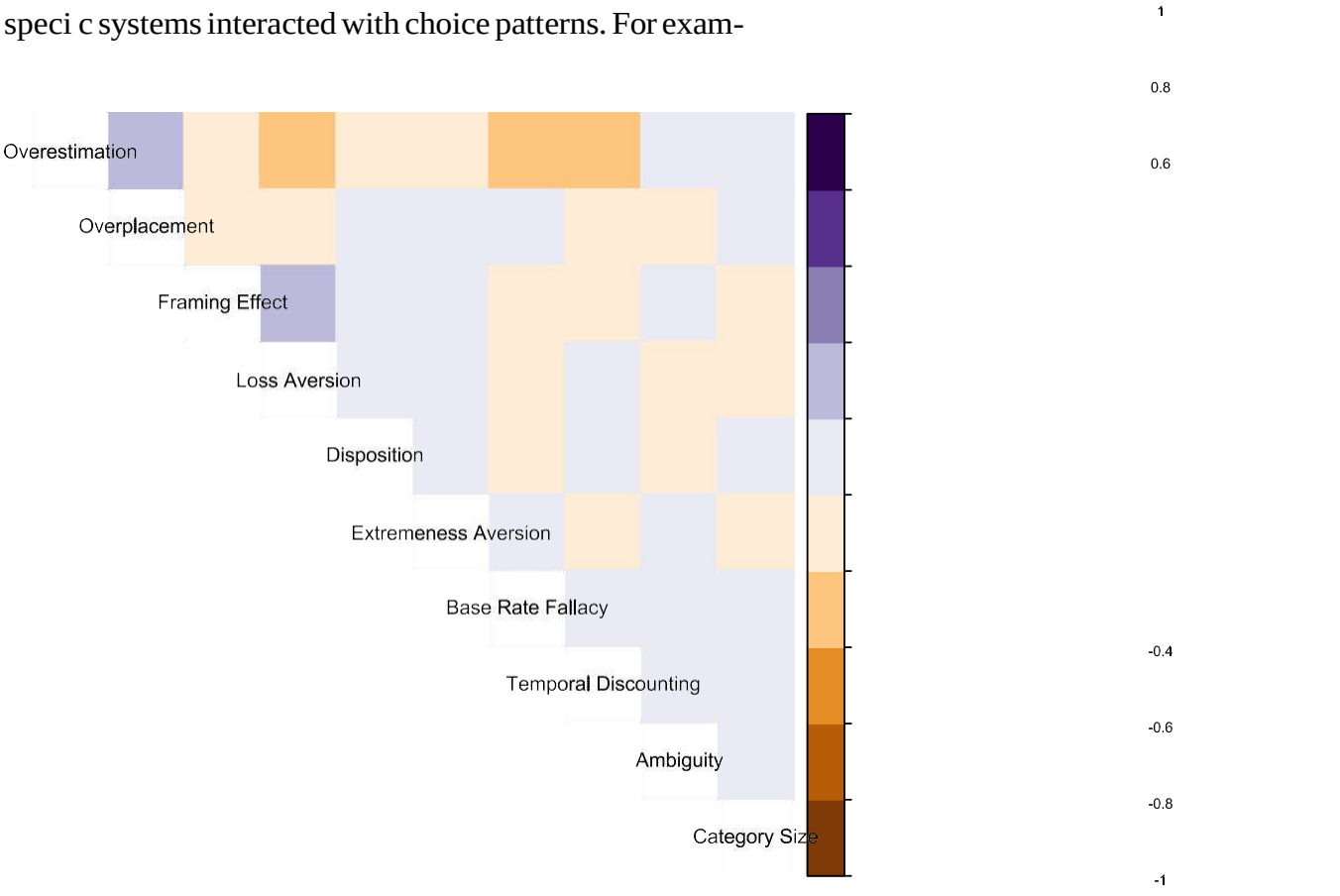

Figure 2. Correlation between ten biases within 3346 participants showed each bias was largely unique and not collinear with other biases assessed, with the exception of overplacement and overestimation (which rely on the presence of some biases).

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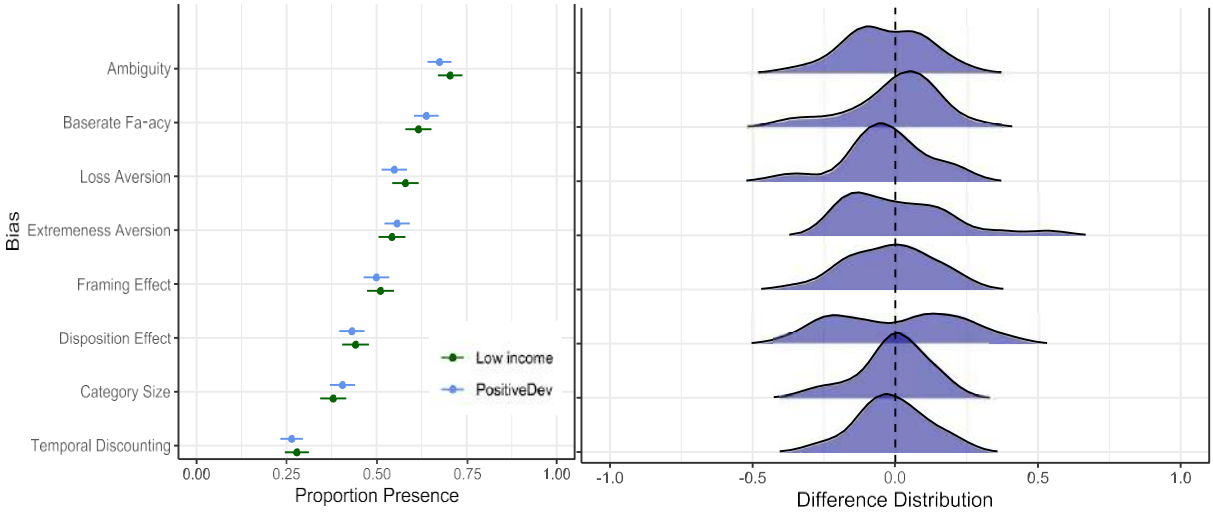

(a) **(b)**

Figure 3. (**A**) Presence of cognitive biases for low income and positive deviant participants for the pooled sample and (**B**) distribution of country mean di erences in observed biases between low income participants and positive deviants. Note that overplacement and overestimation are not included as they are measured in counts rather than proportion.

ple, recent work[12] indicated that temporal discounting is much higher in countries where in ation is extreme. In our case, we wanted to present limits and heterogeneity in di erences that would be explained by local contexts, but we did not anticipate systematically di erent results given that not all biases should be context-dependent (e.g., category size bias). Context-dependent patterns, such as how temporal discounting rates in our data were substantially higher in Turkey, will be reported in a separate paper.

First, we found that within countries, positive deviants did not signi cantly di er in the probability of showing cognitive bias from either low-income, or high-income groups (see Supplementary Materials, Table S5). Next, we built four models (two with all countries for eight biases; two with only the countries where all 10 biases were assessed—see *Selection of Countries* for why seven countries were not included for overplacement and overestimation) using Bayesian meta-analysis to assess di erences in probability of showing cognitive biases within countries, twice for the entire population (N = 3194) and twice with positive deviants only (N = 528). In all models, we found no signi cant di erences in the probability of showing biases between countries ($0.22 < \tau < 0.43; 3.98 < SMD < 4.95$; see Supplementary Materials, Table S4).

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Discussion

is study aimed to determine if rates of cognitive biases were di erent between positive deviants and low- income adults in a way that might explain some elements of what impedes or facilitates upward economic mobil- ity. We anticipated nding small-to-moderate e ects between groups indicating positive deviants were less prone to biases involving risk and uncertainty in nancial choices. However, across a sample of nearly 5000 participants from 27 countries, of which 1458 were low-income or positive deviants, we nd no evidence of any di erence in the rates of cognitive biases—minor or otherwise—and no systematic variability to indicate patterns vary globally. In sum, we nd clear evidence that resistance to cognitive biases is not a factor contributing to or impeding upward economic mobility in our sample. Taken along with related work showing that temporal choice anoma- lies are tied more to economic environment rather than individual nancial circumstances[12], our ndings are (unintentionally) a major validation of arguments (especially that of Bertrand, Mullainathan, and Sha r[11]) stating that poorer individuals are not uniquely prone to cognitive biases that alone explain protracted poverty. It also supports arguments that scarcity[14] is a greater driver of decisions, as individuals of di erent income groups are equally in uenced by biases and context-driven cues[13,32].

What makes these ndings particularly reliable is that multiple possible approaches to analyses had to be considered while working with the data, some of which were considered into extreme detail before selecting the optimal approach. As our measures were e ective at eliciting biases on a scale to be expected based on existing research, and as there were relatively low correlations between individual biases (e.g., observing loss aversion in one participant is not necessarily a strong predictor of also observing any other speci c bias), we conclude that there is no evidence from our sample to support that biases are directly associated with potentially harming optimal choices uniquely amongst low-income individuals.

Of course, though our sample was reasonably well powered, it is possible that our focus on two subsets of the overall population may have been too small to detect small e ects. First, some perspective on this may be use- ful: ensuring that 17% of our sample met the criteria for being positive deviants indicated that our recruitment strategy was e ective at nding a su cient number of participants for a small (by rule) group within a population. When using existing datasets, this can yield as low as 1%[22]. However, since we did not want to over-represent

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	N	Disposition	Ambiguity	Base rate	Category size	Extremeness	Temporal discount	Framing	Loss aversion	N	Overplacement	Overestimation
(Intercept)	132	− 0.466* [− 0.847, − 0.094]	0.719* [0.338, 1.112]	0.182 [− 0.187, 0.554]	− 0.592* [− 0.98, − 0.216]	0.085 [− 0.281, 0.452]	− 0.998*[− 1.431, − 0.589]	0.278 [− 0.089, 0.649]	0.595* [0.221, 0.98]	66	− 0.509 [− 1.037, 0.001]	− 0.068 [− 0.576, 0.438]
Positive deviance	NA	− 0.047 [− 0.265, 0.171]	− 0.152 [− 0.386, 0.081]	0.051 [− 0.176, 0.278]	0 [− 0.222, 0.221]	0.011 [− 0.206, 0.227]	− 0.169 [− 0.415, 0.077]	− 0.056 [− 0.271, 0.159]	− 0.112 [− 0.334, 0.109]	NA	0.139 [− 0.126, 0.405]	0.014 [− 0.25, 0.278]
Bosnia and Herzegovina	80	− 0.68* [− 1.321, − 0.067]	0.023 [− 0.561, 0.617]	0.962* [0.355, 1.6]	0.239 [− 0.335, 0.81]	− 1.188* [− 1.817, − 0.589]	0.452 [− 0.158, 1.06]	− 0.403 [− 0.966, 0.154]	0.019 [− 0.557, 0.602]	NA	NA	NA
Brazil	75	0.025 [− 0.564, 0.607]	0.82* [0.156, 1.531]	0.741* [0.14, 1.366]	0.351 [− 0.23, 0.932]	0.098 [− 0.471, 0.671]	0.719* [0.112, 1.33]	− 0.441 [− 1.016, 0.129]	0.087 [− 0.503, 0.688]	75	0.912* [0.239, 1.602]	− 0.455 [− 1.134, 0.216]
Canada	66	0.432 [− 0.166, 1.032]	− 0.073 [− 0.686, 0.551]	− 0.271 [− 0.867, 0.321]	0.592 [− 0.007, 1.196]	0.672* [0.06, 1.305]	− 0.315 [− 1.066, 0.391]	0.122 [− 0.475, 0.727]	− 0.715* [− 1.321, − 0.118]	NA	NA	NA
Chile	22	− 1.356* [− 2.84,	1.205 [0.064,	1.297* [0.248,	0.033 [−	− 0.272 [−	0.319 [−	− 0.809 [−	− 0.722 [−	NA	NA	NA

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		−0.217]	2.691]	2.579]	0.947, 0.954]	1.198, 0.635]	0.715, 1.273]	1.786, 0.106]	1.653, 0.189]			
Czech Republic	73	0.073 [−0.518, 0.658]	−0.108 [−0.702, 0.493]	1.322* [0.655, 2.046]	0.345 [−0.241, 0.93]	0.502 [−0.081, 1.099]	0.107 [−0.552, 0.751]	−0.609* [−1.195, −0.033]	0.507 [−0.114, 1.154]	73	0.021 [−0.661, 0.706]	−0.983* [−1.709, −0.28]
Denmark	51	0.529 [−0.124, 1.185]	−0.287 [−0.949, 0.384]	−0.01 [−0.66, 0.645]	0.071 [−0.611, 0.736]	−0.208 [−0.86, 0.44]	−0.462 [−1.333, 0.327]	−0.211 [−0.861, 0.44]	−0.102 [−0.762, 0.572]	51	0.244 [−0.498, 0.989]	−0.135 [−0.873, 0.598]
Germany	44	0.396 [−0.297, 1.087]	0.329 [−0.407, 1.114]	−0.022 [−0.708, 0.672]	0.225 [−0.485, 0.921]	0.47 [−0.224, 1.191]	−1.235* [−2.492, −0.232]	−1.123* [−1.885, −0.407]	−0.456 [−1.149, 0.238]	NA	NA	NA
Greece	51	0.607 [−0.045, 1.266]	0.648 [−0.084, 1.444]	1.475* [0.691, 2.369]	−0.283 [−1.004, 0.404]	−0.286 [−0.942, 0.361]	0.723* [0.035, 1.408]	−0.053 [−0.703, 0.602]	−3.741* [−5.579, −2.51]	51	1.135* [0.383, 1.917]	0.755 [0.007, 1.526]
Ireland	34	1.516* [0.708, 2.402]	−0.022 [−0.8, 0.792]	−0.692 [−1.485, 0.07]	−0.757 [−1.732, 0.101]	0.266 [−0.492, 1.046]	−0.22 [−0.651, 1.038]	−0.481 [−1.253, 0.275]	−0.886* [−1.673, −0.124]	34	−0.595 [−1.542, 0.29]	−0.06 [−0.771, 0.892]
		1.185*	0.264	0.386	0.093	−0.313	−0.3 [−	−0.561	−			

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Italy	45	[0.486, 1.919]	[− 0.457, 1.028]	[− 0.305, 1.103]	[− 0.62, 0.788]	[− 1.001, 0.365]	1.179, 0.499]	[− 1.256, 0.118]	0.849* [− 1.55, − 0.165]	NA	NA	NA
Japan	88	0.295 [− 0.26, 0.85]	− 0.124 [− 0.693, 0.45]	− 0.753* [− 1.32, − 0.198]	− 0.506 [− 1.124, 0.091]	0.004 [− 0.543, 0.552]	− 1.02* [− 1.838, − 0.277]	0.295 [− 0.262, 0.86]	0.355 [− 0.228, 0.953]	88	− 0.504 [− 1.196, 0.182]	0.34 [− 0.306, 0.991]
North Mac-edonia	41	− 0.063 [− 0.807, 0.655]	0.232 [− 0.514, 1.024]	0.927* [0.164, 1.762]	− 0.064 [− 0.823, 0.663]	0.256 [− 0.45, 0.978]	0.625 [− 0.128, 1.364]	− 0.4 [− 1.112, 0.304]	− 0.595 [− 1.309, 0.114]	41	0.301 [− 0.49, 1.094]	− 0.084 [− 0.871, 0.698]
Oman	46	0.228 [− 0.46, 0.908]	0.776 [− 0.001, 1.639]	1.072* [0.323, 1.897]	0.418 [− 0.268, 1.1]	− 0.003 [− 0.676, 0.673]	0.734* [0.02, 1.442]	− 0.248 [− 0.924, 0.426]	− 0.537 [− 1.219, 0.142]	46	− 0.391 [− 1.207, 0.4]	− 0.473 [− 1.254, 0.29]
Peru	32	− 0.148 [− 0.987, 0.647]	1.074* [0.127, 2.207]	1.249* [0.355, 2.29]	1.381* [0.576, 2.247]	− 0.092 [− 0.87, 0.686]	1.239* [0.442, 2.051]	− 0.619 [− 1.422, 0.159]	− 0.393 [− 1.175, 0.395]	32	0.665 [− 0.186, 1.536]	0.059 [− 0.79, 0.909]
Poland	33	0.312 [− 0.468, 1.083]	− 0.066 [− 0.85, 0.752]	− 0.031 [− 0.797, 0.746]	− 0.101 [− 0.937, 0.69]	0.469 [− 0.306, 1.281]	0.54 [− 0.293, 1.343]	− 0.549 [− 1.336, 0.217]	− 0.833* [− 1.625, − 0.063]	33	0.119 [− 0.74, 0.968]	− 0.245 [− 1.1, 0.594]
Portugal	95	0.3 [− 0.236, 0.838]	1.034* [0.395, 1.719]	0.615* [0.064, 1.179]	− 0.384 [− 0.968, 0.186]	0.587* [0.046, 1.14]	− 0.372 [− 1.036, 0.266]	− 0.313 [− 0.845, 0.217]	− 0.349 [− 0.888, 0.189]	95	0.629 [− 0.005, 1.276]	0.251 [− 0.378, 0.884]

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Romania	26	−0.146 [−1.065, 0.717]	0.357 [−0.544, 1.358]	0.103 [−0.743, 0.974]	1.062* [0.209, 1.959]	−0.09 [−0.939, 0.759]	0.772 [−0.119, 1.642]	0.386 [−0.473, 1.303]	0.097 [−0.767, 1.017]	26	0.44 [−0.478, 1.363]	−0.409 [−1.359, 0.507]
Serbia	33	−0.486 [−1.374, 0.329]	−0.687 [−1.467, 0.086]	1.099* [0.243, 2.072]	0.033 [−0.784, 0.815]	0.469 [−0.306, 1.281]	0.669 [−0.149, 1.466]	−0.937* [−1.769, −0.154]	−1.221* [−2.058, −0.434]	33	0.364 [−0.482, 1.213]	0.491 [−0.351, 1.357]
Slovenia	86	−0.125 [−0.697, 0.439]	−0.037 [−0.603, 0.536]	0.458 [−0.102, 1.029]	0.732* [0.181, 1.291]	0.532 [−0.023, 1.099]	0.109 [−0.519, 0.726]	0.336 [−0.22, 0.901]	0.213 [−0.357, 0.793]	86	−0.163 [−0.827, 0.502]	−1.135* [−1.845, −0.448]
South Korea	42	0.114 [−0.607, 0.82]	1.393* [0.471, 2.512]	0.267 [−0.437, 0.994]	1.395* [0.668, 2.167]	0.393 [−0.309, 1.12]	0.315 [−0.471, 1.068]	0.456 [−0.259, 1.206]	−0.029 [−0.739, 0.701]	42	−0.284 [−1.11, 0.52]	−0.529 [−1.34, 0.258]
Sweden	81	0.716* [0.157, 1.283]	−0.409 [−0.977, 0.158]	0.32 [−0.243, 0.893]	0.269 [−0.3, 0.836]	0.233 [−0.323, 0.795]	−0.563 [−1.305, 0.13]	−0.519 [−1.082, 0.036]	0.107 [−0.468, 0.692]	NA	NA	NA
Taiwan	39	0.019 [−0.732, 0.747]	0.421 [−0.357, 1.265]	0.051 [−0.667, 0.782]	−0.101 [−0.879, 0.642]	0.273 [−0.446, 1.011]	−1.092 [−2.353, −0.082]	−0.508 [−1.24, 0.209]	−1.011* [−1.765, −0.285]	39	−1.729* [−3.021, −0.674]	0.319 [−0.474, 1.125]
Continued												

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	N	Disposit	Ambig	Base	Categor y size	Extreme	Tempor al	Frami	Loss aversion	N	Overplace	Overestim
Turkey	36	0.947* [0.2,	0.629 [–	– 0.213 [–	0.593 [–	– 0.662 [–	1.673* [0.901,	– 1.065* [–	– 0.527 [–	NA	NA	NA
United Kingdo	107	0.51 [– 0.006,	– 0.317 [–	– 0.116 [–	– 0.494 [–	0.23 [– 0.283,	– 0.513 [–	0.308 [–	0.061 [–	107	0.037 [– 0.589,	– 0.577 [– 1.207,
Total	145	–	–	–	–	–	–	–	–	101	–	–

Table 1. Logistic regression coe cients for predicting biases by residence and income group. Regarding income group, participants in this analysis are either low-income or positive deviants. e 'Positive Deviance' variable in the table captures the behavior of positive deviants, with low-income as the baseline (high-income participants are not included in this analysis). Regarding residence, all country variables re ect participants' country of residence, with the USA as the baseline (for disposition to loss aversion; Canada is the baseline for Overplacement and Overestimation since the USA is excluded from those analyses along with Bosnia and Herzegovina, Chile, Germany, Italy, Sweden, and Turkey).

a group, but instead have a reasonable re ection of groups while also su cient samples for analyses, we were satis ed that overall we had over 750 participants meeting the criteria out of a total sample of nearly 5000. With that said, future work may wish to focus on expanding the sample of low income or positive deviant groups in case large samples yield small but signi cant e ects. Given the consistency of our null ndings, however, we do not speculate a likelihood for this. We do not argue that behavior has no link to individuals overcoming or remaining in negative nancial circumstances. On the contrary, it is very evident that biases do exist despite income levels, and that targeting those may be bene cial. However, we argue that further work is particularly necessary to understand why similar choice patterns do not lead to similar outcomes. If those patterns were validated and still produced di erential outcomes, it would likely be a result of substantial system barriers and scarcity of opportunities[11,33]. If validated, it would provide even stronger arguments toward investment in substantive structural changes to reducing inequality, rather than assuming that individual changes can alone overcome broader barriers[34]. is again does not mean there is no place for individually targeted behavioral interventions, but that they should be developed in combination with those that involve addressing systems and barriers[35].

Limitations.

is is one of the rst large-scale studies on positive deviance tested between countries and using cognitive biases as a frame. Our approach is therefore limited by not having been previously validated and used items that only super cially elicit biases but not necessarily re ect behaviors in real-world settings. Also,

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frames used may not have been truly re ecting biases but simply a random preference set based on the options given. is was evident in the intended items on mental accounting, which were removed a er the study began based on a later determination that the items did not measure the intended choice pattern as written. However, it may also be true of the category size bias measure, which showed essentially a 50-50 behavior and may not be especially useful. We are also limited in how we identi ed income groups, both due to the self-report nature and that partici- pants were typically higher income as adults. is may also be collinear with the number of positive deviants that identi ed as immigrants: if they were born in low-income communities but migrated to a high-income country, whether they should qualify as positive deviants may be up for further debate. Similarly, we only measure a nar- row set of biases, which are each tested discretely, rather than in combination (or controlling for) other factors such as personality, resilience, numeracy, personal beliefs (e.g., political or religious), or nancial literacy. Future work may nd that factoring in these aspects may elucidate di erent patterns.

Given our ndings, one advantage of this approach is that there does not appear to be a need for longitudinal study on if or when positive deviants shi decision-making styles. at approach is typically recommended in static studies, where it is unclear if choices would have been the same prior to achieving nancial wealth. Our ndings indicate this may not be mandatory. However, we have attempted to avoid speaking to absolutely gen- eralizability from our ndings. ough we have a large and diverse sample, as the rst study of this type and a sample that was intentionally not representative in order to engage many low-income participants, we strongly encourage further, multi-site studies to validate (or refute) our ndings.

Conclusion

We sought to determine if individuals that had overcome low-income childhoods showed signi cantly di erent rates of cognitive biases from individuals that remained low-income as adults. We comprehensively reject our initial hypotheses and conclude that outcomes are not tied—at least not exclusively or potentially even mean- ingfully—to resistance to cognitive biases. Our research does not reject the notion that individual behavior and decision-making may directly relate to upward economic mobility. Instead, we narrowly conclude that biased decision-making does not alone explain a signi cant proportion of population-level economic inequality.

us, any attempts to reduce economic inequality must involve both behavioral and structural aspects. Other-wise, similar decisions between disadvantaged individuals may not lead to similar outcomes. Where combined e ectively, it will be possible to assess if genuine impact has been made on the nancial well-being of individuals and populations.

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Methods

Ethical approval for this research was given by the Institutional Review Board at Columbia University. All methods were carried out following relevant guidelines and regulations. All country surveys were provided in at least one primary local language, as well as screened for cultural appropriateness, ow, and overall quality. Each participant provided informed consent to participate in the study. All materials and methods followed our pre-registered plan (osf.io/wj9yn), except for certain deviations, which are described later. Further details are provided in the Supplementary Materials.

Selection of countries.

ere was no systematic approach to country inclusion, but we explicitly empha- sized including some countries that are not typically represented in behavioral research. Countries were essen- tially chosen based on locations and languages where study volunteers were capable of recruiting substantive samples ethically (i.e., with reasonable oversight and appropriate methods). is means selection was not entirely at random, but there was no speci c guiding criterion in which countries were included apart from representation in the study team. No country was added based on any unique factors, such as wealth, economic systems, or idiosyncratic contexts.

Following data collection, 27 countries were fully included, using 22 languages. Two countries were attempted but were unable to ful ll certain tasks or were removed for ethical concerns. Several countries (Bosnia and Herzegovina, Chile, Germany, Italy Sweden, Turkey, and the United States) were part of preliminary work in developing the full study. Participants in those countries answered slightly more questions, some of which were removed for the full study. For this reason, those countries are not included in the overestimation and overplace- ment analyses, as participants in those countries saw slightly di erent versions of the items.

Translations.

All survey instruments utilized forward-and-back translations for all countries in their pri- mary language. At least one native speaker was involved throughout each process, requiring translation into local currencies (and cost standards) as well as applicable aspects such as race, education, and employment reporting standards. In some countries, varying demographic measures were modi ed for cultural and ethical appropriateness. Guidelines for race and ethnicity were observed in countries with speci c rules, such as where racial identity questions are regulated or prohibited. Additional details and full surveys for each country can be found under the pre-registration link (osf.io/wj9yn).

Instrument.

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To measure cognitive biases with implications for decision-making in nancial situations, we used 15 decision items that assessed 10 cognitive biases. ese items were selected following preliminary data from a parallel study that was pre-registered using the Open Science Framework (osf.io/hmk9s) prior to data collection. Following an exhaustive process in which a large number of biases were reviewed from multiple scienti c repositories, biases used in this study were ultimately selected on several criteria. Biases had to be directly relevant to nancial decision-making, su cient at eliciting cognitive biases in a large sample using simple discrete choice methods, and not require long or complex statements. e nal list of biases used was the ambiguity e ect[36], base rate fallacy[37], category size bias[38], extremeness aversion[39], disposition e ect[40], temporal discounting[12], overplacement bias[41], overestimation bias[42], framing e ect[43], and loss aversion[44]. e pre-regis- tered study mentioned earlier details additional biases that were piloted separately from this study, but removed for lack of su ciently meeting these criteria.

Biases and their associated items were also selected speci cally to meet certain practical criteria related to ease of understanding and avoiding complications related to translations. For example, we did not use vignettes or lengthy statements on scenarios to present choices. Instead, we used the most direct and singular approaches that were possible. While this was not always perfectly doable, some potential measures were excluded if they were deemed to be overly complicated or if the speci c aspects might have been unfamiliar to most participants. is was particularly true for items that would have presented complex nancial options only known to nancially active individuals. Finally, we did not select items that would implicitly or explicitly appear to relate to poverty on inequality. Instead, we chose items that would be relevant to any economic class, in a way that may elicit any di erences in choice patterns between groups if such di erences would explain di erential economic outcomes. Financial values were adapted to local currencies and income standards (see: osf.io/wj9yn for the informa- tion on nancial values and supplementary information on them) e survey also includes employment, bill management, income, debit and credit circumstances, and socioeconomic status as a child. We also collect age, gender, education level, parent education level, race, and ethnicity (where permitted and appropriate).

Procedure.

Participant recruitment utilized Qualtrics surveying so ware to collect data. Most participants were recruited using the Demić-Većkalov method[12], which included posting links on discussion threads and online news articles (social media, popular forums, and news websites). We also implemented the Jarke method of identifying popular communication media associated with speci c groups that were not

ISBN Number: 978-93-95305-78-5

represented (e.g., rugby forums on social media to recruit males from New Zealand). e survey was also circulated to local non-governmental and non-pro t organizations, and for-pro t corporations to generate informal "snowballing." Some participants were recruited by convenience sampling. Only residents of Japan were compensated (less than US$1 total). is approach helped to minimize sample bias across countries and generate diverse backgrounds among participants, with the main exception of mostly including populations with direct internet access and social media accounts. Because this study requires internet access and largely relies on visibility on popular (but not universally used) platforms, the team made concerted e orts to make direct contact with organizations, institutions, and government agencies to recruit participants through di erent media. Some of these methods included contacting Human Resource o cers at large employers in di erent countries and speci cally requesting circulation among individuals from lower-income backgrounds. We also communicated with a number of NGOs and non-pro ts to see if they would recruit community members as participants if they visited their sites in order to use computers or access the internet.

A er con rming eligibility and giving consent, participants were presented 15 binary choice scenarios. For example, to measure category size biases, participants were asked to choose if they would prefer a scenario with one winning ticket out of 10 or 10 winning tickets out of 100 (see Supplement Table S9). Decision-making items were shown in a randomized order, except for choices that required a speci c sequence (such as overestimation being required to appear last). Financial and demographic questions came at the end of the survey. e median duration to complete the longer version of the instrument was 14.41 min (from 13.67 min in the US to 18.07 min in Chile). e median duration to complete the shorter version of the instrument was 9.15 min (from 7.45 min in Canada to 16.55 min in Pakistan).

Participants.

dataset consisted of 4958 (46.2% women) responses from 27 countries, ranging from 62 responses in Peru to 380 responses in the U.S. Gender participation was hugely varied, with women mak- ing up as few as 21.3% of participants in France, to 82.2% in Bosnia and Herzegovina. e median age of the entire sample was 38 (median of 34 in two countries to 46 in two countries). Of all participants, 78.8% had completed higher education. Most participants (71.4%) were employed full-time. Across countries, 30.1% of participants came from below-average or poor households, ranging from 17.5% in Pakistan to 51.6% in Peru. We then excluded participants with entries that did not align with our pre-registration requirements and tracked these changes in our "Exclusion Table" (Supplementary Materials, Table S3) which displays

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total participants removed and percent rate of change in each country. Comprehensive details on data inclusion are provided in the Supplementary Materials (Table S7a,b).

Classification.

e classi cation employed in the paper—positive deviants, low-income participants, and above average participants—is based on survey questions eliciting (1) participants' nancial situation in the household they grew up in, (2) their current income, (3) national income data from participant country of residence, and (4) the sample spread of income data from participant country of residence. Positive deviants are de ned as adults who reported growing up in low-income households but who demonstrate a reasonable level of nancial wellness in adulthood. Speci cally, to de ne the cut-o point, we calculated the midpoint between the average national income in each country and the median income within our country samples. is was done so that the cut o did not rely solely on nationally reported averages from each country, as these come from di erent sources and may not account for recent economic changes such as high rates of in ation.

As a result, our midpoint line sits above the national average and below our sample median. Positive deviants are thus de ned as adults who reported growing up in low-income households and whose income falls above this line. Low-income individuals are also adults who reported growing up in low-income households but whose income falls below this line, which means that they started o in a low-income environment but were not able to achieve signi cantly higher incomes as adults. Everyone else was classi ed as above average and excluded from the analyses unless otherwise specied.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

THE SYNERGISTIC ROLE OF BLOCKCHAIN, ARTIFICIAL INTELLIGENCE, AND THE INDUSTRIAL INTERNET OF THINGS IN DIGITIZING SMALL AND MEDIUM-SIZED ENTERPRISES

Mr. Piyush Kumar,
Assistant Professor, Department of Management,
Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh
Ms. Himani Chaudhary,
Assistant Professor,
Banarsidas Chandiwala Institute of Professional Studies, New Delhi
Mr. Raushan Kumar,
MBA Student, Department of Management,
Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh

Due to digitalization, small and medium-sized enterprises (SMEs) have significantly enhanced their efficiency and productivity in the past few years. The process to automate SME transaction execution is getting highly multifaceted as the number of stakeholders of SMEs is connecting, accessing, exchanging, adding, and changing the transactional executions. The balanced lifecycle of SMEs requires partnership exchanges, management, manufacturing, and productivity stabilities, along with privacy and security. Interoperability platform issue is another critical challenging aspect while designing and managing a secure distributed Peer-to-Peer industrial development environment for SMEs. However, till now, it is hard to maintain operations of SMEs' integrity, transparency, reliability, provenance, availability, and trustworthiness between two different enterprises due to the current nature of centralized server-based infrastructure. This paper bridges these problems and proposes a novel and secure framework with a standardized process hierarchy/lifecycle for distributed SMEs using collaborative techniques of blockchain, the internet of things (IoT), and artificial intelligence (AI) with machine learning (ML). A blockchain with IoT-enabled permissionless network structure is designed called "B-SMEs" that provides solutions to cross-chain platforms. In this,

B-SMEs address the lightweight stakeholder authentication problems as well. For that purpose, three different chain codes are deployed. It handles participating SMEs' registration, day-to-day information management and exchange between nodes, and analysis of partnership exchange-related transaction details before being preserved on the blockchain immutable storage. Whereas AI-enabled ML-based artifi neural networks are utilized, the aim is to handle and optimize day-to-day numbers of SME transactions; so that the proposed B-SMEs consume fewer resources in terms of computational power, network bandwidth, and preservation-related issues during the complete process of SMEs service deliverance. The simulation results present highlight the benefits of B-SMEs, increases the rate of ledger management and optimization

ISBN Number: 978-93-95305-78-5

while exchanging information between different chains, which is up to 17.3%, and reduces the consumption of the system's computational resources down to 9.13%. Thus, only 14.11% and 7.9% of B-SME's transactions use network bandwidth and storage capabilities compared to the current mechanism of SMEs, respectively.

e climate of global business and enterprises has changed the nature of development and related connectivity of SMEs. It is also because of the competitive uctuates in the market and day-to-day challenges rising in the recent era, in which small and medium-sized businesses are performing only as receiving and adopting regulatory bodies. Manufacturing sectors contribute most of the ratio to economic development[1]. Whereas small and medium- sized enterprises, especially the production and manufacturing units, are on the developing agenda of various developed countries across the globe. While designing and creating units, one needs to consider the constraints

Department of Computer Science, Sindh Madressatul Islam University, Karachi 74000, Pakistan. 2Departmentof Computer Science and Information Technology, Benazir Bhutto Shaheed University Lyari, Karachi 75660, Pakistan. 3Software Collage, Shenyang Normal University, Shenyang, China. 4School of Software Technology, Dalian University of Technology, Dalian 116620, China. 5Research & Development Institute of Northwestern Polytechnical University in Shenzhen, Shenzhen 518057, China. *email: lipeng2015@mail.dlut.edu.cn of production and manufacturing development by size, scaling, and fund availability. In addition, owing to the amount, geographical reach, ability and capability of employees, and working intensity of entrepreneurs to drive their ideas to function. ese are the main building blocks of SMEs that help in economic development[2]. Accord- ing to the recent report on US economic cooperation and development (2021), all the connected stakeholders, including small companies countrywide and SMEs represent market uctuations, which is more than 90% of overall enterprises[3,4]. However, SMEs generate half of the employment in the country and provide a turn ratio of more than 47% of the total increment of the business gross domestic product[5]. In a customer-driven environ- ment, the production and manufacturing units are designed according to the procedures to respond back to mass customization using internet of things (IoT) technology, which provides a new pathway to value its customers. Digitalization is a new paradigm that provides an opportunity to maintain SMEs in a better manner as com- pared to the traditional ones and transform them to allow more exibility and agility. And so, SMEs' engines maintain the customer requirements by providing improved responsiveness accordingly. However, quality is a core component of customer-oriented infrastructure, being too upfront the transformation focus under

ISBN Number: 978-93-95305-78-5

the process of digitalization. e process hierarchy of creating SMEs is categorized as follows: (i) designing, (ii)planning, (iii) manufacturing, and (iv) performing functions or services.

While the quality of product, which is dispatched before to the customers of SMEs, is the fundamental objective to measure the favorable impact of production and manufacturing initially. Until there are no stand- ard quality processes proposed, and no proper hierarchy currently being followed by the developers to design manufacturing units of SMEs that have evolved with the time and are converted to production. And so, these changes in the process hierarchy with developers maintain mass customization. e quality measurement has increasingly facilitated decisions based on the data collected in the dynamic time, from the marketplace and customer side. It is important to prioritize the processes that support SMEs' production and manufacturing and mitigate product development-related risks to design, plan, manufacture, develop, and perform functions within the de ned resource constraints, such as less time and limited cost while ful lling the customer requirement[6]. It is well noted, thus, to analyze the impact of digital manufacturing on quality measurement and to ensure that events of node transactions are functionally connected and synchronized at the same time.

Whereas the Internet of ings (IoT) and wireless sensor networks (WSN)-enabled SMEs' manufacturing process to change the traditional working operation of data gathering, examination, analysis, preservation, and present industrial and production records among the connected units[7]. It is possible to react directly and e ciently to customer-generated records with the use of the recent version of smaller batch sizes. Industrial IoT intends to corporate e ectively with the processes of manufacturing SMEs, which is general to detect and recognize from the huge scale production. And so, because of industrial settings, where products are manufac- tured by indie with the help of a customer-speci c approach. Mass customization is a concept that has drastically evolved in industrial production, need to design a cost-e cient method, which means the cost is equivalent to the mass products. A manufacturing unit based on the industrial IoT provides a modular architecture for replacing traditional systems[8]. It mainly focuses on the centralized server-based decision-making processes, and speci c value-added evaluation is strictly limited in nature. However, SMEs and industrial IoT-enabled framework col- laborates replace with versatile, recon gure manufacturing and decentralized systems that provide e ectiveness, responsiveness, strategic management, and building capability for decision making, as shown in Fig. 1 (using Draw.io for image generation).

In addition, the advancement in digital technology, such as IoT technology with SMEs provides improve pro- ductivity and income, captures market shares, creates brand awareness, mass customization, real-time

ISBN Number: 978-93-95305-78-5

feedback that enhances organizational implementation and necessary changes, helps in decision making, and evaluates customers sentiments[9]. On the other side, these highlighted factors pose a signi cant limitation in the SMEs- related transformation and digitalization. For this reason, various enterprises are unwilling and unsatis ed with speed cost, time, and related resource constraints because it consumes high engineering and investment initially, and the output is not cost-e ective and satisfactory. However, to manage and optimize manufacturing and production-related data or transactions of SMEs in a ledger, various arti cial intelligence (AI)-enabled machine learning (ML) techniques (supervised, unsupervised, and semi-supervised) are proposed[9]. Substantially, to expand the scope and context of AI development by tuning the mentioned SMEs' operations and integrated market uctuations. Most importantly, the collaboration of AI with social computing performs a crucial role to develop a strong digital marketing strategies for SMEs by employing post and share mechanisms to spread awareness related to new manufacturing, production, and industrial development. Whereas performance and productivity depend to a certain degree. erefore, it counts as long-term bene ts. In the current scenario, the centralized server-based network infrastructure is used for SMEs transactions acquisition towards deliverance. It a ects directly SMEs' ledger integrity and privacy because of weak security, which means information is tracked and accessed easily, especially tracing customers' personal records through the Internet. Distributed ledger technology has been adopted widely in various small and medium-sized enter- prise environments to avoid tampering and forgery[10–13]. us, blockchain is recently enabling SMEs to secure their running systems and process hierarchy to realize integrity, transparency, traceability, provenance, trust- worthiness, and access ledger via distributed application (DApp). e existing SMEs are integrated with the collaborative approach of AI-blockchain, help to secure the process hierarchy, maintain customer-orientation strategy, encrypt exchanging information between customers and ecosystem, protected distributed node-to- node transactions, platform interoperability, and storage immutability. Furthermore, the individual event of node transaction is being stored before proper veri cation and validation using chain codes (smart contracts). A chain-like structure along with chronological order is designed that connects participating stakeholders in a public permissionless network to initiate SMEs' transactions and exchange. is helps to achieve privacy and security for SMEs, which is hard to tamper with or forge and preserve optimized records in a secure storage container with hash-encrypted form.

ISBN Number: 978-93-95305-78-5

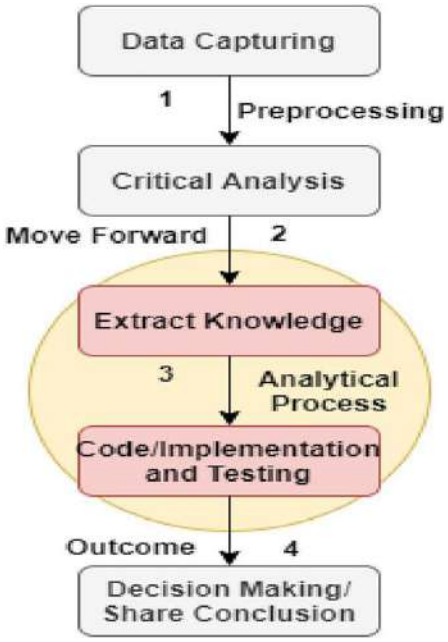

Figure 1. e current process of SMEs with IoT for data management and decision making.

The main research contributions and objectives of this paper are discussed as follows:

This paper addresses the current process between customers and SMEs, such as manufacturing, production, and industrial units interconnective, including data gathering, management, and optimization. It is also analyzed that the implementation of digital technology with AI creates a new paradigm. Probably analysis of the impacts of SMEs on the countries' economy highlights the benefits of adoption.

In this paper, we highlight comparative research results related to digitalization, SMEs, industrial IoT, AI, blockchain, and their transformation conducted in Asia over the past few years.

The outcome of the research in which a standard process hierarchy is derived, that led to managing customer relationships with SMEs at a secure, protected, and standard level. e proposed B-SMEs (a blockchain and AI-enabled distributed framework) provide a platform where the DApp is designed, created, and deployed for the sake of a transparent transactional environment. e main objectives are to handle SMEs-related automation, especially transaction verification and validation, exhaling, and sharing of resources among participants.

With the development of blockchain distributed public permissionless networks integrated with AI provide a lightweight authentication mechanism that reduces the cost of computational resources along with network bandwidth and storage.

There are three different chaincodes created and deployed for stakeholders' registration, SME transactions and exchange updates, and information management and optimization of immutable storage. However,

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individual transactions are protected with the use of the NuCypher threshold re-encrypted throughout the deliverance. And so, the proof-of-work (PoW) and proof-of-stack (PoS) pre-de ned ethereum consensus is adopted along with a digital signature to schedule, initiate, manage, and approve transactions and related information exchange among participating stakeholders.

At last, this paper highlights a few of the open challenges, limitations, and issues involved in the implementation and deployment of DApp BSMEs in real-time, which will consider as future developments for technological maturity.

The remainder of this research paper is structured as follows: In Section "Related work", there is various IoT, blockchain, and AI-enabled techniques involved in an industrial environment, and SMEs for better production and manufacturing are discussed. e primary knowledge of blockchain, IoT, and AI-enabling technologies is presented, along with the problem formulations and problem descriptions in Section "Fundamental knowledge and preliminaries". B-SME, blockchain, IoT, and AI-enabled distributed framework, is proposed for smart SMEs development and related processes in Section "Proposed framework". However, Section "Future direction" dis- cusses the open implementation issues, challenges, and limitations and highlights future research directions with possible solutions. Finally, we conclude this paper in Section "Conclusion".

Related work

In digitalization, the concept of digital transformation is considered an e cient and e ective business approach used to build improved enterprises' business practices compared to the traditional ones[14]. It reduces the impact of external limitations and introduces a great change in SMEs' operations by providing business strategies. While the adaptation of digital technology (DT), various challenging issues rises in both the sustainable economic development and social values of enterprises. However, the proper utilization of DT improves the regional economical-social conditions. To empower enterprises at every level, need to focus on the di erent phases of manufacturing growth, production, and sustainability. Due to this, there are various studies presented that inves- tigated the types of issues, challenges, and limitations, and proposed di erent methods, such as moderating the role of entrepreneurial orientation, dynamic capability IoT strategy, resource-based views, etc. In this manner, we separated close methods, models, mechanisms, strategies, approaches, and conceptual architectures that use AI, industrial IoT, and blockchain-based modular framework to enhance the capabilities of SMEs. A few related works that highlight the research gaps involving the current systems of SMEs, and further discussion related to open changes popped up as follows, as mentioned in Table 1.

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e integration of newly emerging technologies is ongoing, for example, AI, ML, federated learning, block-chain, hyperledger, IoT in industry, and green technology for SME assets that enables a modern collaborative approach[20–28]. e distributed ledger technology started gaining popularity as an evaluation of cryptocurrency, which is an automated distributed transaction platform that handles a number of requests without any centralized or third-party involvement.

Research papers	**Research development**	**Research bene ts and outcomes**	**Research challenges, limitations, and issues**
A role of moderating an entrepreneurial orientation to design a sustainable SMEs[14]	is study proposed practical and theoreti-cal implications related to managers and ledgers of SMEs. e o ered mechanism helps to transform their existing companies into digital enterprises. For this purpose, the study presented various theoretical implications, processes, and strategies that help in digital transformation	Volatile high velocity of business environ- ment Dynamic capability review Resource-based review Bene ts for startup SMEs as well	Cross sectional limitations External validity issues Hardly handle the generation to a large population Defect of context insensitivity e result of the proposed model in up to 68%
Automobile assembly model for design and implementation of SMEs using federated AI and blockchain	e paper presented a new design for SMEs called Trust reshold Limit (TTL) that helps moderate the existing use of embed- ded tools,	Smart contract is involved in the automa-tion of operational controls, events of nodes executions, and legalization of	Trust threshold limit Limitation in federated learning of AI Consume more computational power to evaluate transactions

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technology[15]	sensors, energy, and cost of func- tions in the production and manufacturing process	production and manufacturing Blockchain-based automobile assembly model	Customization and graphical UI
An empirical study of SMEs: Analysis of the relationship between digital transformation and performance[16]	e authors of this paper presented an empirical analysis of the current perfor- mance of SMEs undergoing digital transfor- mation and demonstrated a state-of-the-art review description	Interview method used e process of sustainable development is proposed Analysis digital transformation on nancial performance	Cross chaining platform limitation Automation and deliverance related chal- lenges Centralized data management and organiza- tion issues
A collaborative approach of knowledge, di usion, and blockchain technology in SMEs[17]	is research presented a novel process hierarchy by adopting knowledge manage- ment perception, drawing on the distrib- uted ledger technology, and highlighting the involvement of di usion in intelligent SMEs and related transactions	A questionnaire-based evaluation Perform a logistic regression to analysis the determinate of futuristic digital transforma- tion Use blockchain permissionless public network	Cost of data privacy and security Scope of data automation Interoperability platform issues Expensive data preservation on distributed storage
Fintech for SMEs sustainable business model and transformation[18]	is research highlighted the role of ntech in sector development under the in u- ence of the fourth industrial revolution.	Sustainable business model Improve circular economy practices A conceptual framework is proposed	Linking ntech application Privacy and security issues SMEs data management and optimization

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	In addition, this paper presented a novel framework using the ReSOLVE model for both the theoretical and practice advance- ment in SMEs	Use Fintech-enabled ReSOLVE model	limitations
e green blockchain for SMEs[19]	is paper proposed a secure distributed monitoring framework for the execution of core operations of SMEs using a blockchain public permissionless network	Eco-friendly systems Involvement of IoT technology Circular economy development Perform computationally intensive ML task	Regulatory and compliance issues Risk controlling procedure for data organi- zation Data integrity and transparency-related challenges while connecting di erent SMEs

Table 1. Blockchain, AI, IIoT-enabled SMEs related literatures.

In this manner, SMEs and IoT collectively utilized blockchain as a secure infrastruc- ture or a ledger that records events of node transactions and logs the changes in SMEs' expert status. However, there are various other bene ts of using collaboratively blockchain, IoT, and AI, for the sake of improving the e ciency and capability of SMEs, cost-e cient transactions deliverance, and a secure information exchange environment. Therefore, we systematically reviewed various related studies that highlight the role of technology and its involvement in building a secure and protected SME environment (as discussed in Table 2). e list of comparison is mentioned as follows:

Using artificial intelligence technique.

- Machine learning.
- Internet of things.
- Industrial and manufacturing process hierarchy.
- Process development.
- Customer oriented strategy.

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- De ne relationship between customer and SMEs.
- Information management and organization.
- Blockchain involvement.
- Addresses privacy and security.

Fundamental knowledge and preliminaries In this section, we discuss some fundamentals and preliminaries of the problem and formulate the possible solutions, which are as follows.

Notation, problem formulation, and description. is paper discusses three di erent and major problems that have become the hot domain of SMEs nowadays, such as SMEs' data generation and process hierarchy, data management, and resource consumption, and privacy-protection preservation. ese problems are tackled individually with various e cient solutions previously but integrating all these solutions into one environment is one of the challenging issues. Although, there is no standard mechanism available that integrates these technologies into a single platform with e ectiveness and a reliable manner.

As we discussed, till now, there is no standard process hierarchy/lifecycle of SMEs proposed. In this regard, the proposed work identi ed this problem and addressed. And so, we proposed a B-SMEs standardized process hierarchy/lifecycle, as shown in Fig. 2. is lifecycle follows the standard procedure (according to the law of US economic cooperation and development) for IoT infrastructures to data gathering and management. Wire- less sensor networks (WSN) associates with the IoT devices for the purpose to transmit data from one node to

AI-enabled data resource management, as shown in Fig. 2. e process hierarchy of IoT-enabled devices for industrial, manufacturing, and production of SMEs are discussed as follows:

Data capturing (capture-as-the-data-occur).

Data examination.

Data extraction.

Data analysis.

Design procedure to schedule process (priority bases).

Implement a pathway for data traveling with the use of WSN.

For data management and optimization, we evaluate a classi cation mechanism that examines redundancy in data/transactions of SMEs and extracts the original ones while discarding duplication during the pre-veri cation process. is procedure helps computational resource management to reduce the computing cost and submit veri ed data in the ledger for further processes. For using this ML technique, especially

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arti cial neural network (ANN) in the proposed B-SMEs to manage day-to-day transactions. In analyzing the ledger, ANN considers a breakthrough as it solves the data management, organization, and optimization. Before implementing, we identi ed a number of emerging loopholes involve in the distributed data management environment, such as data/transactions detection issues, and unstable recognition of les in the di erent nodes. us, to analyze these issues, we construct a data identi cation mechanism using machine learning and associate this with ANN, which

Categories	Research years and references									Our
	2013[2]	2014[2]	2015[2]	2016[2]	2017[2]	2018[2]	2019[2]	2020[2]	2021[2]	2022
Artificial intelligence	✓	✓	✓	✓		✓			✓	✓
Machine learning	✓	✓	✓	✓		✓			✓	✓
Internet of things					✓		✓	✓	✓	✓
Industrial and manufacturing						✓	✓		✓	✓
Process development	✓	✓		✓			✓	✓		✓
Customer oriented strategy	✓		✓	✓	✓	✓			✓	✓
De ne relationship between		✓				✓	✓	✓		✓
Information management and	✓						✓	✓	✓	✓
Blockchain involvement						✓	✓	✓	✓	✓
Privacy and security		✓		✓		✓			✓	✓

Table 2. Systematic review of the technologies.

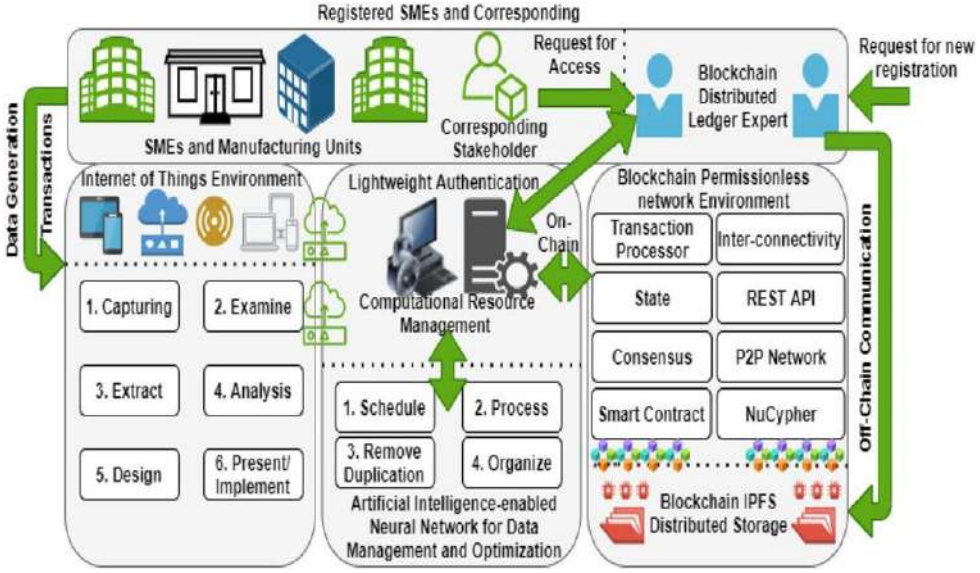

Figure 2. The proposed B-SMEs.

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Sciently extracts pattern, detect, recognize, and classify data les/transactions of SMEs. A self-correlation connects with the ANN to schedule logs for processing, along with that, it minimizes the risk of data capturing/loss by providing large-dimensional space for classi cation. notation of ANN with respect to the process of classi cation is discussed as follows:

- Weight (w').
- Bias (b').
- Input neurons (n').
- Counter (c').
- Single layer inputs (s').
- Reshold (t').
- Output neurons (o').
- Activation function (σ).

For data veri cation process, weight is de ned that objective is to create connection between the participating neurons in the ANN architectural design. Whereas single neuron holds a certain number of events od nodes data/transactions (values of data occurring). However, individual neuron of designed ANN assigns a unique values/label, then the input values are n_1', n_2', n_3', and n_S', with the assign weight w_1', w_2', w_3', and w_S', respectively.

sum of inputs and weights, demonstrating the level of excitation, is as follows:

If the range of the threshold uctuates in an increasing manner of the proposed SMEs, then the output neuron (o') = to the total (excitation uctuation), which is de ned in the expression discussed below:

However, the σ (sigma) is performed as the nonlinear function, where the t' value = '0', in which t' down towards the minus side consider a negative sign. us, that is the reason, we customize parameters of t' by providing b' and w' values, such as w'0 = negative t'.

Therefore, a bias values b'0 = t' is added to maintain ANN large-dimensional for data classi cation, such as if n' value of n' = 1 with formal inputs.the output (o') equation is expressed as follows

Proposed framework

Figure 2 presents the working hierarchy of the proposed B-SMEs. An integrated blockchain and AI-enabled framework that is divided into three di erent folds. e rst is the IoT process hierarchy, which is designed to collect, separate, examine, and analyze generated data or transactions of SMEs. A er proper examination, we design a schedule to transmit data via wireless sensor networks and implement a managerial hierarchy that manages day-to-day transactions. Second, the AI compartment is split into

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two, such as computational resource management and AI-enabled neural network algorithm. A lightweight authentication is created in the middle, which aims to provide an automated capability to grant access to each applicational request a er veri cation through the DApp. A new SME or corresponding registration is handled by the Blockchain Distributed Ledger Expert (BDLE). e BDLE is responsible for initiating new registration validation a er a complete analysis of receiving requests and allows stakeholders to initiate transactions in the chain and exchange details. It is only a one-time process otherwise a er registration it only needs to provide registration credentials to access the ledger. However, an Arti cial Intelligence-enabled machine learning algorithm (such as an arti cial neural network) is used that manages and optimizes data. is procedure discards duplication of data/transactions and organizes logs in a sequential order, which reduces the consumption of computational resources and preservation load at the same time. the blockchain permissionless public network (a peer-to-peer network with node interconnectivity) is deployed along with two di erent chain-of-communication, such as o -chain and on-chain. ese two designed communication channels tackle a number of transactions that occur in the chain, for example, applicational requests, node-to-node activities, operational control, external communication, and information exchange. For instance, the on-chain receives internal transactional requests, which are implicitly handled. On the other side, o -chain communication tackles all explicit activities (outside of chain/cross-chain platform). However, the main objective of a blockchain transaction processor is to schedule a list of transactions, which is provided by outsourcing computation and execution, as shown in Fig. 2 (using Draw.io for image generation). For transaction protection and automation, we collaborate the concept of NuCypher threshold re-encryption with smart con- tracts and consensus policies, as discussed in Table 3. is is a new paradigm proposed in a public cryptographic encryption environment, which provides no cipher conversion. By the act of this, it reduces the load of computa- tion by calculating hashes of individual transactions that occur in the B-SMEs. Whereas an InterPlanetary le storage system (IPFS) is used to store logs of individual transactions that occur in the B-SMEs chain. e purpose is to use this distributed immutable storage because provides ledger preservation facilities with minimal cost compared to other distributed storage, such as Filecoin. e major reason to use it is because it allows scalability and cost-e cient hierarchy (calculates usage of preservation) in a distributed manner.

Chain codes (smart contracts). is paper presents three di erent chain codes and discusses their purposes to design, create, and deploy in this section. e list of contracts and consensus policies are as follows:

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(i) SMEsR(), (ii) corresponding(), (iii) addNInfo(), (iv) updateInfo(), (v) logsPre(), (vi) PoW(), and (vii) PoS().

The working operation of proposed B-SMEs is categorized into two di erent folds, such as chain codes and consensus policies with digital signature, as shown in Table 3. First, the aim of these designed contracts is to automate the veri cation and validation of new startups or SMEs registration along with the corresponding stakeholder. e SMEsR() and corresponding() contracts are initiated between the participating stakeholders and the system (B-SMEs DApp). ese contracts are responsible to register new SMEs as per the policies created in B-SMES consensus (proof-of-work and proof-of-stack), as mentioned in Table 3. e function addNInfo() is created to record every transaction of all the participating SMEs and exchange. Whereas each transaction is recorded in the blockchain IPFS immutable storage and distributed on di erent nodes with protection using NuCypher threshold re-encryption. It also maintains B-SMEs ledger and optimizes while removing redundant logs with the help of ML-based neural network algorithm. However, the ledger updates a er receiving update request from any of the corresponding SME for the purpose to revised transactions; it only possible when 51% votes received from the connected SMEs in accordance with the deployed protocol of digital signature of B-SMEs. A er this, updateInfo() revised the logs and exchanged updated details among the participating stakeholders. While logsPre() is responsible for storing each and every activity that occur in the chain of B-SMEs.

Results and discussion. A er the problem description of data management and optimization using ANN (as discussed in Section "Notation, problem formulation, and description"). In this section, we present the work- ing operation along with the simulation results of B-SMEs ledger data management, optimization, computa- tional processing with lightweight authentication, and privacy preservation. For lightweight B-SMEs authentica- tion, we connect a blockchain permissionless P2P public network with additional computing nodes to power the data processing, as shown in Fig. 3 (using Draw.io for image generation). Individual node is equipped with the eight-core i9 Evo processors (3.0 GHz with turbo boost). e systems run on Windows 11 with the blockchain docker and on their backend, the generic kernel is performed. ese nodes are implemented with two di erent types of memories, such as static (limited in nature) and dynamic to preserve data/transactions during overall execution. However, the B-SMEs practically simulate on the simulated data with a few assumptions that are discussed as follows:

A xed size of node transactions = 4 MB.

Local area network is designed with limited bandwidth of up to 1 Mb/s.

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Heterogenetic nodes interconnectivity is designed for intercommunication with two channels.

Input Constraints: Blockchain Distributed Ledger Expert is the responsible for SMEs ledger management and organization

Expert is able to maintain transactions scheduling and exchange details Expert is able to handle applicational request of participating stakeholders Expert is able to manage distributed storage and updates**Variables:** Main():X.file[x.txt]: SMEs registration,(SMEsR());register stakeholder for individual SME, (corresponding());communicationchannels, (comCh());add new information/records, (addNInfo());information exchange, (infoEx());update information, (updateInfo());logs preservation, (logsPre());

Blockchain timestamp [blockchain-ledger execution]; **Process: if** SMEs is != SMEsR() add new registration of SMEs and corresponding; each request verifies and validates; update SMEsR() and corresponding();individual SMEs transactions are records in addNInfo(); and, updateInfo; counter (cont()) + 1 = true;any update in the previous records by the updateInfo() and exchange; Blockchain Distributed Ledger Expert handle and manage all contracts and records in

For stakeholders' lightweight authentication, we deployed smart contracts of BDLE to monitor the CPU usage and limit the systems' computational energy, as shown in Figs. 2 and 3. e 3D simulation results (Fig. 4(1),(2)) of lightweight authentication show that current PoW and PoS consume more resources compared to the B-SMEs.

e contrast between both the Figures illustrated the proposed B-SMEs customized consensus reduces the workload down to 9.13% and achieves remarkable cost reduction. However, with the adaptation of the B-SMEs consensus in real-time, we alleviate the usage of resource constraints in the complete process of user authentication and provide robust performance.

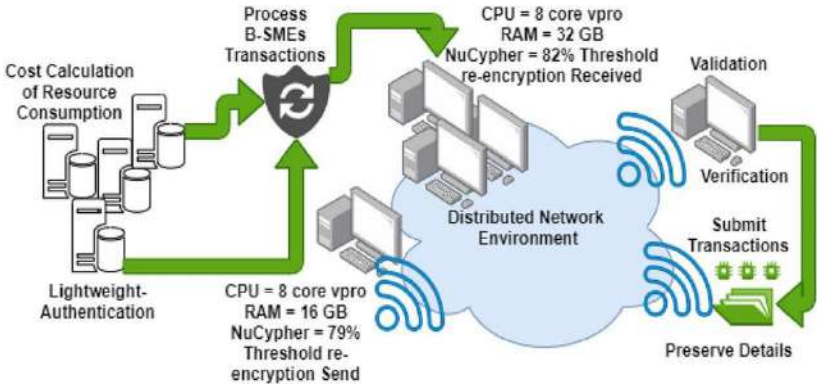

Figure 3. e simulation results of the proposed B-SMEs consensus for lightweight authentication, (**1**) shows the uctuation of previous prede ned consensus (PoW), and (**2**) shows the di erence of adoptation of B-SMEs consensus (PoW and PoS).

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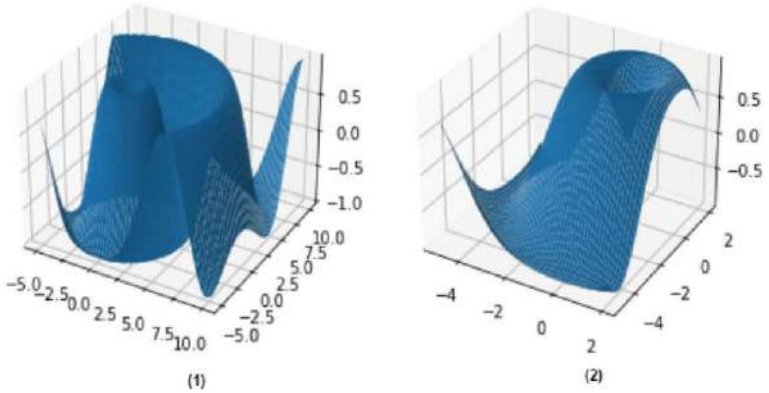

Figure 4. Lightweight authentication simulation assumptions.

The analytical evaluation of IoT-enabled data/transactions collection and processing of SMEs is presented in Fig. 5. e result of this simulation is divided in to four folds; Fig. 5(1) and (2) illustrated the frequency of data generated by IoT devices, whose metrics is the number of data capture or transmitted using WSN and loss values (function). Whereas Fig. 5(3) and (4) presented the di erence between the data transmitted and analysis, which is directly proportional to each other. is simulation helps in the ledger management and optimization while connected with the ANN. In fact, the integration of IoT with ANN reduces the delay and throughput and increase the response of data/transaction transmission. However, the proposed B-SME increases the rate of ledger management and optimization while exchanging information between di erent chains up to 17.3%.

Figure 6 shows the uctuations occurs in the cost of resource consumption while transactions of SMEs are acquired to deliverance. e practical result of the proposed B-SMEs illustrated that the only 14.11% and 7.9% of B-SME's transactions use network bandwidth and storage capabilities compared to the current mechanism of SMEs[30–33], respectively.

In this context of comparison with other state-of-the-art, the paper presents a comparative table of a few related well-known studies that use AI, IoT, and blockchain-enabling technologies to improve the developments of small and medium-size enterprises' environment [29]. However, the comparison results (in Table 4) show that the B-SMEs performed better and more e ciently. As the evaluation details are discussed in Table 4 as follows:

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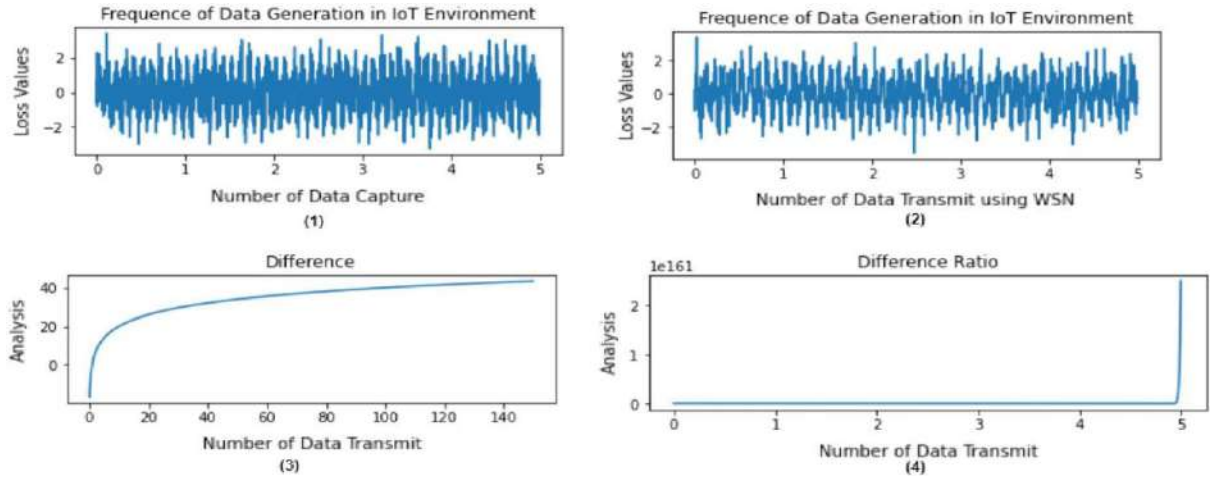

Figure 5. Frequency of data generation in IoT environment, (**1**) shows the number of data capturing, (**2**) shows the number of data transmitting, (**3**) shows the di erence between the number of data transmission and analysis (**1**), and (**4**) shows the di erence between the number of data transmission and analysis (**2**).

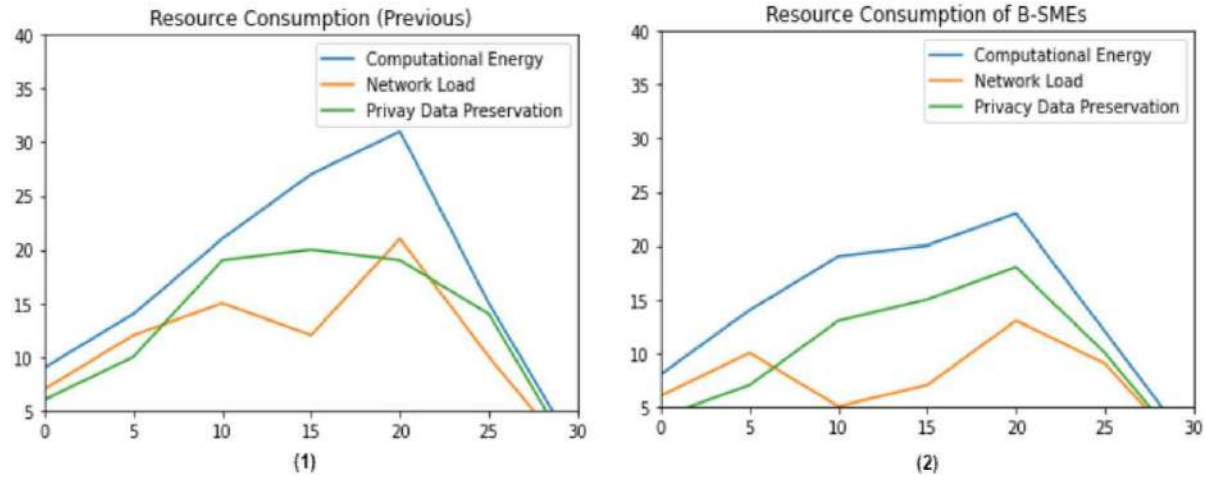

Figure 6. Cost of resource consumption (1) shows the graph of pervious work, and (2) shows the graph of the proposed B-SMEs.

Future direction

In this context, the open research areas are presented in four di erent subsections; two are related to the digitali- zation and scope of SMEs in the future. And so, others are based on the customer relationship between SMEs- enabled privacy, security, and automation concerns using industrial IoT, AI, and blockchain.

Blockchains and digitalization and scope of SMEs in the next decade. Nowadays, various nan- cial institutions invest their assets in the development of blockchain infrastructure to create their all opera-

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tions digitally and ensure security and robust e ciency. It is due to the increase acceleration in the develop- ment of information communication technology and digitalization that make SMEs and related activities more reliable[35,36]. For this infrastructure management, the designed system facilitates the process hierarchy of SMEs to manage reporting to top enterprises and regulatory authorities and provides convenience to combat money laundering. e distributed ledger technology confronts participating stakeholders at a chain-like structure, where individual transactions and information exchange can be seen (get through noti cation) and deliver every operation securely and smoothly along with logs preservation (immutable storage). However, the most suitable use of this collaborative technology with KYC compliance for robust industrial, manufacturing, and production of SMEs. Although, the usage of these integrated technologies will stimulate ideas about the current and the futuristic development of SMEs.

Scalability of data privacy and security. It is highlighted that scalability of data management and the cost of privacy and security consider one of the critical challenges when designing and developing blockchain-

Other state-of-the-art	Contribution	Advantages and weakness	Our proposed system
Internationalization in India: A role of blockchain technology in small-medium enterprises[30]	is study proposed an advancement and integration model of business-to-consumer driven SMEs and robust them possess that perform more accurate operational deliver- ance. Substantially, it provides a holistic view compared to other states of the art	Survey on forty-three SMEs and collected records Regional speci c eoretical contribution Lack of data integrity, privacy, and security	In this attribute, we highlight the contribu- tion, advancement, and bene ts of the proposed B-SMEs. e list of improvement is discussed as follow: Integrated technologies: AI, blockchain, and IoT Chain: Chronological order (on-chain and o - chain) Infrastructure: Blockchain public
Small business emergence and adaptation for development of market	is paper presented an identi cation process for selecting ntech and analytical algorithms. And so, designed SMEs which provide more reliability in	Emerging markets and developing econo- mies Big data involvement Data management, optimization, and preservation limitations	

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growth[31]	terms of operations, control, strategic decision, and deliverance		network infrastructure Network: Distributed permissionless network
Quality evaluation and potential impact in the development of SMEs[32]	e study focused on the development of SMEs authority, where all the startups and small businesses get the bene ts of equality, such as industrial, manufacturing, produc- tion, and investment related	Small and medium development authority Compliance related issues in Pakistan Streamline automation of data handling issues	Node Size: Fixed size 4-MB Encryption: NuCypher Re-encryption Consensus: Custom-build PoW and PoS Real-time usage: available to adoption for industrial use
A state-of-the-art method: the research on Industry 4.0 disruption in various industrial and manufacturing sections[33]	is research discussed the convergence of twelve disruptive technologies, such as AI, blockchain, IoT, cloud computing, big data, robotics, augmented reality, etc. And so this highlighted the need for extensive research in SMEs to increase the application of the disruptive	Level of discombobulation Cross chain platform limitations Retro tting issues Increase cost of privacy and security	Reduce resource consumption: Down to 9.13% E ciency: Increases up to 14.11% com- pared to others Accuracy: increases up to 7.9%

Table 4. Comparison with other state-of-the-art methods.

enabled DApp[36]. In the domain of SMEs, the blockchain-based modular architecture collaborate with AI tech- nology archives ledger integrity, system provenance, and transaction traceability by continuously stimulating distributed IPFS when every executing SMEs transactions and incorporating transmission details from the participating SMEs along with corresponding stakeholders. In this manner, the corresponding individual SME can check the details of nancial growth, new participant, business logs, and related information with a click regardless of who direct the operations. ere is no central authority or

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middleman available between the SMEs and regulatory body that manually veri es and validates a number of transactions. As developing this, the risk of tampering and forgery in the information exchange between participating stakeholders is reduced or almost restricted compared to the traditional ones. us, along with this, the blockchain permissionless public network avoids the concerns of participants while exchanging their operational logs with the regulatory and compliance authorities because of peer-to-peer connectivity.

Distributed SMEs transaction and. In the B-SMEs environment, all the data manage and optimize in a distributed manner in the decentralized consortium, especially in public ledger using blockchain. With this development, the SMEs exchange critical information in a secure chain like structure via chronological order, for example, registration credentials, sale and purchase details, growth of nancial assets, market uc- tuations, startups values, and others[35,36]. e corresponding SMEs records core datils in blockchain distributed ledger and trace according to the requirement, such as futuristic employment and business growths, etc. ese records are provided through the DApp with the use of blockchain public permissionless network-enabled envi- ronment, that is the reason it allows access to the participating SMEs to this sensitive and other-related details for robust economical contribution. However, the critical issues are to analysis and restrict repetitive data records, that consume more time to separate individual logs; for the act of this, it uses more power to computes. To overcome this situation, we design and create smart contracts (chain codes) along with consensus protocols to automate transaction veri cation and validation in accordance with the strategy of ledger records.

Regulatory and cross platform issues. ere are various challenges, limitations, and issues associated with the existing SMEs including the registration of startups, nancial transactions exchange, and privacy, trans- parency in intercommunication, ledger maintenance **automation** in the centralized server-based preservation[34]. And so, it is relying on third-part data management and optimization tools with security solutions as well. In addition, to manage these issues, there are various tools, techniques, and applications used with the IoT technology to cap- ture the records from portable devices[35,36]. Examine and analyze each log with di erent ML techniques to extract redundancy in the ledger and optimize it.

Conclusion

Is paper discusses the existing security and privacy procedure and separates the loopholes while SMEs are interconnected and exchange related information during the intercommunication between node-to-node over the centralized network. In this paper, we propose a B-SME, a collaborative technological framework using block- chain, IoT, and AI, that alleviates the resource usage of the collaborative technologies in the distributed network environment and create the system more reliable

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and e cient. is B-SMEs has implemented and deployed a secure process hierarchy of data management and optimization to be cost-e ective and resource-e cient creating no problem in terms of the system's provenance. It maintains e cient data integrity and a transparent, traceable, and reliable environment without a ecting the container of blockchain docker. e experimental results shows that the exchanging information between interoperable chains increases up to 17.3%, where it reduces the consumption of the system's computational resources down to 9.13%. us, only 14.11% and 7.9% of B-SME's transactions use network bandwidth and storage capabilities compared to the current mechanism running for SMEs, respectively.

However, for this purpose, we created three di erent chain codes (smart contracts), along with customizing consensus policies (such as PoW and PoS) to automate and investigate individual transactions of SMEs with proper veri cation and validation process. In this manner, B-SMEs reduce the consumption of resources, such as the cost of computational energy, network load, and preservation. During each SMEs' transactions acquisition to deliverance, the information of nodes is optimized and stored in blockchain ledger enabled IPFS according to the protocol designed in the chaincode, which is developed as per the requirement of a data structure for overall streamlining transmission, content management, and broadcasting. Substantially, all these SME-related transmissions (nancial, social, economic, etc.) are scheduled and executed with two di erent distributed com- munication channels, such as on-chain and o -chain. Whereas on-chain communication handles all implicit operations. And so, o -chain manages operations explicitly. Finally, the experimental results illustrated that this proposed B-SMEs is a good candidate when implemented in the real-time industrial environment.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to further investigation running on the same project for futuristic solutions but are available from the corresponding author on reasonable request.

References

1.Zutshi, A., Mendy, J., Sharma, G. D., omas, A. & Sarker, T. From challenges to creativity: Enhancing SMEs' resilience in the context of COVID-19. *Sustainability* **13**(12), 6542 (2021).

2.Pereira, V. *et al.* An exploratory study into emerging market SMEs' involvement in the circular Economy: Evidence from India's indigenous Ayurveda industry. *J. Bus. Res.* **142**, 188–199 (2022).

3.Adam, N. A. & Alari , G. Innovation practices for survival of small and medium enterprises (SMEs) in the COVID-19 times: e role of external support. *J. Innov. Entrep.* **10**(1), 1–22 (2021).

4.Soni, G. *et al.* A decision-making framework for Industry 4.0 technology implementation: e case of FinTech and sustainable supply chain nance for SMEs. *Technol. Forecast. Soc. Chang.* **180**, 121686 (2022).

5.Denicolai, S., Zucchella, A. & Magnani, G. Internationalization, digitalization, and sustainability: Are SMEs ready? A survey on synergies and substituting e ects among growth paths. *Technol. Forecast. Soc. Chang.* **166**, 120650 (2021).

6.Pappas, N., Caputo, A., Pellegrini, M. M., Marzi, G. & Michopoulou, E. e complexity of decision-making processes and IoT adoption in accommodation SMEs. *J. Bus. Res.* **131**, 573–583 (2021).

7.Tudor, A. I. M., Chițu, I. B., Dovleac, L. & Brătucu, G. IoT technologies as instruments for SMEs' innovation and sustainable growth. *Sustainability* **13**(11), 6357 (2021).

8.Hansen, E. B. & Bøgh, S. Arti cial intelligence and internet of things in small and medium-sized enterprises: A survey. *J. Manuf. Syst.* **58**, 362–372 (2021).

9.Baabdullah, A. M., Alalwan, A. A., Slade, E. L., Raman, R. & Khatatneh, K. F. SMEs and arti cial intelligence (AI): Antecedents and consequences of AI-based B2B practices. *Ind. Mark. Manage.* **98**, 255–270 (2021).

10.Shaikh, Z. A. *et al.* Blockchain hyperledger with non-linear machine learning: A novel and secure educational accreditation reg- istration and distributed ledger preservation architecture. *Appl. Sci.* **12**(5), 2534 (2022).

11.Khan, A. A. *et al.* Healthcare ledger management: A blockchain and machine learning-enabled novel and secure architecture for medical industry. *Hum. Centric Comput. Inf. Sci.* **12**, 1–10 (2022).

12.Shaikh, Z. A., Khan, A. A., Teng, L., Wagan, A. A. & Laghari, A. A. BIoMT modular infrastructure: e recent challenges, issues, and limitations in blockchain hyperledger-enabled e-healthcare application. *Wirel. Commun. Mob. Comput.* **2022**, 3813841 (2022).

12.Khan, A. A., Laghari, A. A., Shaikh, Z. A., Dacko-Pikiewicz, Z. & Kot, S. Internet of ings (IoT) security with blockchain technol- ogy: A state-of-the-art review. *IEEE Access* **10**, 122679–122695 (2022).

13.Vrontis, D., Chaudhuri, R. & Chatterjee, S. Adoption of digital technologies by SMEs for sustainability and value creation: Mod- erating role of entrepreneurial orientation. *Sustainability* **14**(13), 7949 (2022).

13.Manimuthu, A., Venkatesh, V. G., Shi, Y., Sreedharan, V. R. & Koh, S. C. L. Design and development of automobile assembly model using federated arti cial intelligence with smart contract. *Int. J. Prod. Res.* **60**(1), 111–135 (2022).

14.Teng, X., Wu, Z. & Yang, F. Research on the relationship between digital transformation and performance of SMEs. *Sustainability*
14(10), 6012 (2022).

15.Bracci, E., Tallaki, M., Ievoli, R. & Diplotti, S. Knowledge, di usion and interest in blockchain technology in SMEs. *J. Knowl. Manage.* **26**, 5 (2021).

16.Pizzi, S., Corbo, L. & Caputo, A. Fintech and SMEs sustainable business models: Re ections and considerations for a circular economy. *J. Clean. Prod.* **281**, 125217 (2021).

16.Hatzivasilis, G., Ioannidis, S., Fysarakis, K., Spanoudakis, G. & Papadakis, N. e green blockchains of circular economy. *Electronics*
10(16), 2008 (2021).

17.Schneider, S. & Spieth, P. Business model innovation: Towards an integrated future research agenda. *Int. J. Innov. Manag.* **17**(01), 1340001 (2013).

ISBN Number: 978-93-95305-78-5

18.Asili, G. R. *et al.* Developing technical competency model to promote HRM in project-oriented organisations: A case for 3D petroleum system modelling in the Persian Gulf and Oman Sea (PEARL programme). *Int. J. Prod. Qual. Manage.* **13**(1), 1–18 (2014).
19.Roos, C. *e Motivation and Factors Driving Crypto-Currency Adoption in SMEs* (University of Pretoria, 2015).
20.Ciuriak, D. *TPP's Business Asymmetries: Megaregulation and the Conditions of Competition Between MNCs and SMEs*. SSRN 3472317 (2016).
21.Box, S. & Lopez-Gonzalez, J. e future of technology: Opportunities for ASEAN in the digital economy. *Glob. Megatrends* **1**, 37–60 (2017).
22.Serrano-Calle, S., Robles, T., Martín, D. & Mateos, R. *Digitalization of Operations Management with Emotional and Intelligence Tools. Blockchain and IoT integration, the last disruption?* (2018).
23.Li, Z. *et al.* A blockchain and automl approach for open and automated customer service. *IEEE Trans. Ind. Inf.* **15**(6), 3642–3651 (2019).
24.Wong, L.-W., Leong, L.-Y., Hew, J.-J., Tan, G.W.-H. & Ooi, K.-B. Time to seize the digital evolution: Adoption of blockchain in operations and supply chain management among Malaysian SMEs. *Int. J. Inf. Manage.* **52**, 101997 (2020).
25.Chatterjee, S., Chaudhuri, R., Vrontis, D. & Basile, G. Digital transformation and entrepreneurship process in SMEs of India: A moderating role of adoption of AI-CRM capability and strategic planning. *J. Strategy Manag.* **15**, 416–433 (2021).
26.P ster, P. & Lehmann, C. Returns on digitisation in SMEs: A systematic literature review. *J. Small Bus. Entrep.* **680**, 1–25 (2021).
27.Rakshit, S., Islam, N., Mondal, S. & Paul, T. In uence of blockchain technology in SME internationalization: Evidence from high- tech SMEs in India. *Technovation* **115**, 102518 (2022).
28.Akpan, I. J., Udoh, E. A. P. & Adebisi, B. Small business awareness and adoption of state-of-the-art technologies in emerging and developing markets, and lessons from the COVID-19 pandemic. *J. Small Bus. Entrep.* **34**(2), 123–140 (2022).
29.Ahmad, I., Serbaya, S. H., Rizwan, A. & Mehmood, M. S. Spectroscopic analysis for harnessing the quality and potential of gem- stones for small and medium-sized enterprises (SMEs). *J. Spectrosc.* **2021**, 1–20 (2021).
30.Bongomin, O. *et al.* Industry 4.0 disruption and its neologisms in major industrial sectors: A state of the art. *J. Eng.* **2020**, 1–45 (2020).
31.Khan, A. A., Shaikh, A. A. & Laghari, A. A. IoT with multimedia investigation: A secure process of digital forensics chain-of-custody using blockchain hyperledger sawtooth. *Arab. J. Sci. Eng.* **2022**, 1–16 (2022).
32.Khan, A. A., Laghari, A. A., Sha q, M., Awan, S. A. & Gu, Z. Vehicle to everything (V2X) and edge computing: A secure lifecycle for UAV-assisted vehicle network and o oading with blockchain. *Drones* **6**(12), 377 (2022).
33.Khan, A. A. *et al.* A drone-based data management and optimization using metaheuristic algorithms and blockchain smart con- tracts in a secure fog environment. *Comput. Electr. Eng.* **102**, 108234 (2022).

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

EVALUATING THE EFFECT OF GREEN BANKING STRATEGIES ON ENVIRONMENTAL SUSTAINABILITY AND PROFITABILITY IN PRIVATE SECTOR BANKS

Dr. Rashmi Soni
Assistant Professor
Dept of Commerce
Prime Minister's College of Excellence
Govt Hamidia College, Bhopal Madhya Pradesh
rashmisoni2015as@gmail.com

Abstract

This examination talks about the effects of green financial strategies on benefit and ecological execution. This research investigates the following important concepts using a sample of 200 respondents from various banks in different areas: green banking policy, daily operations, financing for green projects, environmental performance, and profitability. Reliability and discriminant validity assessments confirm the reliability and uniqueness of the study's scales. As suggested by path coefficient studies, regulations of green banking have the second-strongest positive influence on banks' environmental performance next to supporting or investing in green projects. In addition, profitability is positively related to environmental performance, implying potential financial benefits from following a sustainable approach. The study further shows specific indirect effects, such as the fact that investments in green projects rather than usual operations have a higher influence on environmental performance because of green banking regulations. It is evident from the findings that banks can achieve long-term profitability with sustainability promotion. This goes to prove that green banking regulations and sustainable investments are key in the improvement of financial and environmental performance.

Keywords: Green Banking, Environmental Performance, Profitability, Sustainable Investments, Day-to-Day Operations, Green Projects.

1. INTRODUCTION

The banking industry is significant to economic growth and development, but due to the consumption of resources and its impact on the environment as a result of its financial operations, it also contributes to environmental problems. The strategies of green banking help banks incorporate their operations in tandem with the objectives of environmental sustainability in response to growing environmental concerns and a need for sustainable practices. This is known as "green banking" and takes the form of adopting procedures that reduce its harmful effects on the environment, such as promoting environmentally friendly

ISBN Number: 978-93-95305-78-5

financial goods, putting energy-efficient operations into place, and funding green initiatives like energy-efficient technologies and renewable energy.

Banks in the private sector, in particular, are realizing more and more how crucial it is to implement green banking practices for both their long-term financial success and corporate social responsibility (CSR). Green banking programs have the potential to improve banks' standing, lower operating expenses by using less energy, and draw in eco-aware clients. Moreover, investments that are related to green or environmentally friendly financial services/products, for example, bonds and sustainable loans, present new opportunities for income-generation and market competitiveness.

No matter what these expected advantages, inspecting the effect of green putting money on bank productivity and ecological sustainability is as yet significant. While certain investigations show that green financial upgrades the ecological effects, it stays indistinct how this effects the benefit. The goal of this study is to assess the effect of green financial practices on confidential area banks' monetary results and natural execution. This will zero in on two of the main regions: supportable practices and monetary achievement, and it will illuminate the conceivable compromises and collaborations between these two.

The outcome of this research is expected to expand knowledge about the relationship between environmental sustainability, profitability, and green banking practices. Besides helping private sector banks improve their green banking procedures, this will guide regulators and legislators to make sense in laws promoting environmental stewardship without causing financial instability in the banking industry.

2. LITERATURE REVIEW

Chen et al. (2022) analyzed the association between natural execution and green financial practices with regards to Bangladeshi confidential business banks (PCBs). They gathered data from 330 financial staff individuals utilizing a study strategy. Their examination uncovered that while client related green financial practices didn't display measurable importance, regular tasks and strategy related green financial practices emphatically affected green funding. Besides, banks' ecological presentation was fundamentally improved by supporting green ventures. To work on ecological execution, the review stressed the meaning of integrating green approaches into everyday activities and financing supportable undertakings.

Aslam and Jawaid (2023) accumulated suppositions from 400 financial laborers about the job of (GBAP) in Pakistan. Their exploration showed that GBAP well affected banks' functional, monetary, and ecological execution. The reception of green banking generally affected natural execution out of these, trailed by gains in functional and monetary execution. This shows how green banking might further develop bank execution and natural supportability.

ISBN Number: 978-93-95305-78-5

Zhang et al. (2022) completed research on what green financial practices mean for natural execution and green money in Bangladesh. According to their analysis, banks' environmental performance and their sources of green finance were both greatly improved by green banking practices. The study also showed that the association between environmental performance and green banking operations was mediated by green funding, indicating that green project investments are essential to strengthening banks' sustainability initiatives. While stressing the advantages of green banking, such as greater competitiveness and lower carbon footprints, the report also noted a number of barriers to its growth, such as low client awareness, high investment costs, and technological difficulties.

Bose, Khan, and Monem (2021) used information from 172 firm-year observations from 2008 to 2014 to investigate the connection between a bank's financial performance and its green banking performance. According to their data, cost effectiveness is the main factor driving the favorable correlation between green banking performance and financial performance. They did discover, though, that political ties had a detrimental effect on this association, indicating that political and regulatory considerations may have an impact on how successful green banking programs are. This study was noteworthy since it concentrated on Bangladeshi regulations, providing a distinct viewpoint on the impact of mandated green banking regulations on financial results.

Rehman et al. (2021) examined Pakistan's embrace of green banking practices, highlighting the contribution of green project financing and policy-level initiatives to improving environmental performance. Their research, which was founded on the Sustainable Resource Investment (SRI) hypothesis, discovered that the adoption of green banking practices was significantly impacted by everyday operations, policy decisions, and investments in green projects. This study emphasizes how crucial it is to take a holistic approach to green banking, where operational procedures and policy support are in line with sustainable development objectives.

3. RESEARCH METHODOLOGY

3.1.Research Design

The purpose of this descriptive and correlational study is to examine how bank profitability is affected by green banking policies, daily operations, financing and investing in green projects, and environmental performance. Using a cross-sectional research approach, the study gathers information from bank managers and staff via surveys.

ISBN Number: 978-93-95305-78-5

3.2.Population and Sample

Employees of banks that are putting green banking policies and practices into effect make up the study's population. A wide range of banking experts from different parts of India are represented in the sample. The sample was chosen using a convenience sampling technique because the goal was to find people who had relevant expertise with green banking practices. There are 200 responses in all, 94 of whom are men (47%) and 106 of them are women (53%). A variety of age categories are also represented in the sample, including those aged 20–30 (26%), 31–40 (46%), 41–50 (21%), and over 50 (7%). The sample is further divided into geographical areas and banks.

3.3.Data Collection

To gather primary data, a structured questionnaire was used. To find out how respondents feel about green banking policy, daily operations, financing green projects, and environmental performance, the survey has both closed-ended and Likert-scale questions. Additionally, secondary data about the financial and environmental performance of banks was gathered from annual reports and other published sources.

3.4.Variables and Constructs

The study investigates the following key variables:

- **Green Banking Policy**: Bank policies that support environmental sustainability.
- **Day-to-Day Operations**: The bank's operational procedures that support sustainability.
- **Funding or Investing in Green Projects**: The amount of money banks invest in environmental sustainability programs.
- **Bank Environmental Performance**: The banks' total environmental performance as measured by emissions, resource use, and sustainability programs.
- **Profitability**: The profitability of banks as a measure of their financial performance.

3.5.Instrument and Measurement

Based on pre-existing frameworks, the questionnaire was created with scales to measure each construct. Good internal consistency was shown by the high reliability values for the majority of the constructs (Green Banking Policy: 0.950, Funding for Green Projects: 0.935, Bank Environmental Performance: 0.830, and Profitability: 0.805). By comparing the square root of each construct's Average Variance Extracted (AVE) to the correlations between constructs, discriminant validity was examined. The findings demonstrated that every construct was unique and assessed several ideas.

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3.6.Data Analysis Techniques

The sample's demographic characteristics was investigated using descriptive statistics. Cronbach's Alpha was used for reliability analysis in order to make sure the scales were internally consistent. To determine whether the builds were unmistakable, discriminant legitimacy was assessed utilizing the Fornell-Larcker basis. The immediate and roundabout connections between the develops were tried utilizing way investigation using primary condition demonstrating (SEM). To assess the heading and strength of the associations between bank execution and green financial practices, way coefficients were determined. To survey the interceding job of mediating factors, for example, financing or putting resources into green ventures and everyday activities, in the connection between bank ecological execution and green financial approach, explicit aberrant impacts were processed.

4. RESULT AND DISCUSSION

The sample demographic analysis indicates relatively balanced distribution in gender, age, bank, and state categories. Regarding gender, there are more females than males, signifying the diversified representation in the study. The highest number is recorded in the age category of 31-40 years, which would represent mid-career professionals engaged with the green initiatives of the banking sector.

Table 1: Sample Demographic

Sample Profile	Category	Frequency	Percentage (%)
Gender	Male	94	47
	Female	106	53
Age	20-30 years	52	26
	31-40 years	93	46
	41-50 years	42	21
	Above 50	13	7
Name of the Bank	HDFC	50	24
	ICICI	40	26
	Kotak Mahindra	20	21
	Axis	25	7
	IndusInd	20	15
	IDBI	30	5
	Yes Bank	15	2
State	Madhya Pradesh	35	14
	Maharashtra	20	12
	Uttar Pradesh	24	21
	New Delhi	10	7
	Chhattisgarh	15	15
	Assam	5	10
	Karnataka	16	10

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	Uttarakhand	24	5
	West Bengal	30	4
	Punjab	21	2

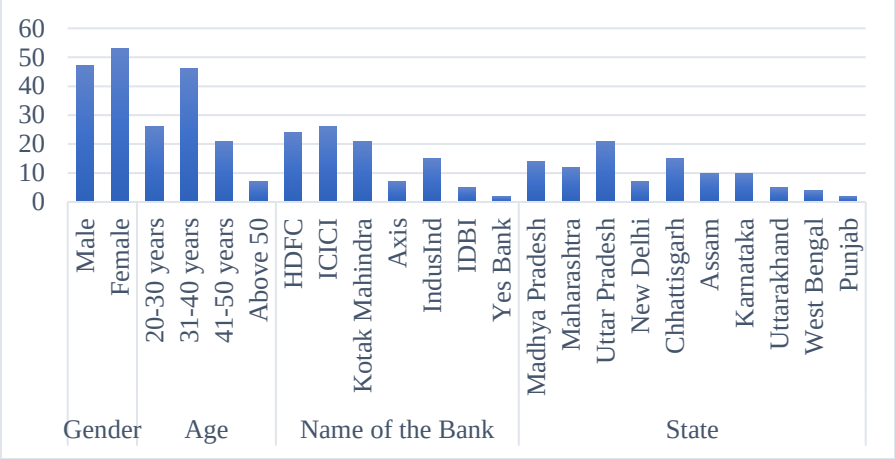

Figure 1: Graphical Representation of Sample Demographic

Younger staff and those in the age group of 41-50 years are also represented, though in lesser number, showing a mix of experiences in the sample. About the banks, the presence of bigger institutions like ICICI and HDFC is high, indicating that they seem to be more engaged with green banking practices, whereas the relatively smaller banks like Axis and Yes Bank have a minor share. Geographically, the Uttar Pradesh and Madhya Pradesh states are the hotspots where more economic activity is happening, thus contributing a larger sample and pointing out their central role in green banking practices. Other regions have smaller representations and point to varying levels of green banking adoption across India. Overall, the demographic breakdown points to a wide reach of green banking with concentric concentrations that occur in key regions and major banks.

Table 2: Analysis of Reliability

Variables	**Cronbach's Alpha**	**Comparable Value**	**Explanation**	**Number of Statements**
Green Banking Policy	0.950	0.8	Reliable and consistent	7
Day-to-Day Operations	0.710	0.8	Reliable and consistent	8
Funding or Investing in Green Projects	0.935	0.8	Reliable and consistent	9
Bank Environmental Performance	0.830	0.8	Reliable and consistent	5
Profitability	0.805	0.8	Reliable and consistent	5

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Majority of the constructs have good to excellent internal consistency, based on the reliability analysis. The constructions of Bank Environmental Performance 0.830, Funding or Investing in Green Projects 0.935, Green Banking Policy 0.950, and Profitability 0.805 all exceed the recommended Cronbach's Alpha cutoff of 0.8, thus showing a high degree of consistency and dependability. With a Cronbach's Alpha of 0.710, the Day-to-Day Operations construct is well below optimal but still shows enough reliability, meaning that further improvements are required to enhance consistency. The investigation concludes that generally the scales are dependable enough, with only slight modifications needed in the day-to-day operation.

Table 3: Utilizing the Fornell-Larcker criterion to determine discriminant validity

Constructs	Banks Environmental Performance	Day-to-Day Operation	Funding or Investing in Green Projects	Green Banking Policy	Profitability
Banks Environmental Performance	0.774				
Day-to-Day Operation	0.367	0.717			
Funding or Investing in Green Projects	0.368	0.142	0.866		
Green Banking Policy	0.754	0.158	0.768	0.884	
Profitability	0.274	0.607	0.122	0.178	0.792

The Fornell-Larcker criterion is adopted to check the discriminant validity of the constructs and is found that the constructs are unique and measure several concepts. One important measure for assessing discriminant validity is through diagonal values, where these values are greater than off-diagonal correlations, thereby indicating the square root of Average Variance Extracted (AVE) for every construct. In contrast to the correlations with other constructs, like 0.367 for Day-to-Day Operations and 0.368 for Funding or Investing in Green Projects, the AVE value of the Banks Environmental Performance construct is 0.774. Further evidence for discriminant validity arises from the fact that the AVE value of Funding or Investing in Green Projects is 0.866 and its correlation with Green Banking Policy is lower than its AVE at 0.768. With an AVE of 0.884, the Green Banking Policy construct is measurably assessing a dimension different from the correlations it displays towards other constructs, including Day-to-Day Operations (0.158) and Profitability (0.178). Lastly, profitability possesses adequate discriminant validity with an

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AVE of 0.792 because its correlations with other constructs are lower than its own AVE value. Overall, the results of Fornell-Larcker criterion show that the constructs are different from one another, which proves that the measuring model is appropriately discriminable.

Table 4: Path coefficient

Paths	Path Coefficients
Banks Environmental Performance → Profitability	0.274
Day-to-Day Operation → Banks Environmental Performance	0.234
Funding or Investing in Green Projects → Banks Environmental Performance	0.938
Green Banking Policy → Banks Environmental Performance	0.359
Green Banking Policy → Day-to-Day Operation	0.160
Green Banking Policy → Funding or Investing in Green Projects	0.768

From the way coefficient information, it is clear that green financial strategy significantly affects banks' ecological presentation (0.359), while subsidizing or putting resources into green activities meaningfully affects banks' natural exhibition (0.938). Banks' natural exhibition emphatically influences productivity (0.274). Everyday activities respectably influence banks' natural exhibition (0.234), while subsidizing or putting resources into green undertakings (0.768) and everyday tasks (0.160) are both affected by green financial approach. All things considered, therefore, green policies and investment in sustainable initiatives have come to be important drivers of banks' environmental performance and profitability.

Table 5: Particular Indirect Impacts

Specific Indirect Paths	Specific Indirect Effects
Green Financial Approach → Everyday Activity → Banks Natural Execution pathway	0.042
Green Financial Strategy → Subsidizing or Putting resources into Green Undertakings → Banks Natural Execution way	0.718

Specific indirect effects help to explain the mediation process since they indicate how one construct impacts another via an intervening variable. For instance, the particular roundabout impact along the Green Financial Approach → Everyday Activity → Banks Natural Execution pathway is 0.042. Such a worth is exceptionally low, and this demonstrates that while Green Financial Strategy impacts the natural exhibition of banks through their day-to-day tasks, such impact is tiny. This suggests that with progress in everyday tasks, green strategies of banks affect ecological execution.

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Be that as it may, the particular roundabout impact of 0.718 is profoundly critical for the Green Financial Strategy → Subsidizing or Putting resources into Green Undertakings → Banks Natural Execution way. Thusly, through interests in green undertakings, the Green Financial Strategy by implication affects banks' ecological presentation, as shown by major areas of strength for this worth. The significant impact reveals that regulations in favor of environmentally friendly banking practices are a must to encourage investments in green initiatives, which significantly enhance the environmental performance of the bank. The association through investments in green projects is stronger even if the indirect impacts are generally positive. This goes to show how important it is to achieve environmental objectives with focused green investments.

5. CONCLUSION

The report provides insightful information regarding how green banking policies influence the profitability and environmental performance of banks. Results showed that a bank's environmental performance is significantly affected by its green banking policy, financing for sustainable projects, and daily operations. Most important among these was financing or investing in green projects, which significantly improved environmental results. The report also stresses the point that environmental performance adds value to profitability; thus, it is shown that green practices in banks can boost financial performance along with supporting sustainability. It also exhibits how green banking practices which support investments in environmentally friendly initiatives, have a positive indirect impact on environmental performance. All things considered, this study underlines the importance of including sustainability into banking operations and investments. This is to the point that green banking practices are not only good for the environment but also important in boosting the long-term profitability and competitiveness of banks.

REFERENCES

1. *Aslam, W., & Jawaid, S. T. (2023). Green banking adoption practices: improving environmental, financial, and operational performance. International Journal of Ethics and Systems, 39(4), 820-840.*
2. *Bătae, O. M., Dragomir, V. D., & Feleagă, L. (2021). The relationship between environmental, social, and financial performance in the banking sector: A European study. Journal of cleaner production, 290, 125791.*
3. *Bose, S., Khan, H. Z., & Monem, R. M. (2021). Does green banking performance pay off? Evidence from a unique regulatory setting in Bangladesh. Corporate Governance: An International Review, 29(2), 162-187.*

4. *Chen, J., Siddik, A. B., Zheng, G. W., Masukujjaman, M., & Bekhzod, S. (2022). The effect of green banking practices on banks' environmental performance and green financing: An empirical study. Energies, 15(4), 1292.*

5. *Gunawan, J., Permatasari, P., & Sharma, U. (2022). Exploring sustainability and green banking disclosures: a study of banking sector. Environment, Development and Sustainability, 24(9), 11153-11194.*

6. *Hasan, M. M., Al Amin, M., Moon, Z. K., & Afrin, F. (2022). Role of environmental sustainability, psychological and managerial supports for determining bankers' green banking usage behavior: an integrated framework. Psychology research and behavior management, 3751-3773.*

7. *Hoque, M. K., Masum, M. H., & Babu, M. A. (2022). Impact of financial performance on green banking disclosure: Evidence from the listed banking companies in Bangladesh. Universal Journal of Accounting and Finance, 10(2), 450-456.*

8. *Julia, T., & Kassim, S. (2020). Exploring green banking performance of Islamic banks vs conventional banks in Bangladesh based on Maqasid Shariah framework. Journal of Islamic Marketing, 11(3), 729-744.*

9. *Karyani, E., & Obrien, V. V. (2020). Green banking and performance: The role of foreign and public ownership. Jurnal Dinamika Akuntansi Dan Bisnis, 7(2), 221-234.*

10. *Kumar, J., Rani, G., Rani, M., & Rani, V. (2024). Do green banking practices improve the sustainability performance of banking institutions? The mediating role of green finance. Social Responsibility Journal, 20(10), 1990-2007.*

11. *Rabea'Hadi, M., Hasan, M. F., Flayyih, H. H., & Hussein, M. K. (2023). Green banking: A literature review on profitability and sustainability implications. Ishtar journal of economics and business studies, 4(2), 1-6.*

12. *Ratnasari, T., Surwanti, A., & Pribadi, F. (2021, March). Implementation of green banking and financial performance on commercial banks in indonesia. In Recent Developments in Asian Economics International Symposia in Economic Theory and Econometrics (Vol. 28, pp. 323-336). Emerald Publishing Limited.*

13. *Rehman, A., Ullah, I., Afridi, F. E. A., Ullah, Z., Zeeshan, M., Hussain, A., & Rahman, H. U. (2021). Adoption of green banking practices and environmental performance in Pakistan: A demonstration of structural equation modelling. Environment, Development and Sustainability, 1-21.*

14. *Salim, K., Disli, M., Ng, A., Dewandaru, G., & Nkoba, M. A. (2023). The impact of sustainable banking practices on bank stability. Renewable and Sustainable Energy Reviews, 178, 113249.*

15. *Zhang, X., Wang, Z., Zhong, X., Yang, S., & Siddik, A. B. (2022). Do green banking activities improve the banks' environmental performance? The mediating effect of green financing. Sustainability, 14(2), 989.*

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

PHYTOSOCIOLOGICAL ANALYSIS OF MIXED DECIDUOUS FORESTS OF BUNDELKHAND REGION

Ekta Rai and Sachin Singh
Ecological Research Laboratory
Department of Botany,
P. K. University Shivpuri (M. P.)

ABSTRACT

Forest is a grandest biological association of the nature predominated by the trees and other plant species. The present study deal with investigation and characterize the floristic composition and vegetation diversity of the two Mixed deciduous forests (Banguon and Orchha) of Bundelkhand region. The climate of the two forests almost similar and can be said as semi-arid with undulating topography. The 19 trees species were found in Orchha forest while 16 trees species occur in Banguon forest. *Alangium lamarkii* was most frequent in Banguon forest whereas in Orchha forest *Tectona grandis* appeared to most frequent. Only 8 species were common in both forests. *Lantana camara* had the highest density (8.625 individual/m^2) on Banguon Forest while highest density (18.05 individual/m^2) tree of Orchha forest was *Tectona grandis*. The community coefficient value of these forests was 59.537% which indicates less similarity.

INTRODUCTION

Phytosociological analysis of a plant community is an important aspect of ecological study of any piece of vegetation. It reveals the structural picture of the vegetation and helps in analysis the community dynamics. Among the various kinds of ecosystem encountered in the Mixed deciduous forest, due to their unique features have always attracted ecologists. These ecosystems have evolved their own ways of complex biological processes and deserve attention as special ecological entities (Vidyasagaran et al. 2004).

Vegetation analysis is important as the structure of the vegetation expresses most relevant results and is a flexible tool in the analysis of complex system (Weed et al. 1977). Bundelkhand region is covered by the mixed deciduous forest. Jhansi is situated between latitude 24˚11´- 26˚27´ and Longitude 78˚17´- 81˚34 E at 275mm above sea level. Temperature range from 20˚C -45.7 ˚C and minimum from 2.5 ˚C-29 ˚C. The climate of Jhansi is semi-arid with an average rainfall of 900mm mostly between last week of June to September (Pandey et al. 2002).

A thorough knowledge of the community can be best acquired if ecology of individual plant species, forming a constituting part of the community is studied (Joshi and Gupta, 1982). To have complete idea

ISBN Number: 978-93-95305-78-5

of the structure and composition of a community, it is essential to understand it is various analytical characters. Analytical characters viz. Relative frequency, Relative density. Relative basal area and IVI are very useful in the composition of two different forest communities. From the above information it is evident that is a scope for studying the Phytosociological attributes of Bundelkhand region in view to understand their conservation status.

Thus, A thorough knowledge of the community can be helpful in understanding the ecological implication of the forest. Phytosociological studies in forest have carried out by many workers viz. Das and Lahiri (1997), Jose et al. (1994) and Balaji and Nitant(2002). There is paucity of data on performance, adaptability association and growth architecture of individual species.

The present syudy envisages Phytosociological behavior of Mixed deciduous forest in relation to its other associates at different topographic region of Banguon and Orchha forests.

MATERIAL AND METHOD

Phytosociological studies were carried out through quadrate methods. The both Banguon and Orchha forest were divided in the equal compartments arbitrarily 40 of 10X10m size each placed at equal distance in parallel lines. The study was carried out in July 2023. Three analytical characters viz. Relative frequency, Relative density. Relative basal area were considered for the calculation of IVI of each species (Curtis and Cotton,1962). The formulae for the determination of these parameters are given below.

$$\text{Relative Frequency} = \frac{\text{Frequency of species}}{\text{Sum of Frequency value of all species}} \times 100$$

$$\text{Relative density} = \frac{\text{Density of species}}{\text{Sum of Density of all species}} \times 100$$

$$\text{Relative Basal area} = \frac{\text{Basal area of a species}}{\text{Sum of Frequency value of all species}} \times 100$$

IVI = Relative frequency+ Relative density+ Relative Basal area

The species distribution of species in different stands has been derived from whitford index of A/F ratio (Whitford, 1949). The A/F ratio if below 0.025 indicates regular distribution, between 0.025-0.05 indicates random distribution and when above 0.05 indicates a contagious distribution (Curtis and Cottam, 1956). The similarity between the two forest stand (Banguon and Orchha) was determined by using the community coefficient.

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RESULTS AND DISCUSSION

Botanical composition, Percentage frequency, density/m^3, Abundance, frequency class and IVI of each species of Banguon and Orchha forest are given in the Table 1 and 2.

Tatallt 16 species were present in Banguon forest and 19 species in Orchha forest. The 8 species were found common in both forests viz. *Butea monosperma, Cassia fistula, Tectona grandis, Flacourtia indica, Holoptelia intrigrifolia, Acacia leucophloea, Carissa carandas* and *Capparis aphylla*. The Alangium lamarkii was most frequent in Banguon forest whereas in Orchha forest it was lacking. This might have due to microclimate and edaphically variation at these two sites. *Tectona grandis* appeared to be both the forests. *Capparis aphylla, Butea frondosa* and *Holoptelia intrigrofolia* were noted more frequent in Banguon forest as compared to Orchha forest. *Cassia fistula* which is a miscellaneous tree occur in the both forests. *Wrightia tinctoria, Anogeissus pendula, Lantana camara* and *Azadiacta indica* were totally absent in Orchha forest. In Banguon forest *Zizyphus xylopyrus, Terminalia belerica, Albizia lebbek, Mitragyana parvifolia, Diospyrus melonoxylon, Aegle marmelos, Eugenia jambolana, Melia azedarach, Terminalia arjuna* and *Cordia myxa* completely absent. In view of the above the Orchha forest appear rich as regard to species diversity than Banguon forest most provably this variability should associate with the reserve nature of Orchha forest. *Butea monosperma* which is the common species in both the forest has higher average height (8.670m) in Banguon forest. The average height of *Butea monosperma* in the Orchha forest is 9.5m.

Density gives the numerical strength of a species in a community. In Banguon forest Lantana camara had the highest density (8.615 individual/m^2). Followed by *Alangium lamarkii* ((7.6 individual/m^2), *Butea monosperma* (4.75 individual/m^2) and *Tectona grandis* (3.45 individual/m^2). At Orchha forest *Tectona grandis* had the highest density (18.05 individual/m^2). *Butea monosperma* had 1.2 individual/m^2 density other species of Orchha forest have density less than 1.

The Abundance gives the number of individuals of a habitat. On Banguon forest *Lantana camara* has highest Abundance value (10.147). Other highest Abundance species are *Alangium lamarkii* (7.6) and *Wrightia tinctoria* (5.842). On orchha forest *Tectona grandis* has highest Abundance value (18.05). Other higher Abundance species are *Eugenia jambolana* (6.5) and *Terminalia arjuna* (6). Other species of Orchha forest have Abundance between the range of 1 to 2. The higher Dbh value in Banguon forest is reported in *Butea monosperma* (56.78cm.). Other higher Dbh value in Banguon is *Alangium lamarkii* (27.95cm) and *Cassia fistula* (33.28cm.). in Orchha forest the higher Dbh value is reported in *Butea monosperma* (56.78cm.) and *Cassia fistula* (35.37cm.).

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Importance value index (IVI) represent the extent of dominance of a species in the community. In Banguon forest *Lantana camara* represent hightest IVI value (57.263) followed by *Alangium lamarkii* (46.113) and *Butea monosperma* (33.459) respectively. At Orchha forest *Tectona grandis* represent highest IVI value (138.135).

The analysis of distribution pattern of individual species on Banguon and Orchha forest indicates that among the three distribution pattern viz. regular, random and contagious, the contagious distribution was found most common in the study area. The dominance of contagious distribution may be due to the fact that a majority of trees species reproduce vegetatively in addition to sexually and most of the species occur low frequency and high Abundance.

The value of community coefficient of the two forests was reported to be 53.537 which indicate marked dissimilarities of the species composition.

Table-1 Vegetation Characteristics of Banguon forest

Name of the species	**Frequency %**	**Density**	**Abundance**	**Frequency class**	**A/F ratio**	**Relative frequency**	**Relative Density**	**Relative dominance**	**IVI**
Alangium lamarkii	100%	7.6	7.6	E	0.076	12.853	20.416	12.844	46.113
Wrightia tinctoria (R.Br.)	47%	2.775	5.842	C	0.124	6.041	7.454	9.87	23.365
Butea monosperma (Roxb.)	97%	4.75	4.871	E	0.502	12.467	12.760	8.232	33.459
Cassia fistula (Linn.)	15%	0.15	1	A	0.067	1.928	0.4029	1.690	2.733
Tectona grandis (Linn,)	77%	3.45	4.451	D	0.057	9.897	9.267	7.522	26.686

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Anogeissus pendula (Edgew.)	45%	1.75	3.889	C	0.086	5.784	4.701	6.572	17.057
Flacourtia indica (Burm.f.) Merr.	60%	1.425	2.375	C	0.039	7.712	3.828	4.013	15.553
Laucaena leucocephala (Benth.)	30%	0.75	2.5	B	0.083	3.856	2.014	4.225	10.095
Lantana camara (Linn.)	85%	8.625	10.147	E	0.119	10.925	23.169	17.149	57.263
Azadiracta indica (Adr. juss)	7%	0.075	1	A	0.142	0.899	0.2014	1.690	2.7904
Holoptelia intrifolia (Planch.)	45%	1.125	2.5	C	0.055	5.784	3.022	4.225	13.031
Acacia leucophloea (Willd.)	47%	0.85	1.789	C	0.038	6.041	2.283	3.023	11.347
Albizia odoratissima (Benth.)	7%	0.075	1	A	0.142	0.899	0.2014	1.690	2.790
Zizyphus oenoplia (mill.)	27%	0.5	1.818	B	0.067	3.470	1.343	3.072	7.885

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Carissa carandas (Linn.)	5%	0.05	1	A	0.2	0.642	0.134	1.690	2.466
Capparis aphylla (Roth.)	67%	2.725	4.037	D	0.060	8.611	7.320	6.822	22.753

Table-2 Vegetation Characteristics of Orchha forest

Name of the species	**Frequency %**	**Density**	**Abundance**	**Frequency class**	**A/F ratio**	**Relative frequency**	**Relative Density**	**Relative dominance**	**IVI**
Butea monosperma (Roxb.)	65%	12	1.846	D	0.0284	15.987	5.189	3.630	24.806
Acacia leucophloea (willd.)	57%	0.95	1.652	C	0.0289	14.004	4.108	3.249	21.361
Tectona gandis (Linn.)	100%	18.05	18.05	E	0.1805	24.579	78.054	35.502	138.135
Cassia fistula (Linn.)	27%	0.3	1.090	B	0.403	6.633	1.297	2.143	10.073
Zizyphus oenoplia (mill.)	25%	0.4	1.6	B	0.064	6.142	1.729	3.147	11.018
Zizyphus xylopyrus (Willd.)	10%	0.125	1.25	A	0.125	2.457	0.540	2.4562	5.453
Terminalia belerica (Roxb.)	27%	0.325	1.181	B	0.0437	6.633	1.405	2.322	10.36
Carissa carandas (Linn.)	10%	0.15	1.5	A	0.15	2.457	0.648	2.950	6.055
Flacourtia indica (Burm.f.) Merr.	32%	0.625	1.923	B	0.0600	7.862	2.702	3.782	14.346
Capparis aphylla (Roth.)	7%	0.075	1	A	0.1428	1.719	0.324	1.966	4.009
Albizia lebbak (Benth.)	2%	0.025	1	A	0.5	0.491	0.108	1.966	2.565
Mitragyna parvifolia (Roxb.) Korth	7%	0.1	1.333	A	0.1904	1.719	0.432	2.556	4.707

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Holoptelia intrifolia (Planch)	7%	0.05	0.666	A	0.0951	1.719	0.216	1.309	3.244
Diospyros melanoxylon (Roxb.)	7%	0.075	1	A	0.1428	1.719	0.324	1.966	4.009
Aegle marmelos (Correa.)	10%	0.125	1.25	A	0.125	2.457	0.540	2.456	5.453
Eugenia jambolana (Lom.)	5%	0.325	6.5	A	1.3	1.228	1.405	12.784	15.417
Melia azedarach (Linn.)	5%	0.05	1	A	0.2	1.228	0.216	1.966	3.41
Terminalia arjuna (Bedd.)	2%	0.15	6	A	3	0.491	0.648	11.801	12.94
Cordia myxa (Linn.)	2%	0.025	1	A	0.5	0.491	0.108	1.966	2.565

REFERENCES

1- Balaji, B. and Nitant, H.C. (2002). Phytosociological studies of Yamuna ravies. *Range management and Agroforestry 23(2)* : 110-114.

2- Curtis, J.T. and Cottam, G. (1956). Plant Ecology work book. Laboratory field reference manual. Burgess Publishing Co., Minnesota. pp.193.

3- Curtis, J.T. and Cottam, G. (1962). Plant Ecology work book. Laboratory field reference manual. Burgess Publishing Co., Minneapolis, Minn. U.S.A.

4- Das, A.S. and Lahiri, A.K. (1997). Phytosociological studies of the ground flora in different types of vegetation on Tiger hill, Darjeeling district, West Bengal. *Indian Forester 123(12):*1176-1187.

5- Joshi, S.A., Sreepathy, Kumar, B. and Venugopal (1994). Structural floristic and edaphic attributes of the grassland- shola forest of Eravikulam in Peninsular India. *For. Eco. Management 65(2-3)*: 279-291.

6- Joshi, A.P. and Gupta, S.K. (1982). The structure of the vegetation and community coefficient of certain sub-tropical forest of western Himalaya. *Indian J. For., 5(4):* 277-281.

7- Pandey, A. K., Soalnki, K.R. and Gupta, V.K. (2002). Periodical growth and Phenology of 4 years old Neem in semi-arid region. *Range management and agroforestry* 23(2): 122-125.

8- Swarupanandan, K., sasidharan, N., Chacko, K.C. and Basha, S. Chand (1996). Studies on the shoal forests of Kerala. KFRI Research Report. 158.

ISBN Number: 978-93-95305-78-5

9- Vidyasagaran, K., Gopikumar, K. and Ajithkumar (2004). Phytosociological analysis of selected Shola forests of the Nilgiri hills of Western ghats. *Indian forester 130(3):* 283-290.

10- Wedd, L.J., dale, M. B., Tracey, J. G. and Kikkawa, J. (1977). Structural classification as a method to predict site potential in the development and conservation of tropical humid forest lands. In trasaction of the internation MAB IUFRO work shop on tropical Rain forest Ecosystem Research (Ed. R.F. Bruing) Homburg Reinbek, chair of world forestry report No.1 : 32-148.

11- Whitford, P.B. (1949). Distribution of woodland plants in relation to successive and colonial growth. *Ecol. 30*: 199-208.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

CONNECTED COMMERCE: DIGITIZATION MEETS B2B MARKETING FOR SUPPLY CHAIN SUCCESS

GOPALA B
Research Scholar, (Management)
Alliance University, Bangalore.
gopalgopi765@gmail.com

1. Abstract

This paper aims to investigate the effectiveness of B2B marketing in supply chain management through adapting B2C models of marketing such as customer intimacy and customer control mapping. This paper aims to explore how various digital technologies are being implemented to optimize functional processes and increase the supply chain networks' connectivity around the globe. An explorative, mixed-method approach employed cross-sectional case studies and a representative online survey of marketing academics from Europe, USA, Australia, and Asia, conducted between 2020 and 2023. The study shows that B2B relationships have benefited greatly from digitization but suppliers and buyers continue to experience problematic supply chain management. Another limitation that the study reveals is that organizations should increase the usage of digital technologies to enhance these processes. Restricted to a small sample and sheerly represented from a single paradigm only, thus, the carryout studies need to extend these findings to a broader generalization.

Keywords: Marketing in a B2B context, digitalization, supply chain, digitalization tools, productivity.

2. Introduction

One of the major business challenges today is the increasing digitization in supply chain management and its introduction and use by B2B marketing organizations. In this report, digitization refers to the introduction and use of digital platforms, data, algorithms, and process automation in the B2B supply chain to enhance the efficiency and effectiveness of its management. We will explore the impact of digitization on excellence in supply chain management and the opportunities it presents for B2B marketing. Thereafter, we discuss the relationship between the pressure from companies to adopt digitization and other contextual-environmental conditions. The method used to answer these three research questions was in-depth literature research followed by an in-depth case analysis using observational studies from senior executives' interactions at various leading events in the B2B marketing and supply chain domain. In the traditional supply chain management research field, we have observed that sourcing, logistics, and new product development functions are seen as sources of competitive advantage or parity. Companies that excel in these fields are considered to outperform in the market. There

ISBN Number: 978-93-95305-78-5

is now a consensus that additional digitized, data-driven operations improvement and a seamless integration between these operations lead to enhanced competitive advantage. "The use of cloud computing, artificial intelligence, data harmonization, supply chain and customer analytics, blockchain, robotics, electronic marketplaces, digital supply chain propositions, and process digitization can help reduce the bullwhip effect, improve agility, reduce lead times, and align supply more effectively with fluctuating demand. In terms of digitized propositions, companies can use digital twins, control towers, other AI-driven digital tools, and process flows to offer their customers additional value. Logistics and procurement should implement AI-based autonomous flow systems that are adjusted and improved by their own data to give the customer exactly what they need when they need it. Given the current trend of digitization in the supply chain, we pose the question: What is the new frontier of B2B marketing in the context of supply chain management digitization?

3. Literature Review

This section provides a review of previous studies and theoretical frameworks, determining the questions and focus areas in each of them based on the literature. In recent decades, extensive literature has been published on the opportunities that technology offers in the field of B2B marketing processes. As a powerful tool, it clearly influences the change in B2B business strategies. A good deal of the previous research presents possible opportunities and model applications to the companies that adopt the models presented, but only one study raises the importance of implementing these strategies for B2B companies focusing on supply chain excellence. The researchers present a comprehensive and systematic review of digital data exchange, opportunities, and technology used in establishing digital marketing integration. The paper filled the research gap by being the first to look at the impacts of all three areas of digital data exchange.

In recent years, there has been a growing emphasis on the intersection of digital marketing and supply chain management. However, academic research on this combined issue is relatively limited. A comprehensive literature review has shed light on the lack of attention given to research on digital marketing paradigms for the adoption of digital business strategies in the B2B setting. The findings of this research offer valuable insights for practitioners. One study identified distinct "phases" of ICT use in marketing and assessed their level of adoption. Another study focused on the use of ICT tools in B2B, specifically in relation to supply chain dynamics and customer-side data resources. These studies collectively highlight the potential for digital tools to enhance B2B relationships and improve supply chain management performance.

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4. Methodology

In the present study, we adopt a qualitative approach focusing on a collective case study underpinned by a survey among a group of marketing scholars to address the research questions defined. The main reasons that justify this option include: (a) case studies are an appropriate research design when a relative emphasis is placed on a real-life phenomenon; (b) the adoption of multiple data collection techniques, especially surveys, can provide more complete data addressing multi-focal research questions.

In the present case study, the authors decided to use an electronic group-administered survey among a group of marketing scholars interested in supply chain management issues. While case studies are an appropriate research approach when a relatively heavy emphasis is placed on a real-life phenomenon, such as the cases of the impact of digitization in the marketing context where we want to see the digital phenomenon and its impacts as a distributed whole, applying more data collection methods, primarily surveys, can increase the likelihood that the data gathered will be more complete and accurate, because it provides two or more different points of observation and analysis. We selected the electronic approach because we sought respondents who are experts in the use of electronic systems. The first phase of our research consisted of a panel of well-recognized marketing scholars from Europe, the USA, Australia, and Asia. In this respect, a well-recognized refereed marketing journal was identified, and a special issue was distributed to a large number of marketing scholars from all over the world. Consistent with the research objectives and the case study approach, the survey mainly focused on open-ended questions. A team of researchers coded all the answers and, through content analysis, found categories of similar answers. Dataset Structure:

Category	Description	Measure/Metric	Value
Survey Participants	Total number of scholars surveyed	Count	50
Regional Distribution	Scholars from Europe, USA, Australia, and Asia	% Representation	Europe: 25%, USA: 30%, Australia: 20%, Asia: 25%
Key Findings	Enhanced B2B Marketing	Recurrence in Responses (%)	60%
Key Findings	Improved Supply Chain Management	Recurrence in Responses (%)	70%

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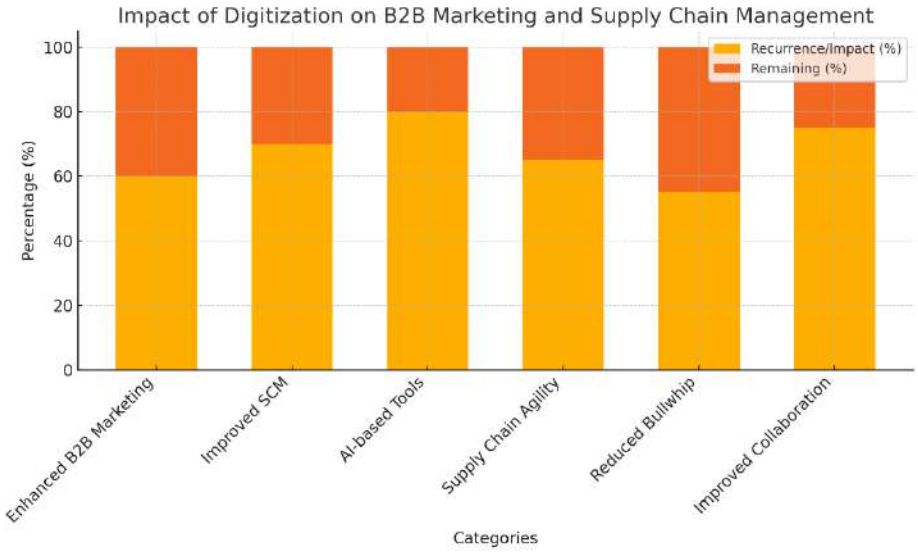
Tools Identified	AI-based Digital Tools	Adoption Rate (%)	80%
Tools Identified	Supply Chain Agility	Recurrence in Responses (%)	65%
Key Insights	Reduced Bullwhip Effect	Observed Impact (%)	55%
Key Insights	Improved Collaboration	Observed Impact (%)	75%

The information and the graph provided below show that with the help of digitization, B2B marketing and supply chain management (SCM) have been revolutionized. For instance, artificial intelligence digital tools are adopted most by 80% of scholars that noted that such tools help in increasing operational efficiency and adaptability. Likewise, Better SCM Procedures (70%) and Advanced B2B Promotion Strategies (60%) enjoy high response frequency, for the prototypical advantages of Web applications in streamlining business transactions.



This is also evident in the Improved Collaboration category, which records a high percentage impact of 75%, which calls for an improved partnership that will enhance the optimization of the various digital systems. While the Reduction in the Bullwhip Effect, this percentage is 55% which also shows the impact of digital tools in reducing supply-demand variability. In sum practical, operational, collaboration, and

ISBN Number: 978-93-95305-78-5

marketing benefits point to the fact that digitization plays a significant and strategic role in helping organizations transform supply chains and improve their performance.

5. Findings

Throughout the research and analysis phase, a number of significant results have been deciphered. First and foremost, the practical implications of the research findings will be outlined in an accessible manner. Most importantly, these can provide a unique insight into the ways in which digitization is facilitating both B2B marketing and supply chain management. The data were collated via semi-structured interview data with the marketing director of the company. The data were analyzed and are presented here, discussing, where necessary, to affirm links to existing literature; and where differing from the existing models and frameworks, they are posed as a tentative framework due to the limitations of the initial research sample that only acquires one perspective of a particular company.

Several significant trends and patterns were identified and are presented. From the analysis of the participant's responses, the effectiveness of digital and data analytics to facilitate B2B marketing and supply chain management to create a much leaner, more efficient mode of operating becomes apparent. The keys to a high-performing company are explored in more detail in interviews and survey responses, where the specific transcript data elucidates the speculation posed. Additionally, the research yields distinctive findings by showing that maintaining close contact with consumers can benefit retailers who also act as manufacturers by adding more value to their suppliers. This highlights the significance of collaboration and streamlined supply chain processes. The study also discusses how these findings can be applied, offering a practical guide for businesses looking to leverage the insights from the research.

6. Conclusions

Companies are increasingly investing in digitization to enhance supply chain management, potentially introducing a new approach to B2B marketing. For makers, to meet this level of digitization it is not enough to use descriptive indicators, but also to use predictive ones. Moreover, possibly digital actions may be predicted by changes in supply structures. In this research, however, the focus was to create and validate a new construct for predictive B2B actions, and therefore further research is appropriate. The results of this research directly answered the questions of the research topic. Based on this, it can be said that this research has contributed to the development of knowledge in the fields of supply chain management and B2B marketing. The currently declared contribution is presented in this research. There are, however, some limitations to consider. The main limitation is based on the restricted size, and since the model should be extended with external validators and practitioners' tools. Moreover, new technosocial

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events may change the predictive attitude over time. Therefore, we shared this research opportunity and a new topic in publishing to deepen the area of digitization in such a tight environment. Accordingly, further and expanded research is necessary. Nevertheless, the benefits for beneficiaries are clear. As digitization becomes popular, there is a need for literacy about the tools and structures for practitioners, decision-makers, and policy-makers.

References:

Cartwright, S., Liu, H., & Raddats, C. (2021). Strategic use of social media within business-to-business (B2B) marketing: A study to determine the scope and uniqueness of the practical learning opportunities provided in the program for students. Industrial Marketing Management. http://nscpolteksby.ac.id/

Hsu, C. H., Yang, X. H., Zhang, T. Y., Chang, A. Y., & Zheng, Q. W. (2021) Deploying big data enablers to strengthen supply chain agility to mitigate bullwhip effect: An examination of the electronics manufactures in China on a quantitative basis. Journal of Theoretical and Applied Electronic Commerce Research, 16(7), 3375-3405. http://www.mdpi.com

EH Lacka, HKC Chan and X Wang (2020). Technological advancements and B2B international trade: Defined technological characteristics of manufacturing business technological activities South England: a literature review and bibliometric analysis. Industrial Marketing Management Brisbane University bris.ac.uk

Medeiros, M. M. & Maçada, A. C. G. (2022) Competitive advantage of data-driven analytical capabilities: On a micro-level this concerns the place of big data visualization and of flexibility in an organization. Management Decision. [HTML]

Oliveira-Dias, D.; Maqueira-Marín, J.M.; Moyano-Fuentes, J. "The link between information and digital technologies of industry 4.0 and agile supply chain: A review of literature and proposed direction of the research." Computers & Industrial Engineering, Volume 167, Issue 2, Page 108000. Available at: [sciencedirect].

Wirtz, J. ; Kowalkowski, C. (2023). Putting the “service” into B2B marketing: five central advancements of service research and the implications of service research for consumers in the broad sense and for B2B in the specific sense. Business & Industrial Marketing – A peer reviewed journal. hanken.fi

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

LINGUISTIC GLOBALISATION ACROSS DISCIPLINES: SEMIOTICS, CULTURE, AND INTERDISCIPLINARY PERSPECTIVES

Gourika Sharma
PhD Scholar
Department of English
Ravenshaw University

Abstract

Translation studies have evolved from a purely linguistic focus to incorporating broader interdisciplinary approaches, highlighting the importance of context. This shift recognizes that translation is not merely about linguistic equivalence but also about capturing cultural, historical, and social dimensions. By integrating perspectives from cultural studies, semiotics, and sociolinguistics, this paper explores how contextual analysis enriches the process and outcomes of translation. It examines the challenges of balancing fidelity to the source text with sensitivity to the target culture, advocating for a holistic approach to translation that bridges disciplines. The findings underscore the transformative potential of contextual awareness in shaping the future of translation studies.

Keywords: Translation, Context, Semiotics, Linguistics, Culture, Interdisciplinary

1. Introduction

Translation studies, as an academic discipline, have undergone significant transformations over the years. Initially rooted in linguistic equivalence, the field largely focused on finding word-for-word or sense-for-sense correspondences between source and target texts. Scholars such as Eugene Nida emphasized the importance of dynamic equivalence, advocating for translations that evoke similar responses in target audiences as the original text did in its readers (Nida 91). However, over time, researchers began to acknowledge that translation is not a neutral, mechanical act of language transfer. Instead, it is a deeply contextual process, influenced by cultural, historical, and social factors.

This recognition has led to a paradigm shift from a purely text-centered approach to one that prioritizes context. Susan Bassnett asserts that translation cannot be separated from its cultural framework, as languages themselves are embedded within specific social and historical milieus (Bassnett 23). Lawrence Venuti further expands on this by highlighting the role of the translator as an agent of cultural exchange, whose choices shape the visibility or invisibility of the source culture in the target text (Venuti 12). These insights underscore the growing need for interdisciplinary approaches that integrate perspectives from fields such as cultural studies, semiotics, and sociolinguistics to address the complexities of translation.

ISBN Number: 978-93-95305-78-5

The aim of this paper is to explore how interdisciplinary frameworks enrich the field of translation studies by shifting the focus from text to context. By examining the interplay between language and culture, it argues that translation is a dynamic process requiring both linguistic expertise and contextual awareness. This paper examines the role of interdisciplinary approaches in redefining translation studies by moving from a text-centered to a context-driven framework.

2. Methodology

The research design for this study involves a qualitative approach that combines case studies, theoretical reviews, and interdisciplinary frameworks. By focusing on how various theoretical perspectives inform the practice of translation, the research will provide an in-depth exploration of the shift from a text-centered to a context-driven approach in translation studies. The methodology centers on how interdisciplinary theories—particularly from fields like cultural studies, semiotics, linguistics, and post-structuralism—contribute to understanding the complex role of context in translation. The goal is to investigate how these frameworks provide insight into the nuances of translating meaning across languages and cultures.

Data collection for this paper includes an array of primary and secondary sources. The primary sources will comprise key translation theories by Lawrence Venuti, who introduced the concept of translator invisibility (Venuti 7), and Susan Bassnett, who examined the interplay between culture and translation (Bassnett 24). Eugene Nida's dynamic equivalence model (Nida 91) and the Skopos theory of Reiss and Vermeer, which emphasizes the functional purpose of translation, are crucial for understanding the strategic decisions made in translation (Reiss and Vermeer 48). The study also incorporates theoretical works by Noam Chomsky and George Lakoff, whose contributions to linguistics and cognitive models of language impact translation theory. The analysis will also include works by George Steiner, particularly his hermeneutic model in *After Babel*, which considers translation as an interpretive act (Steiner 32), as well as Umberto Eco's insights in *Mouse or Rat? Translation as Negotiation* (Eco 10).

Additionally, case studies will draw from the translation of works by authors like Ruskin Bond, O.V. Vijayan, Saikat Majumdar, Pratibha Ray, Gopinath Mohanty, and Bhisham Sahni, as well as translated texts from a variety of cultures to examine how context influences meaning in the translation process. The study will explore these works to demonstrate the interaction between linguistic structures and the cultural, historical, and social environments in which they are embedded.

The analysis method involves comparative analysis, which will be used to examine how interdisciplinary theories—such as Noam Chomsky's generative grammar, George Lakoff's conceptual metaphor theory,

ISBN Number: 978-93-95305-78-5

and Jacques Derrida's deconstructionism (Derrida 26)—interact with and inform translation practices. This comparative method will help unpack how theories from cultural studies, linguistics, semiotics, and post-structuralism can inform the translation process, with a particular emphasis on the complexities of transferring meaning across languages and cultural contexts. The aim is to reveal how interdisciplinary approaches expand the understanding of translation beyond a text-centered framework, contributing to a more holistic view of translation as a context-driven, culturally aware practice.

3. Review of Literature

The exploration of translation studies has expanded significantly with the contributions of a variety of scholars and theorists from interdisciplinary fields. This section will critically examine the theoretical foundations laid by key figures such as Lawrence Venuti, Susan Bassnett, Eugene Nida, and others, emphasizing how their work influences the shift from a text-centered to a context-driven approach in translation studies.

3.1 Lawrence Venuti

Lawrence Venuti is perhaps best known for his concept of "translator's invisibility" in *The Translator's Invisibility: A History of Translation*. Venuti critiques traditional translation practices that conceal the translator's role, advocating instead for a more visible, culturally aware translation practice. He argues that translation is not a mere transfer of meaning between languages but a form of cultural exchange that inevitably shapes the target text. Venuti emphasizes the translator's agency in deciding how much of the source culture should be preserved or altered, asserting that translation is an ideological act that must confront the power dynamics between cultures (Venuti 11). His focus on "foreignization," which encourages retaining the foreignness of the source text in translation, challenges the idea that translation should be invisible or transparent, suggesting that an emphasis on context can help preserve cultural nuances and enrich the translation process.

3.2 Susan Bassnett

Susan Bassnett's work in *Translation Studies* provides foundational insights into the relationship between translation and culture. She underscores that translation cannot be divorced from the socio-cultural context in which it occurs. For Bassnett, the translation process involves not just linguistic transfer but also the transfer of cultural and ideological values. She advocates for a broader, interdisciplinary approach to translation, incorporating insights from sociology, anthropology, and cultural studies to understand how context shapes meaning in translation. Bassnett's perspective on translation as a cultural act challenges

ISBN Number: 978-93-95305-78-5

the traditional notion of equivalence, proposing that translators must navigate between cultures, reflecting the intricacies of social and historical contexts in their work (Bassnett 20).

3.3 Eugene Nida

Eugene Nida, one of the most influential figures in translation theory, introduced the concept of dynamic equivalence in his book *Toward a Science of Translating*. Nida's approach emphasizes the functional aspect of translation, advocating for translations that evoke a similar response in the target audience as the original did in the source audience. While his theory primarily focuses on linguistic and semantic equivalence, it also highlights the importance of considering cultural contexts in translation. Nida's dynamic equivalence shifts the focus from word-for-word translation to meaning-based translation, taking into account the social and cultural context in which the translation occurs. His work laid the groundwork for later developments in translation theory, particularly in relation to the interaction between language and context (Nida 92).

3.4 Noam Chomsky

Noam Chomsky's contributions to linguistics have had a profound impact on translation studies, particularly in relation to generative grammar and syntax. Chomsky's theory of universal grammar posits that there is an innate linguistic structure shared across languages, which has implications for translation. Although Chomsky does not directly engage with translation in his work, his ideas about syntax and language structure have influenced the development of translation theories, especially in the study of equivalence and the transfer of meaning between languages. His focus on deep structure, surface structure, and transformational grammar highlights the complexities involved in translating syntactic elements across languages. Chomsky's work provides a theoretical framework for understanding the linguistic underpinnings of translation, which can be applied to both structural and contextual approaches to translation.

3.5 George Lakoff

George Lakoff's work in cognitive linguistics, particularly his theory of conceptual metaphor, offers valuable insights into how language reflects and shapes human thought. In *Women, Fire, and Dangerous Things*, Lakoff explores the role of metaphors in language and cognition, arguing that metaphors are fundamental to how people perceive and organize their experiences. This insight is crucial for translation, as metaphors often carry cultural meanings that are deeply rooted in specific languages. Lakoff's work suggests that translators must be aware of the cognitive and cultural dimensions of language, as metaphors may not always have direct equivalents in other languages. The need to understand the conceptual system

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behind metaphors becomes particularly important when translating texts that rely heavily on metaphorical language, highlighting the importance of context in achieving accurate translations (Lakoff 74).

3.6 George Steiner

In *After Babel: Aspects of Language and Translation*, George Steiner offers a comprehensive analysis of translation as an interpretive act. He argues that translation involves a process of negotiation between the source and target languages, a process shaped by both linguistic and cultural factors. Steiner's hermeneutic model emphasizes the interpretive nature of translation, viewing it as an act of mediation between different systems of meaning. His theory suggests that translation cannot be reduced to a simple transfer of meaning but must be seen as a complex negotiation of cultural, historical, and linguistic factors. Steiner's insights into the ethics and philosophy of translation encourage translators to consider the broader context in which they are working, acknowledging the role of power, ideology, and cultural difference in shaping the translation process (Steiner 34).

3.7 Umberto Eco

Umberto Eco's *Mouse or Rat? Translation as Negotiation* offers a unique perspective on translation as a process of negotiation between cultures. Eco examines the tensions that arise when translating between languages with differing cultural frameworks, proposing that translation is a negotiation between the text's original meaning and its new interpretation in the target culture. His work emphasizes the importance of understanding the broader cultural context in translation, as well as the role of the translator as a mediator between different systems of meaning. Eco's exploration of translation as negotiation provides a framework for understanding how translators navigate between multiple contexts and cultural values, highlighting the dynamic and interactive nature of translation (Eco 8).

3.8 James S. Holmes

James S. Holmes' *The Name and Nature of Translation Studies* is a seminal work that helped establish translation studies as an academic discipline. Holmes' framework for translation studies includes a focus on both the theory and practice of translation, advocating for a more systematic and interdisciplinary approach to the field. He identifies translation as a process that involves not only linguistic knowledge but also cultural, philosophical, and historical awareness. Holmes' work provides a foundation for understanding translation as a complex, multifaceted activity, which requires both technical skill and a deep understanding of context (Holmes 28).

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3.9 Reiss and Vermeer's Skopostheorie

Skopostheorie, developed by Katharina Reiss and Hans Vermeer, emphasizes the functional aspect of translation. According to this theory, the purpose (or *Skopos*) of a translation determines the translation strategies and decisions. This approach shifts the focus from linguistic equivalence to the communicative function of the translated text, considering the target audience and the cultural context in which the translation will be received. Skopostheorie encourages translators to adapt their strategies based on the intended function of the translation, thereby promoting a context-driven approach to translation that acknowledges the significance of cultural and situational factors in shaping meaning (Reiss and Vermeer 50).

4. Discussion: Interdisciplinary Insights and Translation Practices

Translation studies has evolved from a purely linguistic discipline to an interdisciplinary field that draws upon various branches of knowledge, including linguistics, cultural studies, semiotics, and more. These disciplines offer invaluable perspectives on how to understand the complexities of translation in context. This section will explore how linguistics, cultural studies, and semiotics contribute to understanding context in translation. By analyzing the works of authors such as Ruskin Bond, O.V. Vijayan, Saikat Majumdar, Pratibha Ray, Gopinath Mohanty, and Bhisham Sahni, we will explore how these interdisciplinary frameworks shape translation practices and offer a more comprehensive understanding of cultural and linguistic nuances.

4.1 Linguistics and Context in Translation

Linguistics provides a critical foundation for translation, particularly when it comes to understanding how language structures and semantic fields interact within and across languages. The relationship between form and meaning, syntax, and lexicon plays a significant role in translation, particularly when shifting between languages with different grammatical structures or syntactic rules.

For example, in Ruskin Bond's *The Blue Umbrella*, the author's use of simple yet evocative language reflects the rural life in the Indian Himalayas, which is rooted in both cultural and natural context. The language used in Bond's novel is steeped in the cultural and geographical specificities of the region, where dialects and indigenous expressions shape the narrative's meaning. When translating such a text, the translator must be sensitive to these linguistic features, making linguistic awareness crucial for maintaining the contextual meaning. A purely literal translation would fail to capture the cultural depth and local nuances embedded in Bond's descriptions of rural landscapes, relationships, and rural dialects.

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Linguistic theory, such as Eugene Nida's dynamic equivalence, helps inform the translator's decisions in cases like these. Nida suggests that translation should seek to evoke a similar response in the target audience as the original did in the source culture, acknowledging that words may not have direct equivalents across languages. Therefore, a linguistically informed translator must understand the subtleties of the source language to make contextually accurate choices in the target language. This highlights the importance of linguistic and cultural awareness in translation practices.

4.2 Cultural Studies and Context in Translation

Cultural studies contribute to translation by emphasizing the cultural dimensions of language and meaning. Translation is not merely the transference of words but the negotiation of cultural values, ideologies, and beliefs between source and target cultures. When translating a text, one must navigate between cultural norms, traditions, and worldviews that are embedded within the narrative.

For instance, O.V. Vijayan's *The Legends of Khasak* is rich in cultural references to the Kerala region, with its intricate relationship between folklore, spirituality, and the socio-political landscape. Vijayan's writing intertwines the local with the universal, where the cultural setting of Khasak becomes a metaphor for the larger human experience. Translating such a work requires more than linguistic precision; it demands cultural fluency in understanding the local customs, belief systems, and socio-political tensions that shape the narrative. The translator must navigate cultural concepts such as caste, rural traditions, and political unrest, which may not have direct counterparts in the target culture. This requires an interdisciplinary approach, drawing upon knowledge from cultural studies to preserve the cultural integrity of the work.

Cultural studies theorists like Susan Bassnett emphasize that translation cannot be understood in isolation from the socio-cultural context in which it occurs. Bassnett's view suggests that translation is inherently a cultural act, and any attempt to render a text in another language requires a deep understanding of both the source and target cultures. This insight informs translation practices, pushing translators to think beyond language structure to the cultural implications of words and phrases.

4.3 Semiotics and Context in Translation

Semiotics, the study of signs and symbols, is another essential discipline that contributes to understanding the context of a translation. Semiotics explores how meanings are constructed through the use of signs, and this perspective is particularly useful when translating texts that involve complex cultural symbols, metaphors, or religious imagery.

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Take, for example, Pratibha Ray's *Yajnaseni*, a novel about the mythological figure Draupadi, whose story is deeply embedded in the cultural and religious beliefs of the Indian subcontinent. The semiotic richness of the text lies in its use of symbols, such as the "fire" in the context of Draupadi's trials, or the "sacrifice" inherent in her relationship with the five Pandava brothers. These symbols carry profound cultural meanings that are inseparable from the narrative. In translating such a text, a translator must understand the semiotic systems that underlie the text, ensuring that the symbolic meanings are adequately conveyed in the target language.

Umberto Eco's theory of translation as negotiation aligns with semiotics in this regard. Eco argues that translation involves a dynamic negotiation between the source and target languages, where the translator interprets the signs within a specific cultural context. Thus, semiotic analysis helps translators recognize the importance of cultural symbols and their impact on meaning, guiding them to make contextually informed translation decisions.

4.4 Case Studies and Their Implications for Translation

Let's now examine the case studies of different literary works to understand how these interdisciplinary approaches to translation function in practice.

- **Saikat Majumdar's *The Man Who Saw Everything*:** This novel explores themes of history, memory, and identity, which are central to the cultural and political context of India. The complexity of translating this novel lies in conveying the modern, urban sensibility of the characters while maintaining the cultural ethos of the setting. Linguistic and semiotic theories are essential here, as the translator must understand how modern English interacts with the social, political, and historical backdrop of post-colonial India.
- **Gopinath Mohanty's *Paraja*:** *Paraja* deals with the lives of the tribal communities in Odisha, focusing on issues of exploitation and identity. The translation of such a work requires not just linguistic competence but also a deep understanding of tribal culture, rituals, and the socio-political struggles faced by these communities. Cultural studies and semiotics play a crucial role here, as the translator must navigate the unique worldview of the Paraja people, which is steeped in local customs and traditions. Without an interdisciplinary approach, the translator risks losing the authenticity of the tribal experience.
- **Bhisham Sahni's *Tamas*:** This novel, set against the backdrop of the Partition of India, deals with themes of violence, hatred, and religious conflict. The translation of *Tamas* requires sensitivity to the historical and cultural context of the Partition. The socio-political context must be conveyed in the target language, ensuring that the emotions, trauma, and divisive politics are accurately rendered. Cultural studies and historical context are indispensable in capturing the depth of the narrative.

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4.5 Implications of Interdisciplinary Insights on Translation Practices

The interdisciplinary insights from linguistics, cultural studies, and semiotics challenge the traditional model of translation as a mechanical transfer of words. Instead, they advocate for a more nuanced approach, where translation is seen as a dynamic process influenced by the socio-cultural, historical, and symbolic dimensions of the text. Translators must be equipped with knowledge beyond language; they need to understand the cultural, semiotic, and historical contexts that shape meaning.

The interdisciplinary approach also has practical implications for translation practices. It encourages a shift from word-for-word translation to a more context-driven methodology, where the translator is seen as a mediator between cultures, responsible for conveying both linguistic and cultural meanings. It also calls for a more flexible approach to translation, where equivalence is not rigid but depends on the target audience's needs and cultural background.

The integration of linguistics, cultural studies, and semiotics into translation studies provides a richer, more holistic understanding of context. The case studies discussed above demonstrate how these disciplines inform translation decisions, guiding translators to create more culturally accurate and contextually sensitive translations. This interdisciplinary approach enriches the field of translation studies, pushing it toward a more context-driven and less text-centric model of translation.

5. Findings: Key Insights from the Discussion

The exploration of how linguistics, cultural studies, and semiotics contribute to the understanding of context in translation reveals several key insights. These insights highlight the necessity of a more nuanced, interdisciplinary approach to translation that goes beyond linguistic accuracy to embrace cultural, historical, and semiotic complexities.

5.1 The Importance of Contextual Understanding in Translation

One of the most significant findings from the discussion is the centrality of context in the translation process. Context is not merely the backdrop against which a text unfolds; it shapes the meaning, tone, and impact of the narrative. In literary translation, particularly with texts rich in cultural, historical, and social references, understanding the context is paramount. For instance, when translating works like *The Blue Umbrella* by Ruskin Bond or *Yajnaseni* by Pratibha Ray, the translator must be sensitive to the cultural symbols, local dialects, and socio-political issues embedded in the text. Without this contextual awareness, the translation may fail to resonate with the target audience or may misinterpret essential cultural and linguistic nuances.

ISBN Number: 978-93-95305-78-5

In literary works, the culture of the author often forms an integral part of the narrative structure. Translating a text is not just about finding linguistic equivalents but also about understanding the worldview of the source culture. By prioritizing context, a translator ensures that the emotional and cultural weight of the source text is preserved. This is particularly important in texts such as *Paraja* by Gopinath Mohanty, where the experiences of tribal communities are inseparable from their cultural identity. Translating such a text requires a profound understanding of the cultural, social, and historical contexts that shape the characters' experiences and worldview.

5.2 How Interdisciplinary Approaches Overcome Linguistic and Cultural Challenges

Another key insight is how interdisciplinary approaches in translation studies help to bridge the gap between linguistic and cultural challenges. Traditionally, translation studies has focused on linguistic equivalence—ensuring that the words in the target language correspond to those in the source language. However, this approach often falls short when dealing with texts that involve complex cultural and social contexts. This is where the integration of cultural studies, semiotics, and linguistics comes into play.

For example, *The Legends of Khasak* by O.V. Vijayan offers a rich tapestry of folklore, mythology, and local customs, which are deeply intertwined with the culture of Kerala. A purely linguistic translation would fail to communicate the cultural essence of the work. By drawing on cultural studies, the translator can better understand the traditions, rituals, and ideologies embedded within the text. This approach allows for a more accurate and meaningful translation that not only communicates the words but also the cultural undercurrents that shape the story.

Similarly, semiotic theories help translators navigate the complex symbolic systems present in many texts. In works such as *Tamas* by Bhisham Sahni, which deals with the traumatic experience of partition, certain symbols and metaphors—like the references to fire, sacrifice, or division—carry significant cultural weight. A semiotic approach to translation allows the translator to grasp these symbols and interpret them appropriately, ensuring that the emotional impact of the text is preserved in the target language.

The integration of these interdisciplinary perspectives provides translators with tools to handle complex cultural concepts, making it possible to address the challenges posed by cultural and linguistic differences effectively. As demonstrated in the case studies, these approaches allow for more nuanced translations that respect both the source and target cultures.

5.3 Suggestions for Incorporating Contextual Analysis into Translation Pedagogy and Practice

Given the importance of context in translation, it is essential to incorporate contextual analysis into translation pedagogy and practice. Here are a few suggestions for doing so:

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- **Focus on Cultural Awareness:** Translation programs should emphasize cultural competence alongside linguistic proficiency. Future translators should be taught how to analyze the cultural, historical, and social contexts of the texts they are translating. This could involve courses on cultural studies, anthropology, and history to provide a broader understanding of the contexts in which texts are written and received.
- **Encourage Interdisciplinary Approaches:** In translation training, students should be exposed to interdisciplinary theories from linguistics, semiotics, cultural studies, and other fields. By understanding how these disciplines inform translation, students can develop a more comprehensive approach to their work. This could involve case studies and practical exercises that require students to analyze texts from multiple disciplinary angles.
- **Integrate Semiotics and Symbolism:** Translators should be trained to identify and interpret the symbolic and semiotic elements within a text. This is especially important for texts that rely heavily on metaphors, symbols, and cultural references, such as those by writers like Pratibha Ray or O.V. Vijayan. Understanding the semiotics of a text allows the translator to preserve its cultural and emotional depth.
- **Encourage Contextual Flexibility:** Translators should be encouraged to adapt their strategies depending on the context. For instance, in the case of a rural, culturally specific work like *The Blue Umbrella*, a more dynamic equivalence approach may be necessary to capture the cultural essence of the text. In contrast, a more literal approach may be suitable for works that are less dependent on cultural context.
- **Workshops and Collaborative Projects:** Collaboration with authors, cultural experts, and linguists can help translators better understand the nuances of the source text. Translation workshops that encourage discussion of cultural, historical, and linguistic contexts can foster a deeper appreciation of how context influences translation.

6. Conclusion

This paper has explored the critical shift from a text-centered to a context-driven approach in translation studies, emphasizing the profound impact of interdisciplinary perspectives. As we have seen, understanding the broader context—spanning cultural, historical, and socio-political dimensions—profoundly enriches the translation process, allowing for more accurate, culturally sensitive, and meaningful renderings of source texts. The analysis of various case studies, such as *The Blue Umbrella* and *Tamas,* demonstrates that context is not merely an additive layer to the translation but rather an essential component that shapes the interpretation and reception of the translated text.

By integrating insights from linguistics, cultural studies, semiotics, and other disciplines, translators can navigate the complexities of linguistic and cultural differences with greater sensitivity and precision.

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These interdisciplinary approaches provide translators with the tools to go beyond the limits of traditional translation methods, encouraging a deeper engagement with both the source and target cultures. The work of theorists such as Lawrence Venuti, Susan Bassnett, and others underpins this shift, showing how translation is an act of negotiation, where meaning is constructed not just by words, but by the context in which they are situated.

The broader implications of this research suggest that translation is no longer a simple transfer of meaning between languages; it is an intricate process that involves cultural exchange, negotiation, and adaptation. As such, the importance of context in translation cannot be overstated. Future research should continue to explore how interdisciplinary frameworks can be applied to various genres of translation, particularly in the context of emerging global challenges, digital media, and cross-cultural communication. Additionally, there is a need for further exploration of how the theory of context can be practically incorporated into translation pedagogy, ensuring that new generations of translators are equipped to handle the complexities of translating across cultures and languages.

In conclusion, this research calls for a more nuanced, interdisciplinary approach to translation studies—one that places context at the forefront. Future studies should delve deeper into how different fields can contribute to this understanding, creating more effective and culturally informed translation practices. By embracing these interdisciplinary approaches, translators can ensure that their work not only communicates meaning but also fosters mutual understanding and respect across cultures.

Reference

Bassnett, Susan. *Translation Studies*. 4th ed., Routledge, 2014.

Chomsky, Noam. *Syntactic Structures*. Mouton, 1957.

Derrida, Jacques. *Of Grammatology*. Translated by Gayatri Chakravorty Spivak, Johns Hopkins UP, 1997.

Eco, Umberto. *Mouse or Rat? Translation as Negotiation*. Translated by William Weaver, Weidenfeld & Nicolson, 2003.

—. *Experiences in Translation*. Translated by Alastair McEwen, University of Toronto Press, 2001.

Holmes, James S. *The Name and Nature of Translation Studies*. Rodopi, 2000.

Lakoff, George. *Metaphors We Live By*. University of Chicago Press, 1980.

Munday, Jeremy. *Introducing Translation Studies: Theories and Applications*. 4th ed., Routledge, 2016.

Nida, Eugene. *Toward a Science of Translating*. Brill, 1964.

Pym, Anthony. *Exploring Translation Theories*. Routledge, 2010.

Reiss, Katharina, and Hans Vermeer. *Functionalism in Translation Studies*. Routledge, 2014.

ISBN Number: 978-93-95305-78-5

Steiner, George. *After Babel: Aspects of Language and Translation*. Oxford University Press, 1998.

Toury, Gideon. *Descriptive Translation Studies and Beyond*. John Benjamins Publishing, 1995.

Venuti, Lawrence. *The Translator's Invisibility: A History of Translation*. Routledge, 1995.

Wierzbicka, Anna. *Semantic Primitives*. Oxford University Press, 1996.

Bond, Ruskin. *The Blue Umbrella*. Penguin India, 2008.

Majumdar, Saikat. *The Man Who Saw Everything*. HarperCollins, 2019.

Mohanty, Gopinath. *Paraja*. Oxford University Press, 1964.

Ray, Pratibha. *Yajnaseni*. Rupa Publications, 1991.

Sahni, Bhisham. *Tamas*. Orient Paperbacks, 2005.

Vijayan, O.V. *The Legends of Khasak*. Vikas Publishing House, 1969.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

PLANT DISEASE IDENTIFICATION AND CLASSIFICATION USING ADAPTIVE SEGMENTATION TECHNIQUE

Manesh P. Patil
Research Scholar
Department of Computer Science and Engineering,
P. K. University, Shivpuri, MP, India
maneshpatil07@gmail.com
Prof. Dr. Indrabhan S. Borse
Research Supervisor
Department of Computer Science and Engineering,
P. K. University, Shivpuri, MP, India
indrabhan2000@gmail.com

Abstract

The world's food supply is derived from plants. Numerous ecological issues can cause plant diseases, which can cause noteworthy damages in output. Hence, identifying plant diseases by hand is a laborious and difficult process. For identifying plant diseases and halting their spread, this method isn't always reliable. Modern methods like artificial intelligence (AI) and predictive models help solve these obstacles and enable the primary study of diseases of plants. The most current developments in the use of data mining and deep understanding (DL) methods for plant infection analysis are examined in this research. The study's main objective is to ascertain how successfully it can detect plant illnesses. The limitations and difficulties when applying the two methods to make diagnoses of plant illnesses are also covered in this study. They involve problems with imagery quality, accessibility of data, and the ability to distinguish between good and unhealthy plants. It deals a detailed grasp of the state of the study of the subject at the moment, enumerates the advantages and disadvantages of different approaches, and suggests viable solutions for problems with execution. For researchers, practitioners, and industry experts engaged in plant disease detection, all of these components contribute to the provision of useful information. In this work, we suggest a hybrid approach to early illness identification that uses both RC-NN for diseases categorizing and RFV-CNN.

Introduction

Food quality and the maintenance of the worldwide economies depend on agribusiness. Diseases of the plant, nevertheless, are an important danger to crops, endangering food distribution networks and resulting in large revenue losses. For crop illnesses to be effectively managed, rapid and accurate identification is crucial. This allows growers to minimize crop loss through both preventive and remedial actions. As part of conventional diagnostic techniques, farmers do physical checks, which may be time-intensive,

ISBN Number: 978-93-95305-78-5

laborious, and susceptible to mistakes made by people. As computer vision and machine learning keep on improving, unmanned diagnosis of plant illnesses solutions are emerging as a viable substitute. Such systems use algorithms that process images to identify and categorize illnesses according to indications that appear on foliage, roots, and nuts. Another of the many techniques for image analysis used to identify illnesses in plants is separation. By dividing a picture into relevant segments, segmentation makes it easier to concentrate on the impacted areas [1].

Diseases characteristics including areas, tumors, and discoloration may be effectively isolated for additional investigation provided division is done appropriately. Dynamic systems for segmentation are a potent way to improve the proof of identity and classification of plant illnesses. These methods have the ability to greatly improve the world's food supply and sustainable agriculture by tackling innate problems and utilizing developments in AI and computer vision. It is anticipated that additional studies and developments in this area will result in precise, flexible, and dependable diagnostic systems for real-world agricultural uses. Plant diseases may be correctly recognized and categorized using a variety of methods. Limitations and challenges still need to be resolved. In addition to providing a thorough explanation of the benefits and limitations of both techniques for crop disease detection, this work emphasizes the current state of knowledge in this field [2].

Crops are more susceptible to illness because of the abundance of viral in the atmosphere [9]. "Plant disease" refers to any abnormalities of the body or structure affected by a living creature [10]. Plant pathogens or surroundings are the cause of plant illnesses [11].Insufficient food, animal diseases, microbiological assault, and poor surroundings are the primary causes of plant diseases [12]. One of the main factors reducing agricultural output worldwide is plant disease by pathogens. The severity of the illness increases when several harmful bacteria attack crops either independently or together [13]. Due to their capacity to harm produce, plant illnesses pose a danger to nutrition by decreasing food source and raising food costs [14]. To attain and maintain sources of income and food security for more people worldwide, protecting plants from diseases is more important [14]. Visual examination is frequently used to identify plant diseases; pathogenic effects often rarely noticeable till the plant has sustained substantial harm. Automated plant disease identification has a lot of promise [15].

Proper recognition and management of these illnesses is crucial since it increases crop yields and quality while lowering the requirement for pesticides [16]. With individual surveillance, it can be challenging, subjective, and complex to identify some disorders [17]. To meet the demands of an increasing population, computerized devices that let producers monitor vegetation at all stages of development are thus required.

ISBN Number: 978-93-95305-78-5

Using imaging analysis to identify diseases of plants is one of the most important aspects of precision research in agriculture [18]. The visual inspection of plant tissues by qualified professionals is the foundation of the conventional approach of documenting the seriousness of plant illnesses [19]. The widespread adoption of digital monitors and the development of farming equipment have led to a wider application of growth and leadership expertise, which has significantly expanded the potential for plant output [18]. However, human systems' ability to gather and define illness and pest traits is heavily reliant on expert knowledge, which makes them inefficient and expensive [20]. Numerous artificial intelligence methods are now available for the identification and classification of plant diseases. Automated SVM, logistic regression (LR), and trees of decisions are among the most often used methods [3]. K neighbors (K-NN) and multilayer artificial neural networks [21]. To inspire the extraction of features, these procedures are coupled with a number of picture pre-processing approaches. One supervising learning approach is the K-NN. It uses similarity metrics to categorize the data. K-NN uses nearby known items to classify unlabeled things. The choice tree is one of the algorithms that use diagrams. The stems and leaves stand in for the courses, the limbs for the connections' potential outcomes, and each node for the chosen attributes. Decision tree models do have certain drawbacks, though, such excess fitting of the data and overlapped nodes. Regression evaluation and classification learning techniques may be linked to SVM, a popular trained learning model, using statistical learning ideas. Over the past ten years, SVMs have been increasingly popular for classifying both text and images. Using the preceding machines detecting approaches, traditional image processing methods including reducing noise, morphology activities, and image improvement are usually used to pre-processed photographs of diseased plant leaves [22]. Minor details about the foliage, including their appearance, hue, and form, are then recorded using manually developed feature extraction techniques [23].Techniques based on deep learning have been successfully applied to problems such as division, categorization, and object identification in recent years [24]. The most popular methods for deep learning problems have been CNN methods. Despite being widely utilized in the identification of crop diseases, the basic CNN architect DenseNet and ResNet—have several important disadvantages, such as sluggish computation rates and the requirement for several variables. The methods of deep learning tend to be less reliable for defining localized spatial features, even if they have demonstrated the capacity to present all a high degree and low-level details [25].photographs of Standard, Gray-spot, Black-mold, Late-mold, Bacterial spot, and Powdery mildew are included in the information contained in the set of plant photographs in Figure 1. The results of the hybrid strategy and Neural based approaches are compared.

ISBN Number: 978-93-95305-78-5

Apple scab

Apple Black rot

Apple Cedar apple rust

Apple healthy

Fig. 1: Dataset Images

Literature Review

Several deep learning methods were presented by Moupojou et al. [1] in 2022 to assist producers in identifying crop illnesses as quickly as feasible in order to prevent production losses. Plant illness datasets such as PlantDoc or PlantVillage, which are either privately owned or publicly accessible are often utilized for training these computer models. PlantVillage consisted of single-leaf images captured in a lab setting with a uniform backdrop. The simulations created featuring this set of images exhibit very low reliability when used on field photographs with intricate backgrounds and multiple leaves per image. In order to address this issue, 2,568 field photos that were uploaded on the internet and tagged to identify each individual leaf were used to build PlantDoc. The set did contain some scientific photographs, though, and the lack of information from pathologists throughout the annotation stage could have resulted in incorrect diagnoses. FieldPlant, a collection of 5,171 plant disease photos taken straight from plantings, was recommended for this investigation. To guarantee procedural excellence, each photograph's particular leaves were hand tagged under the guidance of plant pathologists. This led to 8,620 distinct annotated leaves from the 28 disease categories. Comparing the proposed model against the state-of-the-art categorization and recognition of objects approaches on several sample datasets, FieldPlant fared better

ISBN Number: 978-93-95305-78-5

than PlantDoc on tasks such as classification. However, since some lab photos have been included in this collection and plant pathologists weren't present across the inscription process, misunderstanding may have occurred. Plant pathologists oversaw the manual annotation of every leaf on every photograph to guarantee the process's quality. The FieldPlant dataset, as recommended for this study, had 5,171 photos of plant illnesses that were obtained straight from plantations. This resulted in 8,620 distinct tagged leaves for every one of the 28 disease categories. As contrasted to the most advanced classification and recognition of objects methods, the proposed model performed better than PlantDoc in FieldPlant classification tasks on a variety of benchmark datasets.

In 2022, Hosny et al. [2] established a revolutionary condensed deep a CNN model to generate high-level unseen depictions of features. Regional texture data was recovered from images of plant leaves by fusing complex characteristics with conventional generated binary pattern (LBP) features. We used three publicly accessible datasets to train and assess the proposed model. On the three datasets, the suggested method obtained 98%, 97%, and 99 validation accuracy and 98 %, 97 %, and 99 % tested efficiency. The research findings indicated that the recommended strategy offered a more effective way to control plant diseases. A pathogen-based approach to plant disease detection was introduced by Rani and Gowrishankar in 2023 [3]. Keras transfer learning models were used to autonomously detect, classify, and identify the microbe causing plant diseases. To achieve this, pictures of sunflowers and cabbage foliage, blossoms, and bulbs taken in real-world settings were taken into consideration, in addition to the Agri-ImageNet collection. This collection overcomes the limitation of the PlantVillage dataset, which featured photos with standardized backgrounds and controlled conditions. By employing deep transfer learning to reuse information depictions, these issues have been resolved. In the field of plant illness detection and classification, adaptive segmentation approaches have become a significant invention, providing dynamic ways to deal with changes in environmental factors, plant shape, and disease features. Segmented unhealthy areas in plant photos using adaptive thresholding algorithms to improve segmentation accuracy, they used preprocessing techniques such color normalization and noise reduction. This paper's primary goal was to analyze and evaluate each deep transfer learning model in order to determine which one was most suitable for the crop dataset. This study used 38 deep transfer learning models to get the highest classification accuracy fig.2 represents a few leaf picture dataset samples.

ISBN Number: 978-93-95305-78-5

Cherry healthy Leaf

Cherry Powdery mildew

Corn maize Grey leaf spot

Corn maize Common rust

Corn maize healthy

Corn maize Northern Leaf Blight

Strawberry healthy

Strawberry Leaf scorch

Grape Black rot

Grape Esca Black Measles

Grape Leaf blight

Grape healthy

Fig. 2: A few leaf picture dataset samples

Problem Definition

Correctly identifying and categorizing plant diseases by hand requires specialized expertise and acute attention. Crop disease identification by hand takes a lot of effort and is susceptible to error by humans. As a result, automated plant pathogen categorization and diagnosis becomes necessary. Deep intelligence-based models are created for the diagnosis and categorization of agricultural illnesses as artificial intelligence methods cannot handle enormous volumes of data. Table 1 lists some of the categorization and problems of the present deep learning-driven model for the identification and categorization of plant diseases. CNN efficiently and autonomously detects and classifies plant illnesses [1]. Nevertheless, since the visual input data is really gathered in the field, this approach is not the most efficient means of

ISBN Number: 978-93-95305-78-5

identifying and categorizing the plant's condition. The representation must be used in combination with additional segmentation algorithms to improve the total recognition and categorization performance. The calculation performance of CNN and LBP has improved [2].This methodology produces accurate results. This approach isn't general, though. This is not a feasible approach Transferal learning [3] facilitates the implementation of suitable preventative measures by accurately predicting the microbes responsible for illnesses in plants, Still, these approaches do not successfully extract the most main outlines and traits. The representations in question may have excess fitting problems. Any kind of crop may be used using CNN, which is a broad approach [4]. This strategy can be used in practical situations. This approach, however, is unable to identify the identified plant disease. This method does not aid in decision-making. CNN [5] and the optimizer created by Adam employ less parameter. This approach may be used by farms to acquire effective tools for diagnosis and make wise preventative decisions. However, this model is unreliable. Moreover, this approach's durability is insufficient. Plant illness classification and localization are made possible by CenterNet and DenseNet [6]. This method is quite resilient, even in the presence of artifacts. However, this strategy cannot be used by applications that run on handheld devices. This method's complexity over time is a problem. The distinction between the CMD degrees may be accurately determined using PRI [7]. On the other hand, this method is not fully automated. Diseases of plants that affect any section of the plant can be identified using RFCN [8]. However, this method's general efficacy is still insufficient. This initiative will thus develop a model that utilizes deep learning for the identification and categorization of plant illnesses.

Table 1: Properties and Challenges of the Present Deep Learning-Based Model for Plant Disease Identification and Categorization

Author [citation]	**Approach**	**Properties**	**Challenges**
Moupojou *et al.* [1]	CNN	This method enables the automatic identification and categorization of crop diseases.	This approach is not the best option for identifying and categorizing plant diseases whenever the data for the input images is taken straight from the field.

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Hosny *et al.* [2]	LBP and CNN	The calculation speed of this method is faster.	This method is not practical or generalizable.
Rani and Gowrishankar [3]	Transfer learning	This method helps with taking the right measures because it accurately predicts the microorganisms that cause illness in the plants.	The key shapes and characteristics are not efficiently extracted by these techniques. Over-fitting issues can arise with these models.
Shewale, and Daruwala [4]	CNN	This method is universal and can be applied to any type of crop.	The identified plant disease cannot be diagnosed using this method.
Premanandа *et al.* [5]	Adam optimizer and CNN	Farmers can use this method to make suitable preventive decisions and obtain efficient diagnostic tools.	Moreover, the robustness of this approach is inadequate.
Albattah *et al.* [6]	CenterNet and DenseNet	This technique makes it possible to identify and categorize many plant diseases.	Mobile phone-based applications are unable to use this strategy. .
Nair *et al.* [7]	PRI	This method allows for an accurate identification of the variance in the CMD degree.	This method isn't totally automated.
Saleem *et al.* [8]	RFCN	This approach can identify plant illnesses that affect any part of the plant.	This strategy does not provide sufficient overall performance.

ISBN Number: 978-93-95305-78-5

Problem Statement

The following is a list of some of the issues with the present paradigm for identifying and categorizing plant diseases.

- Agriculture is the foundation of the world economy, providing billions of people with food security. However, crop yields are seriously threatened by plant diseases, which result in financial losses and decreased agricultural production. Plant illnesses must be recognized early and accurately in order to lessen their effects. Manual inspection is the foundation of traditional disease detection techniques, and it is labor-intensive, time-consuming, & prone to human mistake.
- Automated solutions for plant disease identification have showed promise with the growth of artificial intelligence (AI) and image processing technology. However, because of differences in lighting, backdrop complexity, plant shape, and the diversity of disease symptoms, these systems have a difficult time precisely identifying diseased areas.
- Individual of the most important steps in the identification of plant diseases is image segmentation, which entails dividing images into relevant areas in order to distinguish sick areas from healthy tissues and unimportant backdrops. Many segmentation techniques, including edge detection, thresholding, and clustering, have poor generalizability and frequently struggle to adjust to a variety of environmental situations. Convolutional neural networks (CNNs), a type of deep learning method, require huge labeled datasets and can be computationally costly, despite their increased accuracy.
- Adaptive segmentation techniques offer a dynamic solution to these problems by modifying parameters according to the properties of the image. These methods have the potential to decrease reliance on manual intervention, increase segmentation precision, and strengthen disease detection systems. However, there are still unanswered questions about how to best optimize adaptive segmentation techniques for practical agricultural applications, especially when it comes to managing complicated datasets and attaining scalability.
- Investigating and creating sophisticated adaptive segmentation methods for plant disease categorization and detection is the goal of this study. The project aims to solve existing constraints in order to help develop effective, precise, and broadly applicable solutions for food security and sustainable agriculture.

Research Methodology

The level of agricultural output in a country has a significant influence on its growth in GDP. The biggest obstacle to ensuring food supply and excellence, nevertheless, is disease in plants. The rapid identification of plant infections is essential to maintaining global wellness and good health. During on-site inspections,

ISBN Number: 978-93-95305-78-5

an expert in pathology physically evaluates every plant as a component of the routine diagnosis procedure. Yet, a shortage of labor and the low reliability of manual disease examination limit its application. The creation of computerized methods that can precisely identify and classify a wide range of plant illnesses is necessary to address such problems. New viruses are constantly emerging on leaves of plants as a result of continuous modifications to crop structure and cultivation methods. Consequently, early identification and precise categorization of diseased plant leaves would prevent the infection from developing and promote robust plant output growth. It is difficult to accurately identify and classify plant diseases due to the striking color resemblance among normal and infected plant regions, disturbances in the specimens, a low-in data present in both the forefront and the background of images, and variations in the dimension, location, colors, and arrangement of leaves on plants. With this concept, an efficient machine learning model will be used to identify and classify plant illnesses.

The necessary picture data will first be obtained from internet databases. An adjustable and attention-based masked region-based neural network with convolution (RCNN) (AAM-RCNN) will be used to process the collected pictures as inputs for the segments step. For better categorization effectiveness, the Integrated Golden Tortoises Bug Optimization (IGTBO) will be used to adjust the AAM-RCNN's settings [26]. After segmenting the images, Mixed Convolution (2D/1D) and Multi-scale Dilated EfficientnetB7 (HC-2D/1D-MDEB7) will be utilized for detection and classification. In the case of Hybrid Convolution (2D/1D) designs, the 2D convolutional layer employs textural sequences as input, whilst the 1D convolution layer incorporates color and morphology information. In the end, the detected and categorized result will be provided by the HC-2D/1D-MDEB7 modeling. The use of the deep learning-powered approach to plant disease detection as well as classification will be demonstrated through testing. A graphical depiction of recognizing and categorizing a model is shown in Fig.3.

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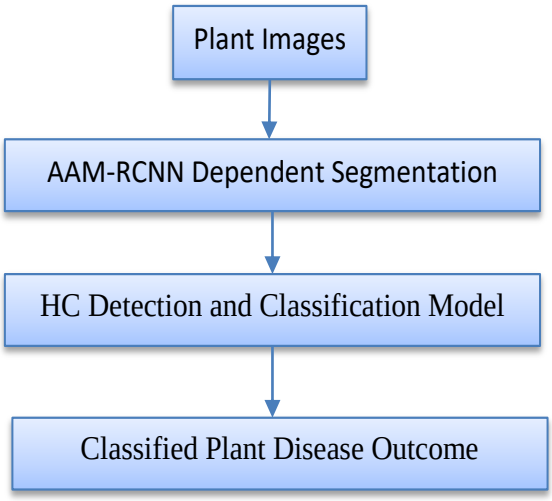

Fig. 3 shows a diagrammatic representation of identification and classification model.

Conclusion

The degree of sensitivity Precision, Particularity, and Negative Prediction Value are among the several favorable metrics that were used to validate the efficacy of the constructed model. A number of studies including the deep learning-based crop identification and categorization model will be carried out in the programming language Python. The results of these studies will include the following metrics: False Negative Rate (FNR), False Positive Rate (FPR), and False Discovery Rate (FDR), as well as the negative metrics, F1Score, Precision, and Mathews Correlation Coefficient (MCC). Additionally, a comparison of current approaches will be conducted.

References

[1] Emmanuel Moupojou, Appolinaire Tagne, Florent Retraint, Anicet Tadonkemwa, Dongmo Wilfried, Hyppolite Tapamo, and Marcellin Nkenlifack, "FieldPlant: A Dataset of Field Plant Images for Plant Disease Detection and Classification With Deep Learning," IEEE Access, vol. 11, pp. 35398-35410, 2023.

[2] K. M. Hosny, W. M. El-Hady, F. M. Samy, E. Vrochidou and G. A. Papakostas, "Multi-Class Classification of Plant Leaf Diseases Using Feature Fusion of Deep Convolutional Neural Network and Local Binary Pattern," IEEE Access, vol. 11, pp. 62307-62317, 2023.

[3] K. P. Asha Rani and S. Gowrishankar, "Pathogen-Based Classification of Plant Diseases: A Deep Transfer Learning Approach for Intelligent Support Systems," IEEE Access, vol. 11, pp. 64476-64493, 2023.

[4] Mitali V. Shewale, and Rohin D. Daruwala, "High performance deep learning architecture for early detection and classification of plant leaf disease," Journal of Agriculture and Food Research, vol. 14, pp. 100675, December 2023.

[5] Sanasam Premananda Singh, Keisham Pritamdas, Kharibam Jilenkumari Devi, and Salam Devayani Devi, "Custom Convolutional Neural Network for Detection and Classification of Rice Plant Diseases," Procedia Computer Science, vol. 218, pp. 2026-2040, 2023.

[6] Waleed Albattah, Marriam Nawaz, Ali Javed, Momina Masood and Saleh Albahli , "A novel deep learning method for detection and classification of plant diseases," vol. 8, pp. 507–524, 2022.

[7] Sadasivan Nair Raji, Narayanan Subhash, Velumani Ravi, Raju Saravanan, Changatharayil N. Mohanan, Thangaraj MakeshKumar and Sukumar Nita, "Detection and Classification of Mosaic Virus Disease in Cassava Plants by Proximal Sensing of Photochemical Reflectance Index," Journal of the Indian Society of Remote Sensing, vol. 44, pp. 875–883, 2016.

[8] M. H. Saleem, J. Potgieter and K. M. Arif, "A Performance-Optimized Deep Learning-Based Plant Disease Detection Approach for Horticultural Crops of New Zealand," IEEE Access, vol. 10, pp. 89798-89822, 2022.

[9] V. K. Vishnoi, K. Kumar, B. Kumar, S. Mohan and A. A. Khan, "Detection of Apple Plant Diseases Using Leaf Images Through Convolutional Neural Network," IEEE Access, vol. 11, pp. 6594-6609, 2023.

[10] Momina Masood, Marriam Nawaz, Tahira Nazir, Ali Javed, Reem Alkanhel, Hela Elmannai, Sami Dhahbi, and Sami Bourouis, "MaizeNet: A Deep Learning Approach for Effective Recognition of Maize Plant Leaf Diseases," IEEE Access, vol. 11, pp. 52862-52876, 2023.

[11] S. Barburiceanu, S. Meza, B. Orza, R. Malutan and R. Terebes, "Convolutional Neural Networks for Texture Feature Extraction. Applications to Leaf Disease Classification in Precision Agriculture," IEEE Access, vol. 9, pp. 160085-160103, 2021.

[12] Q. Zeng, X. Ma, B. Cheng, E. Zhou and W. Pang, "GANs-Based Data Augmentation for Citrus Disease Severity Detection Using Deep Learning," IEEE Access, vol. 8, pp. 172882-172891, 2020.

[13] H. Amin, A. Darwish, A. E. Hassanien and M. Soliman, "End-to-End Deep Learning Model for Corn Leaf Disease Classification," IEEE Access, vol. 10, pp. 31103-31115, 2022.

[14] Uferah Shafi, Rafia Mumtaz, Muhammad Deedahwar Mazhar Qureshi, Zahid Mahmood, Sikander Khan Tanveer, Ihsan Ul Haq, and Syed Mohammad Hassan Zaidi, "Embedded AI for Wheat Yellow Rust Infection Type Classification," IEEE Access, vol. 11, pp. 23726-23738, 2023.

[15] S. Allaoua Chelloug, R. Alkanhel, M. S. A. Muthanna, A. Aziz and A. Muthanna, "MULTINET: A Multi-Agent DRL and EfficientNet Assisted Framework for 3D Plant Leaf Disease Identification and Severity Quantification," IEEE Access, vol. 11, pp. 86770-86789, 2023.

[16] X. Zhu et al., "LAD-Net: A Novel Light Weight Model for Early Apple Leaf Pests and Diseases Classification," IEEE/ACM Transactions on Computational Biology and Bioinformatics, vol. 20, no. 2, pp. 1156-1169, 1 March-April 2023.

[17] M. S. H. Shovon, S. J. Mozumder, O. K. Pal, M. F. Mridha, N. Asai and J. Shin, "PlantDet: A Robust Multi-Model Ensemble Method Based on Deep Learning For Plant Disease Detection," IEEE Access, vol. 11, pp. 34846-34859, 2023.

[18] J. Chen, W. Chen, A. Zeb, S. Yang and D. Zhang, "Lightweight Inception Networks for the Recognition and Detection of Rice Plant Diseases," IEEE Sensors Journal, vol. 22, no. 14, pp. 14628-14638, 15 July15, 2022.

[19] R. Dwivedi, T. Dutta and Y. -C. Hu, "A Leaf Disease Detection Mechanism Based on L1-Norm Minimization Extreme Learning Machine," IEEE Geoscience and Remote Sensing Letters, vol. 19, pp. 1-5, 2022.

[20] Fengdi Li, Zhenyu Liu, Weixing Shen, Yan Wang, Yunlu Wang, Chengkai Ge, Fenggang Sun, and Peng Lan, "A Remote Sensing and Airborne Edge-Computing Based Detection System for Pine Wilt Disease," IEEE Access, vol. 9, pp. 66346-66360, 2021.

[21] N. Schor, A. Bechar, T. Ignat, A. Dombrovsky, Y. Elad and S. Berman, "Robotic Disease Detection in Greenhouses: Combined Detection of Powdery Mildew and Tomato Spotted Wilt Virus," IEEE Robotics and Automation Letters, vol. 1, no. 1, pp. 354-360, January 2016.

[22] M. Ahmad, M. Abdullah, H. Moon and D. Han, "Plant Disease Detection in Imbalanced Datasets Using Efficient Convolutional Neural Networks With Stepwise Transfer Learning," IEEE Access, vol. 9, pp. 140565-140580, 2021.

[23] X. Nie, L. Wang, H. Ding and M. Xu, "Strawberry Verticillium Wilt Detection Network Based on Multi-Task Learning and Attention," IEEE Access, vol. 7, pp. 170003-170011, 2019.

[24] U. P. Singh, S. S. Chouhan, S. Jain and S. Jain, "Multilayer Convolution Neural Network for the Classification of Mango Leaves Infected by Anthracnose Disease," IEEE Access, vol. 7, pp. 43721-43729, 2019.

[25] Z. Xiao, Y. Shi, G. Zhu, J. Xiong and J. Wu, "Leaf Disease Detection Based on Lightweight Deep Residual Network and Attention Mechanism," IEEE Access, vol. 11, pp. 48248-48258, 2023.

[26] Suwarna J, Kirti N. Mahajan, Yogesh B. Pawar, Yogita D. Bhise, Bharti Jagdale, Rajendra V. Patil, "Plant Growth Analysis using IoT and Reinforcement Learning Techniques for Controlled Environment", Advances in Nonlinear Variational Inequalities, 27(3), pp. 706–715, 2024

[27] Omid Tarkhaneh, Neda Alipour, Amirahmad Chapnevis, and Haifeng Shen, "Golden Tortoise Beetle Optimizer: A Novel Nature-Inspired Meta-heuristic Algorithm for Engineering Problems," Neural and Evolutionary Computing, 4 April 2021.

[28] Shrivastava, P., & Pradhan, A. (2018). *Image Segmentation for Plant Disease Detection Using Thresholding Methods.* International Journal of Computer Applications, 182(7), 6-10.

[29] K. C. Jondhale , R. V. Patil, "Edge Based technique to estimate Number of clusters in K-means Color Image Segmentation", *3rd IEEE International Conference on Computer Science and Info Tech, Chegndu , China, 2010*

[30] Rajendra V. Patil, Dr. Renu Aggarwal, Dr. Shailesh Shivaji Deore, "Edge Segmentation based Illumination Invariant Feature Detector Phase Congreuncy", 2024 5th International conference on Mobile Computing and Sustainable Informatics (ICMCSI), pp. 91-96, Jan. 2024

[31] Rajendra V. Patil., Dr. Renu Aggarwal. Edge Information based Seed Placement Guidance to Single Seeded Region Growing Algorithm. International Journal of Intelligent Systems and Applications in Engineering, 12(12s), 753–759, 2024

[32] Rajendra V. Patil, Dr. Renu Aggarwal, Govind M. Poddar, M. Bhowmik. Manohar K. Patil, Embedded Integration Strategy to Image Segmentation Using Canny Edge and K-Means Algorithm. International Journal of Intelligent Systems and Applications in Engineering, 12(13s), 01–08, 2024

[33] Sangeeta Kakarwal, Rahul Mapari, Pranoti Prashant Mane, Madhuri Pravin Borawake, Dhanraj R. Dhotre, Rajendra V. Patil, "A Novel Approach for Detection, Segmentation, and Classification of Brain Tumors in MRI Images Using Neural Network and Special C Means Fuzzy Clustering Techniques", Advances in Nonlinear Variational Inequalities, 27(3), pp. 837–872, 2024.

[34] Rajendra V. Patil, Dr, Renu Aggarwal, Ritesh, Sonawane, Govind M. Poddar, Shailesh Shivaji Deore, , Vaishali Turai, "Automatic Marker Generation to Similarity Based Region Merging Algorithm using Edge Information" , Journal of Electrical Systems, 20 (3s), pp. 2227-2240, 2024

[35] Tarambale, M. ., Naik, K. ., Patil, R. M. ., Patil, R. V. ., Deore, S. S. ., & Bhowmik, M.,, "Detecting Fraudulent Patterns: Real-Time Identification using Machine Learning", International Journal of Intelligent Systems and Applications in Engineering, 12(14s), 650, 2024

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

LOW-COST ADSORBENTS FOR HEAVY METAL REMOVAL: A CASE STUDY USING FLY ASH AND RED MUD AT DAMONJODI

Maruwada Srinivasan[1]; Ramprasad Naik Desavathu[2], Rakesh Roshan Dash[3]

[1]Research Scholar, Dept. of Civil Engineering, Gandhi Institute of Engineering and Technology University, Gunupur, Odisha, India. Email: srinivasan.maruwada@giet.edu

[2] Professor, Dept. of Civil Engineering, Gandhi Institute of Engineering and Technology University, Gunupur, Odisha, India. Email: dnaik@giet.edu.

[3] Associate Professor, Dept. of Civil Engineering, VSSUT Burla, Sambalpur, Odisha, India, Email: rrdash@gmail.com

ABSTRACT

This study assesses the efficacy of three inexpensive adsorbents—china clay, red mud, and fly ash—in removing chromium, lead, and cadmium from wastewater. In order to evaluate the adsorption capabilities of these materials, batch adsorption tests were carried out using water solutions that initially included 100 ppm of metal ions. The results indicated that red mud achieved the highest removal efficiencies: 91% for chromium, 94% for lead, and 89% for cadmium. China clay also demonstrated effective removal, with 89% for chromium, 86% for lead, and 90% for cadmium. Fly ash, though slightly less efficient, removed 84% of chromium, 89% of lead, and 83% of cadmium.

The adsorption process was found to be time-dependent, with removal efficiency increasing as contact time was extended, suggesting a gradual adsorption mechanism influenced by the availability of active sites on the adsorbent materials. These findings show that fly ash, red mud, and china clay are effective for removing heavy metals from contaminated water.

The study highlights the feasibility of using these low-cost, readily available materials as alternatives to expensive and less environmentally friendly adsorbents. These materials present a sustainable and economically viable option for large-scale wastewater treatment, offering a practical solution to address heavy metal pollution. This approach can contribute to more sustainable and cost-effective wastewater management, particularly in regions where affordable treatment options are critical for mitigating environmental contamination.

Key Words: Heavy metals, Adsorbents, Contact time, Agricultural waste, Wastewater treatment

1.1 Introduction

The discharge of toxic heavy metals such as chromium, copper, and lead into water bodies presents a significant environmental challenge with widespread implications for both ecological systems and human health. These metals, commonly introduced through industrial activities, remain persistent in the environment and pose severe risks to water quality, aquatic life, and public health. This abstract explores

ISBN Number: 978-93-95305-78-5

the sources, effects, and regulatory measures concerning these metals in water, while emphasizing the need for effective remediation strategies to mitigate their impact [1].

Chromium, a toxic metal widely found in industrial effluents from processes like metal plating, leather tanning, and dyeing, is particularly hazardous in its hexavalent form (Cr^{6+}). This form is a known carcinogen and has severe health implications for humans, including respiratory issues, skin ulcers, and cancer, particularly when it contaminates drinking water. In aquatic ecosystems, high concentrations of chromium can lead to decreased reproductive rates and abnormal development in fish and other species, causing long-term ecological damage.

Copper, while an essential trace element for human health, becomes toxic when present in excessive amounts. It is often released into water systems through industrial discharge, mining activities, and the use of copper-based pesticides in agriculture [2]. While copper is necessary for biological processes, it's over accumulation can lead to copper poisoning in humans, resulting in symptoms like nausea, abdominal pain, and liver damage. Long-term exposure to high levels of copper in drinking water is also associated with kidney dysfunction and other serious health concerns. In aquatic environments, excessive copper concentrations can disrupt the growth and health of fish and other organisms, leading to broader ecological consequences [3].

Several sectors, including building, manufacturing, and plumbing, have relied on lead, a ubiquitous contaminant. Water bodies often become contaminated with lead due to the breakdown of lead-based paints, the leaching of lead from old pipes, and industrial runoff. Exposure to lead is particularly detrimental to infants and toddlers, as it causes cognitive impairments, behavioral issues, and deficiencies in development. Lead can cause heart disease, renal damage, and reproductive problems in adults if they are exposed to it for an extended period of time [4]. The Bureau of Indian Standards (ISI) has prescribed a maximum allowed quantity of 0.05 ppm for lead pollution in drinking water, which is subject to stringent regulation. Lead poisoning is still a major problem in communities with outdated infrastructure and insufficient water treatment facilities, even though these restrictions have been adopted.

The presence of these toxic metals in water bodies can have far-reaching consequences for aquatic ecosystems and human health. The bioaccumulation of heavy metals in organisms, including fish, shellfish, and plants, can disrupt food chains and biodiversity, ultimately affecting human populations that rely on contaminated water sources for drinking, agriculture, and fishing. Furthermore, the toxic effects of these metals on aquatic life can lead to reduced biodiversity, impaired reproductive rates, and the loss of valuable species that are crucial to ecosystem balance [5].

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Addressing the growing concern of metal pollution in water requires immediate and coordinated action. Industrial activities that release untreated wastewater into water bodies must be better regulated to prevent the release of these metals. Governments and regulatory bodies must enforce stricter wastewater discharge standards to ensure the protection of water quality and the surrounding ecosystems. Moreover, industries must invest in advanced waste treatment technologies to effectively remove or neutralize toxic metals before they are discharged into the environment [6]. A shift toward more sustainable production practices, including the adoption of cleaner technologies and pollution prevention strategies, is essential to reduce the overall burden of metal pollution.

Monitoring water quality and ensuring compliance with established safety standards are crucial for protecting public health. Regular monitoring of water sources can help detect early signs of contamination and provide the necessary data to inform appropriate mitigation measures [7]. Additionally, public awareness campaigns and education on the dangers of heavy metal contamination can empower communities to take action and advocate for better environmental policies.

1.2 Lead: Toxic Effects and Environmental Impact

Lead is a heavy metal that has been used for thousands of years in various industries, including the production of lead-based paints, batteries, and plumbing systems. It is a potent neurotoxin, and even low levels of lead exposure can result in severe health consequences. The main ways that lead gets into drinking water are through plumbing systems, lead-containing pipes, or aging lead-based paints that corrode over time [8].

1.3 Chromium: Health Risks and Environmental Concerns

There are two main types of the heavy metal chromium, and they are called trivalent and hexavalent chromium, respectively. In contrast to hexavalent chromium, which is extremely poisonous and carcinogenic, trivalent chromium is an important mineral that helps with glucose metabolism [9]. Both naturally occurring in soil and rocks and as an effluent from industrial operations like metal plating, leather tanning, and pigment manufacture are frequent places to find it. The most dangerous type of chromium, both for humans and ecosystems, is hexavalent chromium.

1.4 Copper: Health Effects and Ecological Impacts

Red blood cell creation, bone and nerve health, and other biological functions all necessitate copper, a trace mineral that must be present in the human diet. Nevertheless, copper becomes poisonous and can induce many health issues when present in excessive doses. The U.S. Environmental Protection Agency

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(EPA) states that drinking water copper levels cannot be higher than 1.3 mg/L, which is the limit considered safe for long-term usage.

1.5 Sources of Heavy Metal Contamination

Industrial processes, mining, agricultural runoff, and urban infrastructure degradation are the main causes of heavy metal contamination in water bodies. Metal refining, chemical and dye production, and electronics manufacturing are among industrial activities that frequently discharge heavy metals like lead, chromium, and copper into the environment [10]. Heavy metal contamination is already a serious issue, and it is made worse by the improper disposal of industrial waste and the release of untreated wastewater into aquatic environments.

Mining operations, particularly those involving the extraction of metals such as copper, gold, and silver, also contribute to heavy metal contamination. Toxic metals are frequently released into surrounding water bodies by these activities, which may contaminate supplies of drinking water. Additionally, the use of heavy metals in agricultural practices, such as copper-based fungicides, can result in the runoff of these metals into surrounding water sources.

Urbanization and the deterioration of infrastructure also contribute to heavy metal pollution. Lead, for example, is commonly found in older plumbing systems, and the corrosion of lead pipes can result in the leaching of lead into drinking water. Additionally, the use of lead-based paints in older buildings and infrastructure contributes to lead contamination in the environment.

MATERIALS AND METHODS

Preparation of Adsorbents:

1: Fly ash

The Obera Thermal Power Plant in Mirzapur, Uttar Pradesh, India, was surveyed for fly ash. This fly ash was a byproduct of coal combustion in the power plant's boilers and was obtained directly from the plant's collection system. The collected fly ash was used without any pre-treatment.

Fly Ash Preparation:

The fly ash was sieved using a 53 μm pore size sieve to separate the finer particles. This fine fraction was selected for use in experiments due to its higher surface area, which enhances its ability to adsorb contaminants like heavy metals.

Chemical Analysis:

The findings of the analysis of the fly ash's chemical makeup are shown in Table 1:

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Constituent	Percentage by weight
SiO_2 (Silicon Dioxide)	56.04%
Al_2O_3 (Aluminum Oxide)	25.90%
CaO (Calcium Oxide)	2.22%
Fe_2O_3 (Iron Oxide)	1.26%
MgO (Magnesium Oxide)	0.94%
Loss of Ignition	13.64%

This study explores the utilization of untreated fly ash from the Obera Thermal Power Plant in Mirzapur, Uttar Pradesh. The fly ash, sieved through a 53 μm pore size, demonstrated favourable physical properties, including a surface area of 5.77 m^2/g, porosity of 0.360, and a density of 3.420 g/cm^3. The experimental procedure involved mixing the fly ash with water samples containing heavy metals, and measuring metal concentrations using Atomic Absorption Spectroscopy (AAS). Results indicate that fly ash is an effective, low-cost material for heavy metal removal, offering a sustainable solution for water treatment.

2: Red mud-

Red mud, a highly alkaline byproduct generated during the production of aluminum, poses significant environmental challenges due to its large volume and hazardous composition. However, its potential as an adsorbent material for environmental remediation has gained considerable attention. The purpose of this research is to determine whether red mud, a byproduct of the aluminum industry, can be used as an adsorbent to remove heavy metals and other pollutants from water [11]. In order to assess the adsorption potential of red mud, its physicochemical parameters were comprehensively examined. These properties include bulk density, particle size, porosity, water holding capacity, and surface area. Furthermore, adsorption experiments were performed to determine how well red mud removed harmful heavy elements, such as cadmium (Cd), lead (Pb), and chromium (Cr), from wastewater.

Red mud exhibits a variety of characteristics that make it a promising material for environmental remediation. The bulk density and particle size of red mud were found to be conducive for both practical handling and its application in large-scale remediation processes. Its relatively low bulk density ensures that it can be used in expansive applications without imposing significant logistical challenges. The surface area and porosity of red mud, key factors in determining the number of available adsorption sites, were found to be relatively high. These properties provide numerous active sites for the adsorption of contaminants, especially heavy metals, making red mud an effective adsorbent. The water holding

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capacity of red mud also contributes to its suitability, enhancing the material's ability to maintain optimal conditions for adsorption over time.

Chemical Analysis of Red Mud as Adsorbent

Constituent	Percentage by Weight
Fe_2O_3	39.45%
Al_2O_3	22.65%
TiO_2	13.80%
SiO_2	8.55%
CaO	5.20%
Loss of Ignition	10.25%

2.1 Batch adsorption studies:

The metal stock solutions used in batch adsorption experiments have a concentration of 1000 mg/L. In a 250 mL conical flask, 1.0 g of each adsorbent was added individually to 100 mL of each metal solution. To make sure the adsorbate and adsorbent were interacting properly, the mixture was agitated with a magnetic stirrer. To determine how well the adsorbent removed the metal ions from the solution, we tracked its progress over time and evaluated the metal concentrations once equilibrium was attained.

We evaluated the adsorption process over a wide range of contact periods, from 30 to 180 minutes, and changed the pH of the solutions as needed at room temperature. Once the adsorption period had passed, the solution was filtered through Whatman 42 filter paper. The concentration of the filtered solution was then ascertained using a PerkinElmer model 2380 atomic absorption spectrophotometer. Using the following formula, we were able to determine the percentage of metal ions removed:

Percentage Adsorption = $\frac{[Co-Ce]}{C0}$X100

Where,

Co = the solution's initial metal ion concentration (mg/l)

Ce = final metal ion concentration in the solution (mg/l).

2.2 Impact of Adsorption of Heavy Metals on Contact Time:

The adsorption of metal ions was observed to increase continuously with time until equilibrium was reached at 180 minutes. The percentage removal of cadmium varied as follows: red mud (64%-89%), and fly ash (60%-83%) (Figure 1) [12]. This variation may be attributed to the presence of larger surface area active sites on the adsorbents. Similarly, the chromium removal rates were red mud (71%-91%), and fly

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ash (64%-84%) (Figure 2) [13]. Reduced adsorption efficiency, especially at the lower range, could be due to the limited availability of active sites on the adsorbents. For lead removal, the percentages for red mud, and fly ash were 63%-86%, 56%-94%, and 69%-89%, respectively (Figure 3) [14].

The rapid increase in removal rates for chromium, lead, and cadmium in red mud (91%, 94%, and 89%), and fly ash (84%, 89%, and 83%) suggests that activation of adsorption sites, possibly via a surface exchange mechanism, played a significant role in enhancing the adsorption [15]. Moreover, the higher adsorption rates in fly ash can be attributed to its smaller particle size, which allows better penetration of metal ions into the internal pore structure. In contrast, larger adsorbent particles exhibit slower adsorption due to higher diffusive resistance, limiting the mass transport of metal ions into the adsorbent.

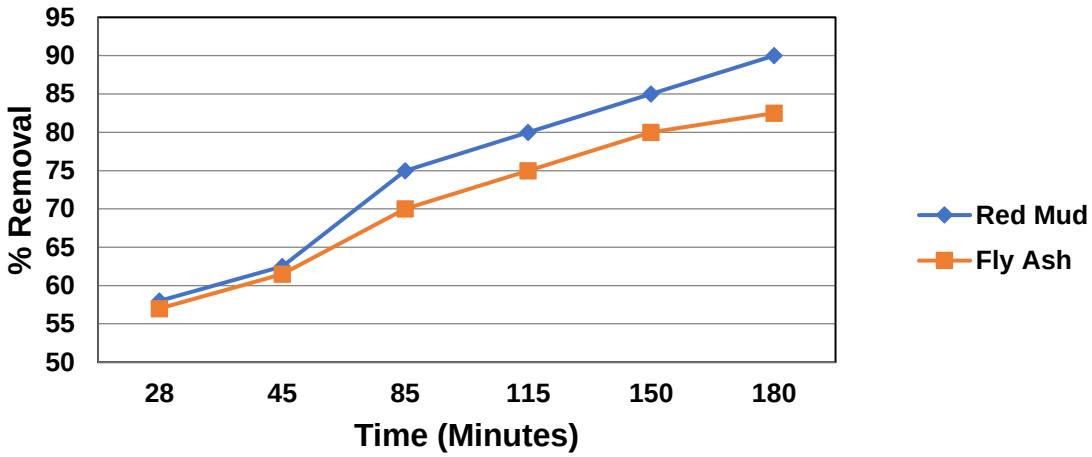

Fig 1 percentage removal of cadmium from different adsorbents

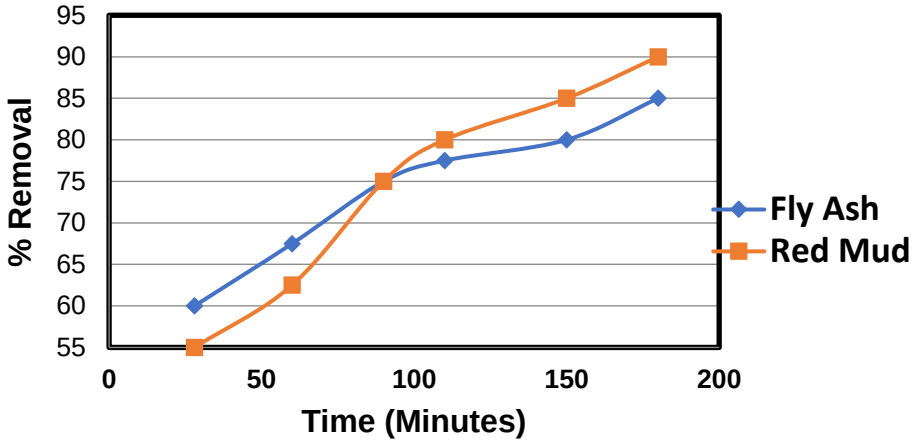

Fig 2 percentage removal of Chromium from different adsorbents

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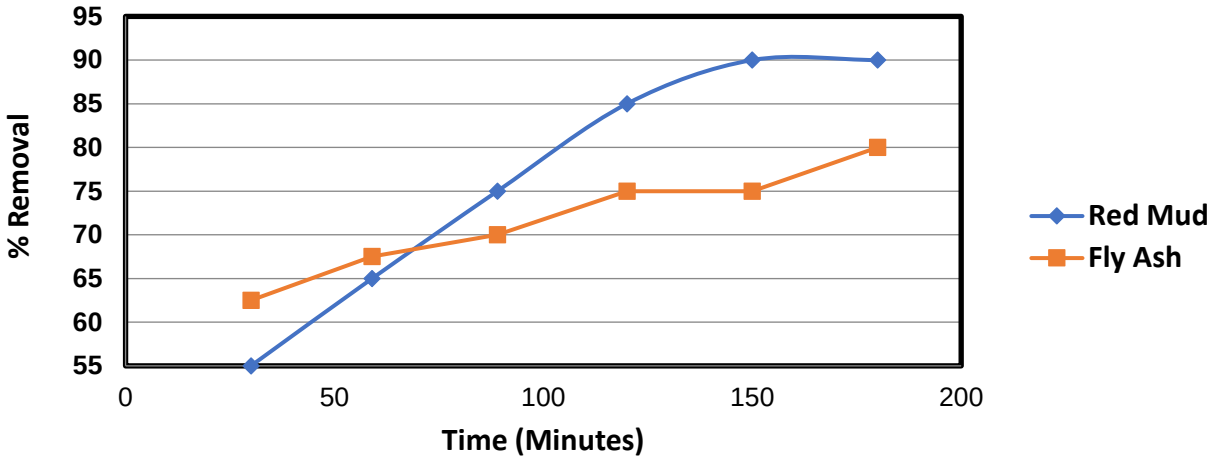

Fig 3 percentage removal of Lead from different adsorbents

CONCLUSION

Heavy metals like cadmium, lead, and chromium were selected for the current study's batch adsorption method of removing them from aqueous solutions [16]. The findings showed that adsorbents' adsorption effectiveness was greatly increased by decreasing their particle size. For the elimination of these metals, a particle size of 53 μm was shown to be quite effective. Because smaller particles have more surface area, there are more active sites available for adsorption, increasing removal efficiency. This emphasizes how crucial particle size is to raising an adsorbent's adsorption capability.

In order to remove lead, cadmium, and chromium from water and wastewater, the study used a variety of adsorbents, such as fly ash and red mud, all of which showed encouraging results [17]. These materials were determined to be cost-effective, environmentally beneficial, technically possible, and user-friendly, which made them perfect for widespread industrial water treatment applications. Their high adsorption effectiveness guarantees little environmental impact in addition to lowering the concentration of hazardous metals in wastewater.

The use of these adsorbents in treating industrial effluents before discharge is crucial for preventing contamination of water bodies. By removing hazardous metals like Chromium, Lead, and Cadmium from wastewater, the risk of environmental and health hazards is significantly reduced. As industries continue to expand, the need for effective wastewater treatment methods becomes more critical, and the use of these eco-friendly adsorbents presents a viable solution for sustainable water treatment [18]. Thus, implementing these materials at an industrial scale could contribute to cleaner, safer water resources and a healthier environment.

REFERENCES

1. Ali, E. N., & Seng, H. T. (2018). Heavy metals (Fe, Cu, and Cr) removal from wastewater by Moringa oleifera press cake. MATEC Web of Conferences, 150, 02008, MUCET, EDP Sciences. https://doi.org/10.1051/matecconf/201815002008
2. Alinnor, I. J. (2007). Adsorption of heavy metal ions from aqueous solution by fly ash. Fuel, 86(5-6), 853–857.
3. Amin, N. M., Kaneco, S., Kitagawa, T., Begum, A., Katsumata, H., Suzuki, T., & Ohta, K. (2006). Removal of arsenic in aqueous solutions by adsorption onto waste rice husk. Indian Journal of Environmental Protection, 45(24), 8105–8110. https://doi.org/10.1021/ie060344j
4. Aziz, N., Jayasuriya, & Fan, N. L. (2016). Adsorption study on Moringa oleifera seeds and Musa cavendish as natural water purification agents for removal of Lead, Nickel and Cadmium from drinking water. Mat Sci Eng., 136, 1–9. https://doi.org/10.1088/1757-899X/136/1/012044
5. Bansal, M., Singh, D., & Garg, V. K. (2009). A comparative study for the removal of hexavalent chromium from aqueous solution by agriculture wastes' carbons. Journal of Hazardous Materials, 171(1–3), 83–92. https://doi.org/10.1016/j.jhazmat.2009.05.124.
6. Chanand, B. K. C., & Dudeney, A. W. L. (2008). Reverse osmosis removal of arsenic residues from bioleaching of refractory gold concentrates. Minerals Engineering, 21(4), 272–278.
7. Cho, H., Oh, D., & Kim, K. (2005). A study on removal characteristics of heavy metals from aqueous solution by fly ash. Journal of Hazardous Materials, 127(1–3),187–195.
8. Dabrowski, A., Hubicki, Z., Podko´scielny, P., & Robens, E. (2004). Selective removal of the heavy metal ions from waters and industrial wastewaters by ion-exchange method. Chemosphere, 56(2), 91– 106.
9. El Nemr, A., Khaled, A., Abdelwahab, O., & El-Sikaily, A. (2008). Treatment of wastewater containing toxic chromium using new activated Carbon developed from date palm. Journal of Hazardous Material, 152(1), 263–7. https://doi.org/10.1016/j.jhazmat.2007.06.091
10. Fu, F., & Wang, Q. (2011). Removal of heavy metal ions from waste waters: A review. Journal of Environmental Management, 92 (3), 407-418. https://doi.org/10.1016/j.jenvman.2010.11.011.
11. Ghafar, F., Mohtar, A., Sapawe, N., Hadi, N.N., & Salleh, M.R.M. (2017). Chemically modified Moringa oleifera seed husks as low cost adsorbent for removal of copper from aqueous solution. AIP Conference Proceedings, AIP Publishing LLC. https://doi.org/10.1063/1.5010524

12. Maina, I. W., Obuseng, & V., & Nareetsile, F. (2016). Use of Moringa oleifera (Moringa) seed pods and Sclerocarya birrea (Morula) nut shells for removal of heavy metals from wastewater and borehole water. J. Chem., 2016. https://doi.org/10.1155/2016/9312952
13. Mohan, D., & Pittman, C. U. (2007). Arsenic removal from water/wastewater using adsorbents-A critical review. Journal of Hazardous Materials, 142(1–2), 1-53. https://doi.org/10.1016/j.jhazmat.2007.01.006
14. Peleka, E. N., & Matis, K. A. (2008). Application of lotation as a pretreatment process during desalination. Desalination, 222(1–3), 1–8.
15. Qdaisand, H. A., & Moussa, H. (2004). Removal of heavy metals from wastewater by membrane processes: a comparative study. Desalination, 164(2), 105–110.
16. Sadegh, H., Mazloumbilandi, M., & Chahardouri, M. (2017). Low-cost materials with adsorption performance. Handbook of ecomaterials, pp. 1-33. https://doi.org/10.1007/978-3-319-68255-6_175
17. Ternes, T. A. (1998). Occurrence of drugs in German sewage treatment plants and rivers. Water Research, 32(11), 3245–3260.
18. Wang, S., & Wu, H. (2006). Environmental-benign utilization of fly ash as low-cost adsorbents, Journal of Hazardous Materials, 136(3), 482–501. https://doi.org/10.1016/j.jhazmat.2006.01.067

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

मंदिर: संस्कृति, अनुसंधान, और नवाचार का केंद्र

परिणीता कुमारी
शोधार्थी (इतिहास),
पी.के. विश्वविद्यालय, शिवपुरी

परिचय:

आज भारतीय मंदिर वास्तुकला शैलियाँ दुनिया भर के भक्तों और पर्यटकों को आकर्षित करती हैं। ये मंदिर भारत की समृद्ध ऐतिहासिक वास्तुकला और धार्मिक परंपराओं की झलक पेश करते हैं। वे पूजा, आध्यात्मिक चिंतन, धार्मिक अनुष्ठानों और उत्सवों में भाग लेने के लिए एक स्थान प्रदान करते हैं।

भारत में हिंदू मंदिर वास्तुकला अपने गहन प्रतीकवाद, जटिल विवरण, और आध्यात्मिक महत्व के लिए प्रसिद्ध है। मंदिर परिसरों में न केवल धार्मिक बल्कि सामाजिक और सांस्कृतिक गतिविधियाँ भी होती हैं। उदाहरण के लिए, मंदिर परिसर विवाह समारोहों का भी केंद्र बनते हैं। मंदिर की संरचना और वातावरण आध्यात्मिक रूप से विस्मयकारी और प्रेरणादायक होते हैं।

मशीनी युग में मंदिरों की प्रासंगिकता:

आज के मशीनी युग में इंसान स्वयं एक मशीन बन चुका है। आधुनिकता की रफ्तार के साथ तालमेल बैठाने के लिए सहयोगात्मक अनुसंधान और नवाचार की आवश्यकता पहले से कहीं अधिक है। प्राचीन युगों के स्वच्छ और शांतिपूर्ण जीवन के तरीकों को नवनीकरण के साथ फिर से अपनाकर हम मानव जीवन को एक नया आयाम प्रदान कर सकते हैं। इसके लिए दैनिक दिनचर्या में कुछ समय ईश्वर के ध्यान में लगाना अति आवश्यक है।

आधुनिक युग में ध्यान और शांतिपूर्ण वातावरण की खोज में मंदिरों का महत्व और अधिक बढ़ गया है। प्राचीन मंदिर न केवल पूजा के स्थान हैं, बल्कि उनके वास्तुशिल्प में भी शोध की व्यापक संभावनाएँ हैं। उनके निर्माण में ऊर्जा संग्रह, चुंबकीय प्रभाव और सकारात्मक ऊर्जा के सिद्धांतों को ध्यान में रखा गया। यह वैज्ञानिक दृष्टिकोण आज भी प्रेरणा का स्रोत हो सकता है।

मंदिरों का वैज्ञानिक और सांस्कृतिक महत्व (बिंदुवार):

1. आध्यात्मिक महत्व: मंदिरों का आध्यात्मिक महत्व है क्योंकि बहुत से लोग आशीर्वाद माँगते हैं और परमात्मा के साथ संबंध स्थापित करते हैं। वे ऐसा स्थान प्रदान करते हैं जहाँ व्यक्ति ध्यान कर सकता है, प्रार्थना कर सकता है और देवताओं को अर्पण एवं प्रसाद चढ़ा सकता है।

2. ऊर्जा संग्रह: प्राचीन मंदिरों की बनावट इस प्रकार से की जाती थी कि वे पृथ्वी की चुंबकीय ऊर्जा का अधिकतम संग्रह कर सकें। गर्भगृह में स्थित मूर्तियाँ इस ऊर्जा को संचित करती थीं, और मंदिर के परिक्रमा पथ या मूर्तियों के स्पर्श से यह ऊर्जा श्रद्धालुओं को भी प्राप्त होती थी।

3. घंटी और अगरबत्ती: तांबे की घंटी की ध्वनि वातावरण के कीटाणुओं को नष्ट करने में सहायक होती है। अगरबत्तियाँ और फूल सकारात्मक ऊर्जा और ध्यान केंद्रित करने में मदद करते हैं।

4. सकारात्मकता: मंदिरों में आने वाले श्रद्धालु सकारात्मक सोच और भावनाओं को साथ लेकर आते हैं, जिससे पूरे वातावरण में सकारात्मकता व्याप्त रहती है।

ISBN Number: 978-93-95305-78-5

5. सांस्कृतिक महत्व: मंदिरों को महत्वपूर्ण सांस्कृतिक विरासत स्मारकों के रूप में भी माना जाता है। वे विशेष और जटिल वास्तुकला, मूर्तियों और एक क्षेत्र के इतिहास और परंपराओं का प्रतिनिधित्व करने वाले कार्यों को प्रदर्शित करते हैं।
6. शैक्षिक महत्व: मंदिर समुदाय को आध्यात्मिकता और दर्शन के साथ-साथ सांस्कृतिक और नैतिक मूल्य प्रदान करते हैं, जो उनकी मान्यताओं को मजबूत बनाते हैं।
7. आर्थिक महत्व: मंदिर पर्यटकों और तीर्थयात्रियों को आकर्षित करते हैं और प्रसाद एवं योगदान के माध्यम से धन जुटाकर स्थानीय अर्थव्यवस्था को बढ़ावा देते हैं। वे मंदिर की मरम्मत और संरक्षण करके निवासियों को रोजगार भी प्रदान करते हैं।

मंदिर: सहयोगात्मक अनुसंधान का केंद्र:

मंदिर न केवल धार्मिक स्थल हैं, बल्कि सामाजिक और सांस्कृतिक शोध के लिए भी अनमोल स्रोत हैं। उदाहरण के लिए:
- मंदिरों की वास्तुकला में निहित जटिल डिजाइन और ऊर्जा संग्रह की विधियाँ।
- समाज के लिए मंदिरों की बहुआयामी भूमिका, जैसे सामाजिक मेलजोल और सांस्कृतिक आयोजन।

मंदिरों ने विभिन्न पर्वों और उत्सवों के माध्यम से हिंदू धर्म, समाज, संस्कृति, कला और हस्तकला को बढ़ावा दिया है। दूरस्थ क्षेत्रों में स्थित मंदिरों ने सामाजिक सम्मेलनों के स्थल के रूप में कार्य किया है और राष्ट्रीय एकता को सुदृढ़ किया है। इन मंदिरों की संरचना और कार्यप्रणाली सहयोगात्मक अनुसंधान और नवाचार के लिए आदर्श उदाहरण हैं।

निष्कर्ष:

मंदिरों का महत्व विद्यालयों की तरह है, जहाँ समाज को आध्यात्मिकता, संस्कृति, और नवाचार की शिक्षा दी जाती है। उनके माध्यम से हम न केवल अपनी जड़ों से जुड़ते हैं, बल्कि भविष्य के लिए मार्गदर्शन भी प्राप्त करते हैं। मंदिरों के वैज्ञानिक, सांस्कृतिक, और सामाजिक पहलुओं को नए अनुसंधान के माध्यम से प्रस्तुत करना, मानवता के लिए नए आयाम खोल सकता है। इस प्रकार, मंदिर न केवल धार्मिक स्थल हैं, बल्कि सह-अस्तित्व और नवाचार के प्रतीक भी हैं।

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

REGENERATIVE BRAKING SYSTEM IN ELECTRIC VEHICLE

Praveen Kumar sharma[1], Nilam N. Ghuge[2]
[1] Research Scholar, University of Technology, Jaipur, Rajasthan, India
Praveenprem.sharma@gmail.com
[2] Professor, Department of Electrical Engineering, JSPM's Bhivarabai Sawant Institute of Tech. & Research, , Wagholi, Pune, India. 412207
ghuge1974@gmail.com

Abstract. Regenerative braking is a mechanism found on most hybrid and full-electric vehicles. It captures the kinetic energy from braking and converts it into the electrical power that charges the vehicle's high voltage battery. Regenerative braking also slows the car down, which assists the use of traditional brakes.

In a conventional braking system, a car slows down due to friction between the brake pads and rotors. But this system is highly inefficient when it comes to conserving energy. Nearly all of the kinetic energy propelling your car forward is lost as heat when you apply the brakes. That's a lot of wasted energy. Regenerative braking solves this problem by recapturing upwards of 70% of the kinetic energy that would otherwise be lost during braking. The amount of energy recovered depends on your car model and driving behavior.

Regenerative braking turns kinetic energy into electricity by reversing the process that drives the car forward. In electric cars, the drive train is powered by a battery pack that powers a motor (or motors), creating torque–rotational force–on the wheels. In other words, electrical energy from the battery becomes mechanical energy that spins the wheels.

With regenerative braking, the energy from your spinning wheels is used to reverse the direction of electricity - from the electric motor(s) to the battery. All you have to do is remove your foot from the accelerator or, in some cases, press the brake pedal to activate regenerative braking. The electric motor not only acts as an electric generator, but it also helps slow your car down because energy is consumed by the wheels as they rotate the shaft in the electric motor.

Keywords: Regenerative Braking System

Introduction

Regenerative Braking System is the way of slowing vehicle by using the motors as brakes. Instead of the surplus energy of the vehicle being wasted as unwanted heat, the motors act as generators and return some of it to the overhead wires as electricity. The vehicle is primarily powered from the electrical energy generated from the generator, which burns gasoline. This energy is stored in a large battery, and used by an electric motor that provides motive force to the wheels. The regenerative braking taking place on the

ISBN Number: 978-93-95305-78-5

vehicle is away to obtain more efficiency, instead of converting kinetic energy to thermal energy through frictional braking, the vehicle can convert a good fraction of its kinetic energy back into charge in the battery, using the same principle as an alternator. Therefore, if you drive long distance without braking, you'll be powering the vehicle entirely from gasoline. Regenerative Braking System comes into its own when you're driving in the city, and spending a good deal of your time braking. You will still use more fuel in the city for each mile you drive than on the highway, though. Thermodynamics tells us that all inefficiency comes from heat generation. For instance, when you brake, the brake pedals heat up and a quantity of heat, or energy, is lost to the outside world. Friction in the engine produces heat in the same way .In most electric and hybrid electric vehicles on the road today, this is accomplished by operating the traction motor as a generator, providing braking torque to the wheels and recharging the traction batteries. The energy provided by regenerative braking can then be used for propulsion or to power vehicle accessories. In Regenerative braking system instead of wasting the kinetic energy of vehicle in the form of heat it is converted into electrical energy to be stored in batteries and capacitors or as mechanical energy of a flywheel having large moment of inertia. In this way a large proportion of energy of vehicle is saved

1.1 Need for Regenerative Brakes

The regenerative braking system delivers a number of significant advantages over a car that only has friction brakes. In low-speed, stop- and-go traffic where little deceleration is required; the regenerative braking system can provide the majority of the total braking force. This vastly improves fuel economy with a vehicle, and further enhances the attractiveness of vehicles using regenerative braking for city driving. At higher speeds, too, regenerative braking has been shown to contribute to improved fuel economy – by as much as 20%.

Consider a heavy loaded truck having very few stops on the road. It is operated near maximum engine efficiency. The 80% of the energy produced is utilized to overcome the rolling and aerodynamic road forces. The energy wasted in applying brake is about 2%. Also its brake specific fuel consumption is 5%.

Now consider a vehicle, which is operated in the main city where traffic is a major problem here one has to apply brake frequently. For such vehicles the wastage of energy by application of brake is about 60% to 65%.

ISBN Number: 978-93-95305-78-5

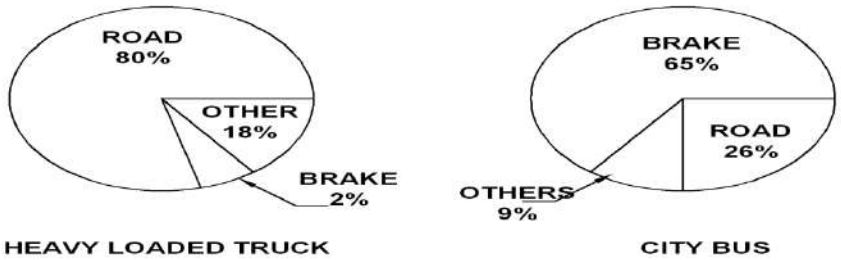

Fig. A - Graphical Representation of Energy Usage of Two Vehicles

2. Idea of Regenerative Brakes

Concept of this regenerative brake is better understood from bicycle fitted with Dynamo. If our bicycle has a dynamo (a small electricity generator) on it for power the lights, we'll know it's harder to peddle when the dynamo is engaged than when it's switched off. That's because some of our peddling energy is being "stolen" by the dynamo and turned into electrical energy in the lights. If we're going along at speed and we suddenly stop peddling and turn on the dynamo, it'll bring us to a stop more quickly than we would normally, for the same reason: it's stealing our kinetic energy. Now imagine a bicycle with a dynamo that's 100 times bigger and more powerful. In theory, it could bring our bike to a halt relatively quickly by converting our kinetic energy into electricity which we could store in a battery and use again later. And that's the basic idea behind regenerative brakes. Electric trains, cars, and other electric vehicles are powered by electric motors connected to batteries. When we're driving along, energy flows from the batteries to the motors, turning the wheels and providing us with the kinetic energy we need to move. When we stop and hit the brakes, the whole process goes into reverse: electronic circuits cut the power to the motors. Now, our kinetic energy and momentum makes the wheels turn the motors, so the motors work like generators and start producing electricity instead of consuming it. Power flows back from these motor-generators to the batteries, charging them up. So a good proportion of the energy we lose by braking is returned to the batteries and can be reused when we start off again. In practice, regenerative brakes take time to slow things down, so most vehicles that use them also have ordinary (friction) brakes working alongside (that's also a good idea in case the regenerative brakes fail).That's one reason why regenerative brakes don't save 100 percent of our braking energy.

ISBN Number: 978-93-95305-78-5

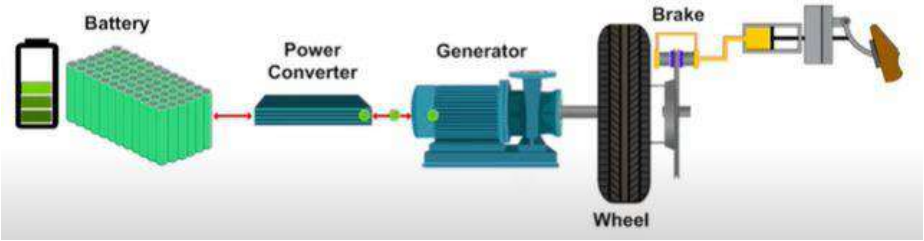

Fig. B - Basic Idea of Regenerative Brakes

3. Basic Elements of the System

There are four elements required which are necessary for the working of regenerative braking system, these are:)

(1) Batteries

With this system as we know, the electric motor of a car becomes a generator when the brake pedal is applied. The kinetic energy of the car is used to generate electricity that is then used to recharge the batteries. With this system, traditional friction brakes must also be used to ensure that the car slows down as much as necessary. Thus, not all of the kinetic energy of the car can be harnessed for the batteries because some of it is "lost" to waste heat. Some energy is also lost to resistance as the energy travels from the wheel and axle, through the drive train and electric motor, and into the battery.

When the brake pedal is depressed, the battery receives a higher charge, which slows the vehicle down faster. The further the brake pedal is depressed, the more the conventional friction brakes are employed.

The motor/generator produces AC, which is converted into DC, which is then used to charge the Battery Module. So, the regenerative systems must have an electric controller that regulates how much charge the battery receives and how much the friction brakes are used.

(2) Fly Wheels

In this system, the translational energy of the vehicle is transferred into rotational energy in the flywheel, which stores the energy until it is needed to accelerate the vehicle.

The benefit of using flywheel technology is that more of the forward inertial energy of the car can be captured than in batteries, because the flywheel can be engaged even during relatively short intervals of braking and acceleration. In the case of batteries, they are not able to accept charge at these rapid intervals, and thus more energy is lost to friction.

Another advantage of flywheel technology is that the additional power supplied by the flywheel during acceleration substantially supplements the power output of the small engine that hybrid vehicles are equipped with.

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(3) Controller

An "ON-OFF" engine control system is used. That means that the engine is "ON" until the energy storage unit has been reached the desired charge capacity and then is decoupled and stopped until the energy storage unit charge fall below its minimum requirement.

4. Different Types of Regenerative Braking System

4.1 Electric Regenerative Braking

In an electric system which is driven only by means of electric motor the system consists of an electric motor which acts both as generator and motor. Initially when the system is cruising the power is supplied by the motor and when the there is a necessity for braking depending upon driver's applied force on the brake pedal the electronic unit controls the charge flowing through the motor and due to the resistance offered motor rotates back to act as a generator and the energy is energy is stored in a battery or bank of twin layer capacitors for later use. In hybrid system, motor will be coupled to another power source normally. I. C. engines is shown in the fig (1).

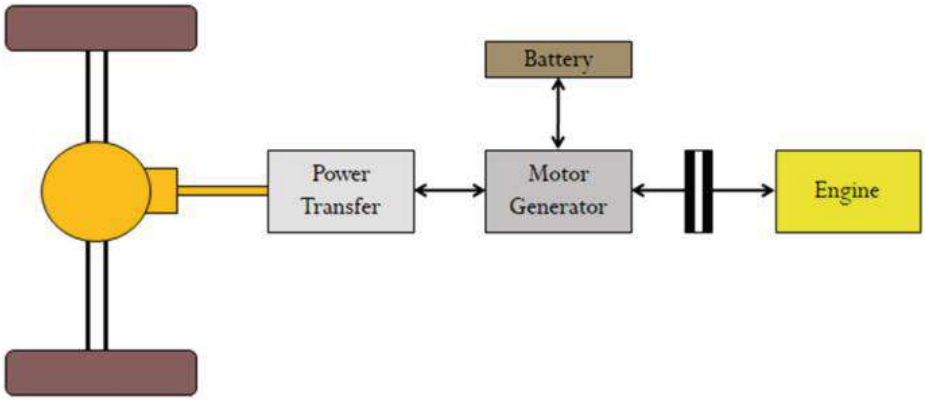

Fig. 1

4.2 Hydraulic Regenerative Brakes

Hydrostatic Regenerative Braking (HRB) system uses electrical/electronic components as well as hydraulics to improve vehicle fuel economy. An alternative regenerative braking system is being developed by the Ford Motor Company and the Eaton Corporation. It's called Hydraulic Power Assist or HPA. With HPA, when the driver steps on the brake, the vehicle's kinetic energy is used to power a reversible pump, which sends hydraulic fluid from a low pressure accumulator (a kind of storage tank) inside the vehicle into a high pressure accumulator. The pressure is created by nitrogen gas in the accumulator, which is compressed as the fluid is pumped into the space the gas formerly occupied. This slows the vehicle and helps bring it to a stop. The fluid remains under pressure in the accumulator until

ISBN Number: 978-93-95305-78-5

the driver pushes the accelerator again, at which point the pump is reversed and the pressurized fluid is used to accelerate the vehicle, effectively translating the kinetic energy that the car had before braking into the mechanical energy that helps get the vehicle back up to speed. It's predicted that a system like this could store 80 percent of the momentum lost by a vehicle during deceleration and use it to get the vehicle moving again.

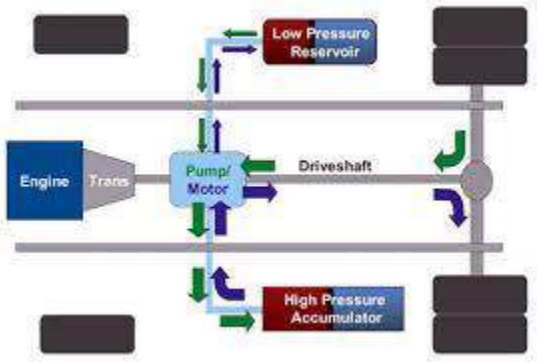

Fig..2

5. Advantages and Disadvantages of Regenerative Braking

1. Advantages of Regenerative Braking

As you can imagine, capturing and reusing more energy from braking has real benefits for the efficiency of your vehicle. Plus, it means less wear and tear on your brakes. Here are the biggest advantages of regenerative braking:

- **Brake Pads & Rotors May Last Longer**

Even though regenerative braking provides a lot of stopping force on its own, EVs and hybrids also come with conventional hydraulic brakes. However, since regenerative braking does much of the work while slowing the vehicle, the brake pads and rotors are used much less frequently. As a result, they typically last much longer between servicing, which can help drivers save on maintenance costs. That being said, it’s still important to have your brakes inspected regularly, and routine checks may be required as part of your manufacturer's suggested maintenance schedule. Just bring your hybrid or electric vehicle into Tires Plus for a quick and convenient inspection.

- **Extended Range Possibilities for EVs**

Capturing braking energy and sending it right back to your EV’s battery pack can extend your driving range. Estimations show that regenerative braking can potentially add hundreds of miles of electric driving range throughout the year. That means less time spent charging and more time getting where you need to go. When charging stations are still far and few between in many areas, every mile counts. Plus, when you

ISBN Number: 978-93-95305-78-5

plug into the electric grid less often, you help reduce emissions from coal and gas-powered electricity suppliers.

- **Better Fuel Efficiency for Hybrids**

  While hybrids still have internal combustion engines under the hood, they're designed to use their electric motor as much as possible. Regenerative braking helps keep the battery pack charged, so drivers don't have to rely on their engines as often, helping them reduce fuel consumption and save money.

2. Disadvantages of a Regenerative Braking System

While the positives of regenerative braking definitely outweigh the negatives, no technology is perfect. Here are a few instances where regenerative braking falls short:

- **May Be Less Effective at Lower Speeds**

  Traveling at slower speeds means your vehicle has less kinetic energy and requires less braking force. As a result, the regenerative braking system is fed less energy and does not supply the battery pack with much charge. Some vehicle manufacturers also feel that coasting may outweigh the benefits of regenerative braking in some situations.

- **Brake Pedal May Feel Different**

  One thing you want to be sure of while driving is that your brake pedal works. While the brake pedals on hybrid and electric vehicles certainly function, they may feel different in a way you're not used to. You may experience momentary unresponsiveness or a pedal that doesn't compress as smoothly as you expect. In some cases, you may need to modulate the pedal differently. The good news is that this change in brake pedal feel is less of a problem than it used to be. Newer hybrid and EV models have more responsive brake pedals that feel the same as any set of conventional brakes.

- **Potentially Less Stopping Power**

  While regenerative braking performs just fine in most braking situations where you gradually come to a stop, it may not provide the same level of stopping force that conventional brakes do. This means hybrid and EV drivers may have to press harder on the brakes to achieve the same effectiveness. However, this problem is also improving with newer regenerative braking systems. In more recent car models, you may not notice a difference in stopping power at all.

6. Comparisons

6.1 Advantages of Regenerative Braking over Conventional Braking

Energy Conservation

ISBN Number: 978-93-95305-78-5

The flywheel absorbs energy when braking via a clutch system slowing the car down and speeding up the wheel. To accelerate, another clutch system connects the flywheel to the drive train, speeding up the car and slowing down the flywheel. Energy is therefore conserved rather than wasted as heat and light which is what normally happens in the contemporary shoe/disc system.

Wear Reduction

An electric drive train also allows for regenerative breaking which increases Efficiency and reduces wear on the vehicle brakes. In regenerative braking, when the motor is not receiving power from the battery pack, it resists the turning of the wheels, capturing some of the energy of motion as if it were a generator and returning that energy to the battery pack. In mechanical brakes; lessening wear and extending brake life is not possible. This reduces the use of use the brake.

Fuel Consumption

The fuel consumption of the conventional vehicles and regenerative braking system vehicles was evaluated over a course of various fixed urban driving schedules. The results are compared as shown in figure. Representing the significant cost saying to its owner, it has been proved the regenerative braking is very fuel-efficient. The Delhi Metro saved around 90,000 tons of carbon dioxide (CO2) from being released into the atmosphere by regenerating 112,500 megawatt hours of electricity through the use of regenerative braking systems between 2004 and 2007. It is expected that the Delhi Metro will save over 100,000 tons of CO2 from being emitted per year once its phase II is complete through the use of regenerative braking. The energy efficiency of a conventional car is only about 20 percent, with the remaining 80 percent of its energy being converted to heat through friction. The miraculous thing about regenerative braking is that it may be able to capture as much as half of that wasted energy and put

6.2 Comparison of Dynamic Brakes and Regenerative Brakes

Dynamic brakes ("rheostat brakes" in the UK), unlike regenerative brakes, dissipate the electric energy as heat by passing the current through large banks of variable resistors. Vehicles that use dynamic brakes include forklifts, Diesel-electric locomotives, and streetcars. This heat can be used to warm the vehicle interior, or dissipated externally by large radiator-like cowls to house the resistor banks.

The main disadvantage of regenerative brakes when compared with dynamic brakes is the need to closely match the generated current with the supply characteristics and increased maintenance cost of the lines. With DC supplies, this requires that the voltage be closely controlled. Only with the development of power electronics has this been possible with AC supplies, where the supply frequency must also be matched (this mainly applies to locomotives where an AC supply is rectified for DC motors). A small number of

ISBN Number: 978-93-95305-78-5

mountain railways have used 3-phase power supplies and 3- phase induction motors. This results in a near constant speed for all trains as the motors rotate with the supply frequency both when motoring and braking.

7. Conclusion

The beginning of the 21st century could very well mark the final period in which internal combustion engines are commonly used in cars. Already automakers are moving toward alternative energy carriers, such as electric batteries, hydrogen fuel and even compressed air. Regenerative braking is a small, yet very important, step toward our eventual independence from fossil fuels. These kinds of brakes allow batteries to be used for longer periods of time without the need to be plugged into an external charger. These types of brakes also extend the driving range of fully electric vehicles. In fact, this technology has already helped bring us cars like the Tesla Roadster, which runs entirely on battery power. Sure, these cars may use fossil fuels at the recharging stage -- that is, if the source of the electricity comes from a fossil fuel such as coal -- but when they're out there on the road, they can operate with no use of fossil fuels at all, and that's a big step forward. When you think about the energy losses incurred by battery-electric hybrid systems, it seems plausible to reason that efficient flywheel hybrids would soon become the norm. But of course it’s not quite so black and white, and further analysis shows that a combination of battery-electric and flywheel energy storage is probably the ideal solution for hybrid vehicles. As designers and engineers perfect regenerative braking systems, they will become more and more common. All vehicles in motion can benefit from utilizing regeneration to recapture energy that would otherwise be lost.

References

[1] Cibulka J. Kinetic energy recovery system by means of flywheel energy storage. Advanced engineering. 3. 2009

[2] howstuffswork.com

[3] Hewko L. O. Automotive traction drive CVTs – An overview. SAE paper 861355

[4] Juan W. Dixon, Micah Ortúzar, Eduardo Wiechmann. Regenerative Braking for an Electric Vehicle Using Ultracapacitors and a Buck-Boost Converter

[5] Chris Brockbank. Development of Full-Toroidal Traction Drives in Flywheel Based Mechanical Hybrids”

[6] Ziqiang Chen, Jiaxi Qiang, Jianhui He, Lin Yang. Intelligent Regenerative Braking Control of Hybrid Buses

ISBN Number: 978-93-95305-78-5

[7] S. J. Clegg. A Review of Regenerative Braking System. Institute of Transport Studies, University of Leeds, Working paper of 471, 1996

[8] Regenerative braking boosts green credentials. Railway Gazette International. 2 July 2007

[9] Omkar Khatavkar " Regenerative Braking System" IJIRMPS | Volume 9, Issue 4, 2021 ISSN: 2349-7300

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

GLOBAL PERSPECTIVES ON AI INNOVATIONS IN EDUCATION: THE ROLE OF CHATGPT

Ms. Rashi Bhati, Assistant Professor, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh

Dr. Diwakar Chaudhary, Assistant Professor, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh

Mr. Rishi Jain, MBA Student, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh

The release and rapid difference of ChatGPT have caught the attention of educators worldwide. Some educators are enthusiastic about its potential to support learning. Others are concerned about how it might circumvent learning opportunities or contribute to misinformation. To better understand reactions about ChatGPT concerning education, we analyzed Twitter data (16,830,997 tweets from 5,541,457 users). Based on topic modeling and sentiment analysis, we provide an overview of global perceptions and reactions to ChatGPT regarding education. ChatGPT triggered a massive response on Twitter, with education being the most tweeted content topic. Topics ranged from specific (e.g., cheating) to broad (e.g., opportunities), which were discussed with mixed sentiment. We traced that authority decisions may influence public opinions. We discussed that the average reaction on Twitter (e.g., using ChatGPT to cheat in exams) different from discussions in which education and teaching learning researchers are likely to be more interested (e.g., ChatGPT as an intelligent learning partner). This study provides insights into people's reactions when new groundbreaking technology is released and implications for scientific and policy communication in rapidly changing circumstances.

Artificial intelligence (AI) has the potential to transform the eld of education, and its applications are becoming increasingly prevalent. e massive discussion and adoption of ChatGPT following its November 30, 2022 release suggest that AI can rapidly change how we learn and communicate. e release of ChatGPT generated a great deal of excitement and trepidation as to its possible effects on education. The announcement from Microsoft to make programs like ChatGPT available for all users through its once program hints at the broad impact of how people may soon leverage AI in their written communication. As generative AI tools such as ChatGPT become more integrated into education, educators must address crucial questions about the future of teaching and learning. Students will need to understand how AI works, it's accordance and challenges, and how they can harness its power without reproducing the biases inherent

ISBN Number: 978-93-95305-78-5

in its training data. Teachers will have to walk along- side, learning as they go and reinforcing preexisting habits such as corroboration and interrogation of sources, critical thinking, and ethical use of sources.

Notably, the spread and speed of innovation o en depend on its usage by early adopters and their perception of the new technology. Therefore, in this paper, we explore the global reception of ChatGPT in the first two months of its release. We aim to understand how the global educational community viewed the potential impact of ChatGPT on education and human learning. This may include topics from the potential to personalize learning to the ethical implications of relying on AI for information and communication. Specifically, we leverage social media data on Twitter to analyze the worldwide reception of ChatGPT, seeking insight into (a) the most prevalent topics discussed regarding ChatGPT in education and (b) how users discussed these topics over this initial implementation period.

Theoretical background

What is ChatGPT? ChatGPT (https://openai.com/blog/chatgpt) is the latest release of the Generative Pre-trained Transformer (GPT) family of language models released by OpenAI (https://openai.com) on November 30, 2022. A language model is a statistical model that can predict the probability of a sequence of words. With this capability, a language model can generate natural language in a human style. Like all statistical models, a language model needs to be trained by many word sequences to calculate the probability of each sequence. e number of word sequences or the training corpus size used to train a model determines how much experience a model can gain about the language and, more importantly, the knowledge incorporated in the language. ChatGPT is a large language model trained with data from the Internet and many scanned books. Brown et al.6 reported using a corpus of 499 billion words to train the GPT-3 model, which was the base model for ChatGPT at its first release. ChatGPT now draws on GPT-4, a much larger and more powerful model. e GPT models are transformer models, allowing downstream ne-tuning for improved performance on more speci c tasks, such as conversations or document classification. The conversation ne-tuning that ChatGPT obtained on top of GPT-3 aims at reducing untruthful, toxic, or unhelpful output that uncontrolled large language models may produce. e ne-tuning approach used in ChatGPT was called Reinforcement Learning with Human Feed- back (RLHF). is method ne-tuned the original model with data annotated by human raters as more or less appropriate responses. Details of the ne-tuning process are reported in Ouyang et al.

Opportunities and risks of ChatGPT for education. ChatGPT and other large language models can potentially have a large e ect on teaching and learning in practice. is may include, for instance, the potential to facilitate more personalized and adaptive learning and organize assessment and evaluation

ISBN Number: 978-93-95305-78-5

processes more efficiently. Also, Kasneci et al. emphasize the potential to compensate for educational disadvantages. Using speech-to-text technologies or automated generation of written texts, visual impairments or partial impairments such as dyslexia can be less limiting in learning, contributing to inclusive education. Zhai looked at the *Next Generation Science Standards* and tested how teachers could use ChatGPT to overcome key instructional challenges, such as providing feedback and learning guidance or recommending learning materials to students. For educational purposes, the specific potential of ChatGPT lies in its interactive component that allows for the execution of effective learning mechanisms. For instance, feedback is a core feature of learner support that is effective in learning. ChatGPT can be understood as a learning partner or teaching assistant that gives feed- back if good prompts are given by the learners. Organizations such as the Khan Academy are quickly trying to exploit the power of ChatGPT as a learning partner by integrating the tool with prompts already built into their platform.

Such education opportunities contrast with AI's limitations and associated risks. One urgent limitation of ChatGPT is that no source of truth was included during the Reinforcement Learning training of ChatGPT (https://openai.com/blog/chatgpt). us, the risk that ChatGPT will produce texts with plausible-sounding but incorrect information is high8–10,13–18. Educators and learners need professional knowledge and critical re ection skills to assess the responses generated adequately19 (see also 21st-century skills20). ChatGPT as a learning partner, may not promote critical thinking per se21. However, use guided by educators can provide opportunities for critical thinking (e.g., as students learn to re ne prompts based on their understanding of the context or genre). e question of how ChatGPT (and its successors) opportunities for education can and should be best exploited and how its risks can be best avoided is an important and interdisciplinary research issue that will unfold over the next few years.

Human reactions to groundbreaking technological innovations. . New technologies like ChatGPT can only achieve their potential if they are used in pedagogically sound ways. Active use is likely if users have a positive attitude toward the technology. Numerous theories postulate the importance of rational processes for accepting and adapting technological innovations. For instance, the Technology Acceptance Model (TAM;22, which is based on the theory of Reasoned Action23,24 and the theory of Planned Behavior25,26, is a frequently used model to describe the actual use of technology27. us, these theories and models provide a framework for conceptualizing human behavior in the context of technological innovations. However, besides cognitive theo- ries describing rational processes and non-rational behaviors like biases or misconceptions, humans' emotions, and feelings are also important factors determining why people adapt to new technologies5,28. For instance, social science research has shown

ISBN Number: 978-93-95305-78-5

that emotions are a crucial factor for decision-making processes (e.g., functioning as helpful guides or as bias factors; Lerner et al.29,) or consumer behavior30 (for more studies, see Valor et al.28,). Regarding ChatGPT, a rst ad hoc study on user sentiment towards the tool is available based on Twitter data for December 5–7, 202231. The authors identified the impact of ChatGPT on education as one primary topic users talked about with mixed sentiment (52% positive, 32% negative, 16% neutral). Statements made by individual education stakeholders shortly a er ChatGPT was released re ect this mixed sentiment. It is interesting, how- ever, that the positive tweets somewhat outweigh the negative tweets overall because equally, just the opposite (i.e., predominantly negative tweets) would have been plausible when thinking about the xed routines in many educational institutions that are potentially challenged using ChatGPT (e.g., performance assessment). However, these findings are only based on data from the first two days a er the release of ChatGPT. Whereas some educational stakeholders express apprehension about ChatGPT, other educational stakeholders are optimistic about the introduction of ChatGPT32. For instance, individual statements by students and scientists illustrate that, on the one hand, there is a fear that students will outsource their writing and thinking when using ChatGPT or that proven routines such as commonly used homework or assessment methods (e.g., essays) can now no longer be used by educators. On the other hand, the opportunity for a transformation of educational processes is seen, for instance, by redesigning written assessments in such a way that less important skills, such as super cial text features such as grammar or spelling, are pushed into the background allowing critical and logical thinking skills to come to the fore.

Twitter data as a measure to gain insights into human reactions. Twitter is a microblogging plat- form where registered users can post brief messages called tweets (up to 280 Unicode characters for non-paying users; tweets). Tweets can be linked to specific persons (through links [@]) or specific topics (via hashtags [#]). Users can follow other users' tweets. Twitter provides access to real-time data that can capture the public perceptions on innovations like ChatGPT (another example CRISPR33), significant events (e.g., Arab spring, U.S. elections, COVID-19:34,35), or reforms36. Twitter data has accordance as a research tool as it provides scalable and unbiased data that is also ne-grained from a temporal perspective37. Therefore, Twitter data is potentially better suited for understanding innovations on a larger scale than more time-consuming traditional research methods like surveys or interviews.

Aims and research questions. ChatGPT can potentially transform educational processes worldwide, but whether and how it does so may depend on how educators take it up. In this study, we aim to gain insights into an unvarnished and immediate global human reaction to the release of ChatGPT that goes beyond

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statements made by individual stakeholders in education. Our study may help estimate human reactions to technology innova- tions that can also be relevant to the education sector in the future (e.g., incorporating measures for acceptance of new educational technologies such as information on bene ts or guidelines on how to use this technology directly when they are introduced). In addition, we examine which education-related topics were discussed by users and which topics tend to be disregarded but should not be ignored in a critical discussion of ChatGPT in educational contexts. We focused on the following three research questions (RQs) in the rst two months a er the ChatGPT release (November 30, 2022):

(RQ1) What was the global reception on Twitter about ChatGPT?

(RQ2) What topics related to ChatGPT emerged in the education topical cluster during this initial period on Twitter?

(RQ3) How were the most prevalent educational topics related to ChatGPT discussed on Twitter?

Methods

Data collection and preparation. . Using the Twitter API for Academic Research, we collected 16,830,997 tweets posted from November 30, 2022, to January 31, 2023. We chose this rollout period to get an initial reaction from the public before many had spent much time thinking about or using ChatGPT. e data collection procedure was as follows: first, we queried the Tweets that mentioned ChatGPT. Second, we identified and collected all conversations with either a sparking tweet (i.e., tweets that start a discussion) or a reply mentioning ChatGPT. A conversation is defined as the sparking tweet and all other tweets directly replying to the sparking tweet. Notably, a conversation needs to include at least two different users. is led to 127,749 unique conversations. Notably, we found no mentions of ChatGPT on Twitter before November 30, 2022.

We anonymized the data to protect users' privacy by replacing Twitter-assigned tweet, author, and conversation identifiers with random numeric identifiers. Email addresses and phone numbers were substituted with placeholders. Similarly, we replaced usernames with anonymous user identifiers. In addition, we removed tweets that were most likely generated by computer programs (i.e., bots) using unsupervised text-based and heuristics approaches. First, we removed bots by removing those 257,858 accounts that posted more than ten tweets during the observation period, or contained the word bot in their screen name, or their screen name ended with app or included app followed by a non-letter symbol (self-declared bots). We set the number of tweets threshold based on the assumption that bots are prone to tweet, on average, significantly more than humans38. We also removed accounts from the dataset that posted more than 1000 tweets. Overall, 283 bots and their 80,389 tweets were deleted based on the first

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rule. Second, we deleted repetitive tweets about unrelated topics (e.g., spam-like product advertisements or cryptocurrency). e groups of tweets were found by clustering the document (tweet) embeddings. is text-based approach is preferred over the available tools for bot detection, such as Botometer39, because of the large dataset size and heterogeneous nature of the data. In addition, modern bots are prone to behave in groups rather than individually. e text-based approach can capture coordinated behavior40. is led to a sample size of 16,743,036 tweets, 5,537,942 users, and 125,151 conversations.

Analytical method. We applied a topic modeling procedure to gain insight into topics users discussed a er ChatGPT was released (RQ1 and RQ2). We selected only tweets in English, deleted empty tweets and duplicates, and removed user mentions starting with "@", hashtags, and links in all tweets. We deleted the term ChatGPT and its derivatives to improve the model performance, as this term appeared in all tweets (due to the inclusion criteria of our data collection:41). Next, we used a BERTopic algorithm41 to retrieve clusters of similar tweets from the dataset. e algorithm allows using document embeddings generated by state-of-the-art language models. It outperforms conventional topic modeling techniques such as Latent Dirichlet Allocation (LDA) and Non-Negative Matrix Factorization (NMF), as it accounts for semantic relationships among words and provides better topic representations.

Moreover, BERTopic was used successfully in recent studies on Twitter43,44. We used a Python implementation of the BERTopic algorithm (https://github.com/MaartenGr/ BERTopic) with the minimum size of a cluster set at 500 and 3 different language models: BERTweet (https://huggingface.co/docs/transformers/model_doc/bertweet), twitter-roberta-base-sep2022 (https://huggingface.co/cardi nlp/twitter-roberta-base-mar2022), and all-MiniLM-L6-v2 (https://huggingface.co/sentence-transformers/all-MiniLM-L6-v2). We examined the performance of each embedding model on our dataset by reviewing 20 tweets from each topic. e last embedding model showed a better performance regarding topic diversity and coherence. We ran the model on all non-conversation tweets written in English, not including retweets (i.e., 520,566 sparking and other non-conversation tweets). We did not include retweets as they decelerate clustering significantly while adding little value to the output of topic modeling. en, we extrapolated the results on retweets (526,780 full-text retweets) using super- vised classification and manually grouped some of these topics into larger topical clusters.

Sentiment analysis. We performed sentiment analysis to gain insight into how users discussed ChatGPT a er it was released (RQ1 and RQ3). For this, we used all tweets in English, including conversations. e preprocessing procedure was identical to the one applied at the topic modeling step. Next, we used the

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rule-based model VADER to perform the sentiment analysis45, as VADER showed a high accuracy on Twitter data46 and outper- formed other sentiment so ware like LIWC when using Twitter data on education47. In addition, we excluded outliers (i.e., tweets identi ed within the topic modeling procedure that are far from other topics) to achieve a more accurate estimate of sentiment for education-related tweets.

We make our data preparation and analysis syntaxes freely available at the following link: https://github.com/twitter-tuebingen/ChatGPT_project.

Ethical approval. An ethics committee approved the study and the collection of the data. It con rmed that the procedures aligned with ethical research standards with human subjects (date of approval: 09-02-2023, le number: AZ.: A2.5.4-275_bi).

Results

The global reception of ChatGPT (RQ1). To gain insights into the global reception on Twitter about ChatGPT, we rst looked at all 16,743,036 tweets (without identi ed bots and spam) of the rst two months a er the release of ChatGPT that include the term ChatGPT and tweets in related conversations (for descriptive statistics regarding the number of likes, retweets, replies, and quotes see Table 1A,B). We found that the number of tweets per day increased on average from 0 tweets before November 30, 2022, to over 550,000 tweets per day at the end of January (Fig. 1A,B). is number is impressive compared to the number of tweets related to other prominent hashtags in the past. For instance, in their analyses of the social media response (i.e., Twitter) to the Black Lives Matter debate, Ince et al.48 found that the Hashtag #BlackLivesMatter (including di erent spellings) was mentioned 660,000 times from the beginning of 2014 to November 2014. A more current comparison is the number of tweets regarding vaccine manufacturers AstraZeneca/Oxford, P zer/BioNTech, and Moderna dur- ing the COVID-19 pandemic. From December 1, 2020, to March 31, 2021, Marcec and Likic49 retrieved 701,891 tweets in English.

Most of the tweets related to ChatGPT (72.7%) were in English (see Fig. A in the appendix), and 52.2% came from the U.S. (Fig. 2). Next, we looked at the sentiment ratio of daily tweets (Fig. B, see also Fig. C in the appendix). Almost all tweets were positive in the very rst days a er the release of ChatGPT. However, the level (i.e., the proportion of tweets classi ed as positive, neutral, or negative) then attened, remaining relatively stable with small overall uctuations throughout the rst two months. Whereas tweets classi ed as positive dominated all analyzed days within the rst two months a er the release of ChatGPT, the daily number of positive, neutral, and negative tweets converged to a 40–30–30 distribution over time. is distribution may suggest that users increasingly discussed ChatGPT more deliberately and re ectively,

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considering not only its impressive capacity but also the challenges that it poses. It is unsurprising for early technology adopters to be more positive than those subsequently investigating the technology. e sentiment change may partially re ect a more diverse universe of tweet authors.

Topics related to ChatGPT in education (RQ2). To gain insights into the topics discussed related to ChatGPT, we rst ranked all 128 topics users discussed in our sample (i.e., gained from topic modeling) by the number of associated tweets. Having identi ed 128 topics indicates that the discussion about ChatGPT on Twit- ter touches upon many topics. Second, we manually grouped these topics into 39 larger topical clusters based on semantic and cosine similarities. Education was the third most prevalent topical cluster (measured by the number of tweets; Table 2) a er discussions of general tweets about AI (the most prevalent topical cluster) and tweets that contain examples of questions and prompts (the second most prevalent topical cluster).

An overview of the ten most prevalent topics in education discussed on Twitter is given in Table 3. e most prevalent topic in the education topical cluster consisted of statements regarding the opportunities, limitations, and consequences of using ChatGPT in educational processes in general (Table 3). ese statements comprised 22% of all conversations (see T1 in Table 3). For instance, the functions of ChatGPT for educational processes

	M	**Media**	**SD**	**mi**	**25**	**50**	**75**	**Max**
(A) All tweets[a]								
Likes	4.568	0	236.468	0	0	0	1	**176,84**
Retweets	229.98	0	1688.00	0	0	0	0	**35,579**
Replies	0.391	0	13.761	0	0	0	0	**17,185**
Quotes	0.036	0	3.449	0	0	0	0	**4612**
(B) Sparking								
Likes	76.837	4	972.979	0	1	4	16	**159,79**
Retweets	13.026	0	186.667	0	0	0	2	**35,568**
Replies	6.556	1	100.024	1	1	1	3	**17,185**
Quotes	**1.708**	**0**	**27.571**	**0**	**0**	**0**	**0**	**4612**

Table 1. Descriptive statistics of likes, retweets, replies, and quotes. [a] ese statistics refer to all *N* = 16,743,036 tweets from November 30, 2022, to January 31, 2023. [b] ese statistics refer to all *N* = 125,151 tweets from November 30, 2022, to January 31, 2023.

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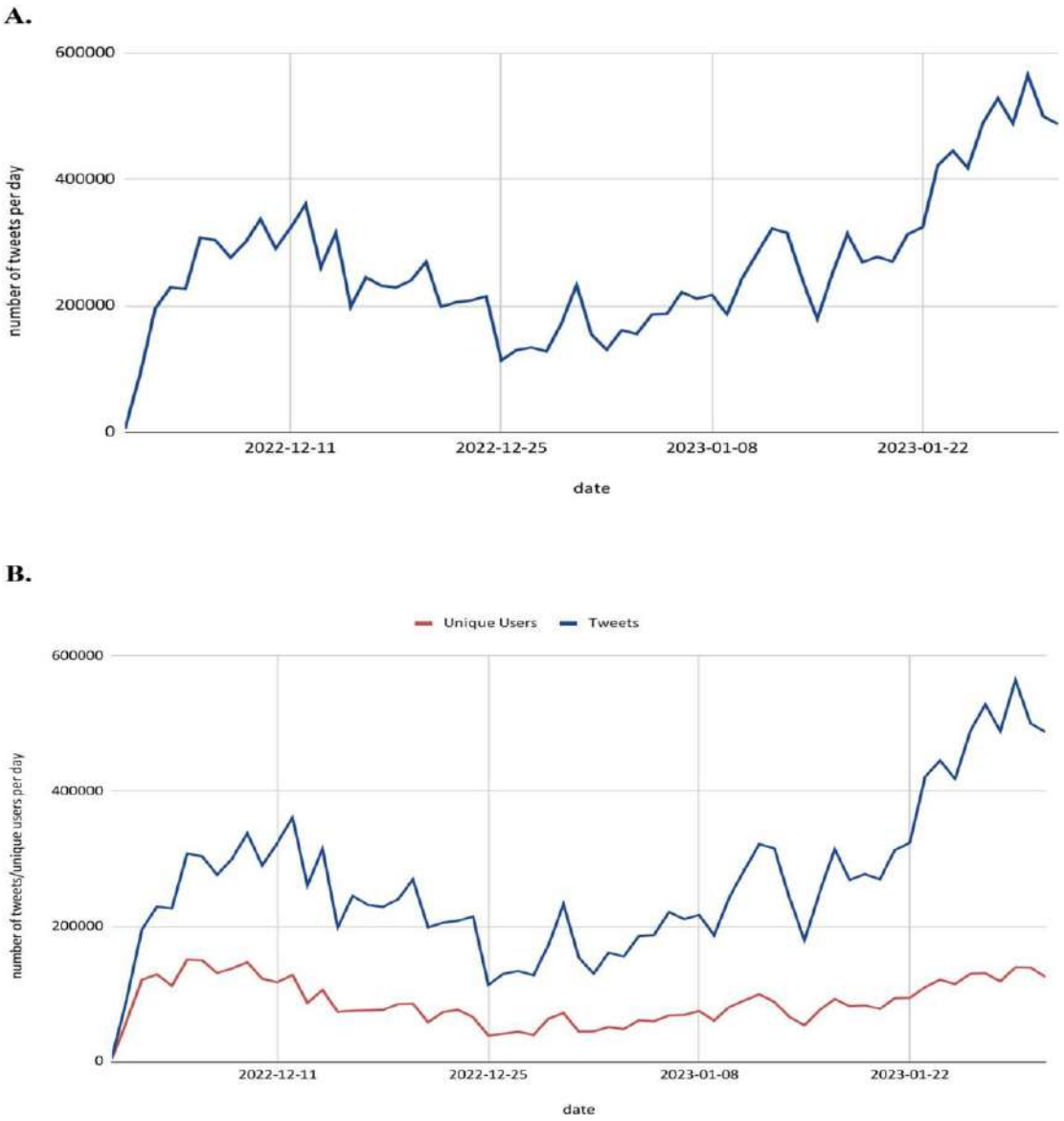

Figure 1. (A) Number of tweets per day dealing with ChatGPT. (B) Unique users and number of tweets per day dealing with ChatGPT. We used all 16,743,036 tweets.

were discussed (e.g., getting feedback), and measures for a successful implementation of ChatGPT in educational processes were discussed (e.g., prerequisites for educators and learners, such as awareness of opportunities and boundaries of ChatGPT and an awareness of ethical aspects). e second most prevalent topic in education con- sisted of statements related to e ciency and cheating when students use ChatGPT to, for instance, do homework like essays. ese statements comprised 18% of all conversations (see T2 in Table 3). Similarly, the role of ChatGPT in academia was discussed (the third most prevalent topic in education, cover- ing 16% of all conversations; see T3 in Table 3). For instance, on the one hand, opportunities of using ChatGPT

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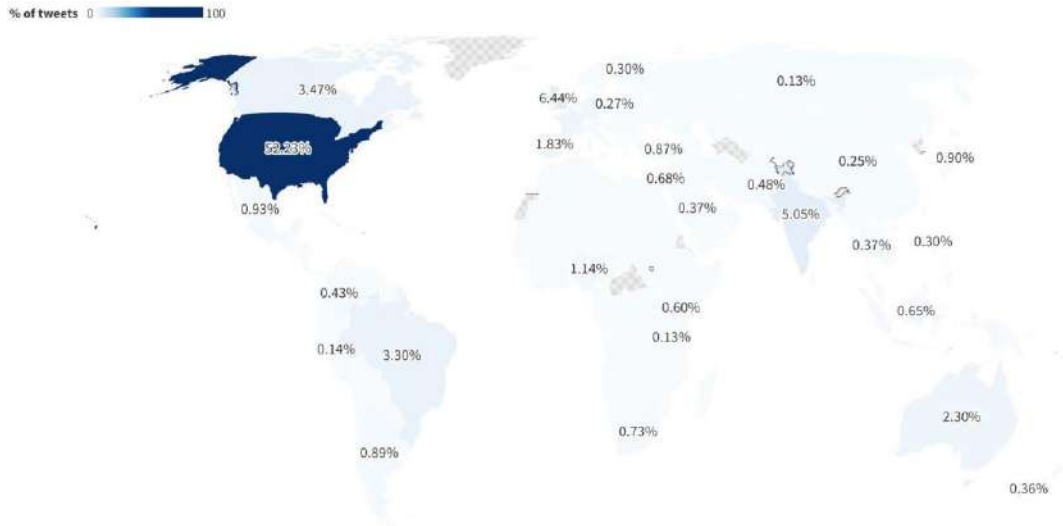

Figure 2. Global distribution of tweets. e visualization is based on 1% (i.e., 160,260) tweets with known locations out of 16,743,036 tweets. For an interactive version of this gure, see https://public.ourish.studio/visualisation/13026492/.

(e.g., support in the standardized process of writing a research paper) and the limitations (e.g., no references or made-up references, potential danger for academia if ChatGPT is not used re ectively) were addressed. e fourth prevalent topic was banning ChatGPT in educational organizations (covering 10% of all conversations; see T4 in Table 3). Although there were discussions worldwide about regulations such as bans in schools and universities, the news that ChatGPT was banned from New York City public schools' devices and networks, in particular, dominated discussions on Twitter. In addition to these four dominant topics, which together cov- ered 66% of the total education-related conversations, the topics T5 (capability of ChatGPT to pass exams), T6 (strategies for using use ChatGPT for writing), T7 (other AI tools for education and developments in the future), T8 (the capability of ChatGPT to replicate students' papers), and T9 (costs of education) each covered between 7.5% and 3.6% of all education-related conversations. e topic of how educators could integrate ChatGPT into teaching–learning processes (e.g., teachers in their lessons) was of minor importance (covering only 2% of all conversations; see T10 in Table 3).

e pairwise cosine similarity between topic embeddings (Fig. 3) illustrates that the ten educational topics are closely related. Closely linked are the topics T1 (i.e., opportunities, limitations, and consequences of the use of ChatGPT), T2 (i.e., e ciency and cheating when students use ChatGPT to write [e.g., homework like essays]), T3 (i.e., opportunities and limitations of ChatGPT in academia [e.g., writing research

ISBN Number: 978-93-95305-78-5

papers]) and T4 (i.e., ban ChatGPT in educational organizations). is means that the words chosen within the topics have signi cant commonalities. e close connection may also indicate that these four topics may have been discussed concur- rently. For instance, the opportunities, limitations, and consequences of using ChatGPT were probably o en discussed with multiple perspectives in mind. Considering, at the same time, how students will use ChatGPT to write essays, what challenges students and researchers face in writing papers, and what consequences should be drawn for regulations regarding the use of ChatGPT by organizations such as schools and universities. In contrast, the topics of how ChatGPT can pass current exams in various disciplines and educational costs had fewer commonalities with the other topics.

Sentiments of most prevalent educational topics (RQ3). To gain insights into how the most prev- alent education topics related to ChatGPT were discussed, we examined the sentiments of all 86,934 tweets related to education (Table 2) and the related 34,732 conversation tweets (i.e., 121,666 tweets in total; Fig. 4). On average, the number of tweets with positive sentiment outweighed tweets with neutral and negative sentiment throughout the rst two months a er ChatGPT's release. Descriptively, positive tweets decreased, and negative and neutral tweets increased over the two months. Before January 5 (see the vertical line in Fig. 4), the largest share of tweets was positive every day a er the release of ChatGPT. Only from January 5 onwards the shares of all three sentiments started to alternate so that the share of negative or neutral tweets was the highest on some days. Sentiments on each of the ten identi ed topics are shown in Fig. 5. e costs of education resulting from using

AI tools such as ChatGPT were discussed with the most positive sentiment (73.3%). is positive sentiment was mainly because many people anticipated a reduction in the cost of education through AI technology such as ChatGPT. e topic that was discussed the second most positively is how educators could use ChatGPT (57.1% positive sentiment). e positive statements referred especially to the possibility of saving time for educators. For example, the potential of ChatGPT to be used to create assignments for worksheets or exams was highlighted. Additional topics were discussed with a diverse sentiment (e.g., banning ChatGPT in educational institutions.

Topic	Volu	%	Average length of
AI in general	114,8	10.96	6.31

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Question examples, prompt	104,5	9.98	5.71
Education	86,93	8.30	5.19
OpenAI and its Investors and	80,07	7.65	5.58
Access and price	77,79	7.43	9.55
LLM technology	70,43	6.72	6.22
Impact on search engines	53,55	5.1	5.85
Impact on art (poems and lyrics,	47,67	4.55	4.69
Digital content	41,67	3.98	5.50
Programming	35,64	3.40	4.84
Business routine	34,42	3.29	5.70
Entertainment	26,14	2.50	4.82
Cybersecurity (writing malware)	24,86	2.37	11.17
ChatGPT on social media	22,70	2.17	8.17
Finance	22,07	2.11	6.35
Healthcare	19,19	1.83	7.17
Emotional reaction (scary, insane)	16,37	1.56	4.20
Politics	13,93	1.33	5.48
Legal issues	11,37	1.09	5.89
Making money with ChatGPT	10,98	1.05	7.49
Social events on ChatGPT, discussion	9178	0.88	3.80
Recipes	8015	0.77	5.38
Calculator, math	7843	0.75	5.09
Climate change	7807	0.75	58.84
Job loss	7802	0.74	7.36
Criticism in terms of ethics	7769	0.74	5.13
Text to audio/voice	7143	0.68	5.08
Spam	6219	0.59	4.33
Sport	4828	0.46	4.33
Robots	4028	0.38	3.63
Religion, sermons	3821	0.36	4.71
Q&A platforms	3776	0.36	6.06
Christmas	3406	0.33	3.18
Translation	2787	0.27	4.11
Gender	2337	0.22	5.53
Real estate	2242	0.21	5.36
ChatGPT's competitors	2170	0.21	4.64
Quantum computing	1853	0.18	4.47
Outliers (small volume topics)	39,09	3.73	8.65

Table 2. Topics overall. 1,047,346 tweets used (i.e., English non-conversation tweets). Volume indicates the absolute number of tweets. LLM large language models.

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[44.1% negative, 25.3% neutral, 30.6% positive sentiment] or how to use ChatGPT for writing [32.6% negative, 30.2% neutral, 37.2% positive sentiment]). Whether ChatGPT will ever replicate student papers was discussed most negatively (72.4% negative sentiment). ese negative statements appear to re ect the view that ChatGPT is only capable of producing schematic essays and is not as original or creative as human writers, thus incapable of generating new ideas.

Discussion

We aimed to gain insights into an unvarnished and immediate global reaction to the release of ChatGPT, focusing on the education-related topics users discussed and the sentiment of these discussions. erefore, we analyzed 16,830,997 tweets posted in the rst two months a er the release of ChatGPT that included the word ChatGPT. First, regarding the global reception on Twitter about ChatGPT (RQ1), we traced the rapid awareness of ChatGPT shortly a er its release. Whereas before November 30, 2022, not a single tweet worldwide contained the word ChatGPT, the rise of ChatGPT a er its release was almost unstoppable, with more than 100,000 tweets per day at the beginning of December 2022 and over half a million by the end of January 2023. is massive worldwide awareness is also con rmed, for instance, the hits on Google (707,000,000 hits when searching Chat- GPT on March 24, 2023) and the high number of users (4 months a er its launch, there are now an estimated

Topic (T)	**Volume**	**%**	**Anchor tweets (synthetic)**
T1. Opportunities, limitations, and consequences of the use of ChatGPT	27,368	22.49	a. #chatgpt is an incredible learning tool. It's like working with a senior devel- oper who has limitless patience and whom you can ask all your questions. What an amazing time to live! b. Being creative and proactive educators, our priority is to support our students in becoming ethical and responsible users of these tools so that they can gradu- ate as technologically literate citizens.
T2. E ciency and cheating when students use ChatGPT to write (e.g., home- work like essays)	21,526	17.69	a. My bro used ChatGPT to write an essay for college and just banged it out in 10 s using ChatGPT… b. e rise of AI in cheating. ChatGPT is able to

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			write compelling, sophisticated essays.
T3. Opportunities and limitations of ChatGPT in academia (e.g., writing research papers)	19,654	16.15	a. Abstracts written by ChatGPT can fool scientists! b. I asked ChatGPT about the topic of my PhD. It generated reasonably looking explanations and references until I fact-checked the references…
T4. Ban ChatGPT in educational organizations	12,084	9.93	a. e NYC public schools are banning ChatGPT on school networks and devices b. e NYC Education Department made a short-sighted decision. It is the same as if we had banned calculators when they rst came out.
T5. Capability of ChatGPT to pass exams	9107	7.49	a. ChatGPT took my exam on Microeconomics and unked. 12/100 for the exam b. ChatGPT passing the Wharton MBA proves that an MBA is the most point- less activity you can engage in
T6. Strategies to use ChatGPT for writing	7090	5.82	a. Tip: Before writing an essay, ask ChatGPT to generate one on the same topic to nd out the typical thing to say so that you can avoid it b. My child, a er asking ChatGPT to write an essay, said: “It’s producing what I’d say, but mine is better because it provides more depth”. Educators should be relaxed about kids using AI. Treat it more like giving ideas
T7. Other AI tools for education and developments in the future	6422	5.28	a. ChatGPT is the tip of the iceberg. 10 AI tools that will change education forever! b. e technology behind #ChatGPT is creating new startups and services every day. ese 7 AI-powered websites are revolutionizing education!
			a. It is impossible for ChatGPT to imitate the

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T8. e capability of ChatGPT to replicate students' papers	5220	4.29	charm of a college paper written by an undergraduate student who did not attend classes or read lecture materi- als. e student's pure determination and desperation allow them to create a unique piece of writing that arti cial intelligence could never replicate! AI can't create. It can only replicate what has already been created.
T9. Costs of education	4413	3.63	a. anks to AI. You can learn anything you want, for free! No need to spend thousands of dollars on a course. b. If both teachers and students use ChatGPT to complete/judge challenges, there is no need to go to universities. Schools are more than Q/A; they are places for ndings and discussions.
T10. How educators could integrate ChatGPT in teaching	2457	2.02	NEW!!! How Can Educators Leverage ChatGPT to Save Time? Have you tried ChatGPT for your classroom? #teachers #chatgpt
Outliers	6325	5.20	

Table 3. e most important topics in education. 121,666 tweets used (i.e., English non-conversation tweets plus English-related conversation tweets). Volume indicates the absolute number of conversations. e volume was used as an indicator of the importance of the topics. Anchor tweets are synthetic tweets that represent typical content of the topics exemplarily.

100 million active monthly users:18,50) indicate that ChatGPT is likely going to have a lasting impact on personal and professional lives.

Second, education was the top content topic for the ChatGPT discussion beyond generic topics (e.g., how to access ChatGPT). is is surprising because ChatGPT could drastically change professional practice in many professions where creative text production is central (e.g., journalism, book authoring, marketing, business reporting). Implications include that educational stakeholders (e.g., school/higher education

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administrators, teachers/instructors, educational policy-makers) must develop guidelines for its use in their contexts.

Third, zooming in on education-related topics (RQ2), we found that both speci c topics (e.g., students' essay writing, cheating, the capability of ChatGPT to pass exams) and broader issues (e.g., opportunities, limitations, and consequences of the use of ChatGPT) were discussed. ese topics may provide initial directions for edu- cational stakeholders to develop ChatGPT usage guidelines.

Fourth, although the ndings indicated that ChatGPT was generally discussed positively in the rst 2 months a er ChatGPT's release, the statements regarding education were more mixed. is aligns with previous research on perceptions of technological innovations, which showed that users face most innovations with varying expec- tations and emotions. Expectations and emotions are associated with attitudes ranging from absolute conviction of the new technology's usefulness and a positive attitude ("radical techno-optimists") to complete rejection of the new technology ("techno-pessimists")51. Especially a er January 5, when it was announced that ChatGPT would be banned from New York City public schools' devices and networks, the sentiment of the discussion began to be more mixed. e mixed sentiment is not necessarily bad; many potentially positive and negative e ects of using ChatGPT in education must be carefully weighed. At the same time, it is important to consider how rapid policy decisions, taken as a precaution without an opportunity to weigh evidence, can in uence public debate on topics. is aspect is important because technologies are only used and thus enfold their potential (e.g.,

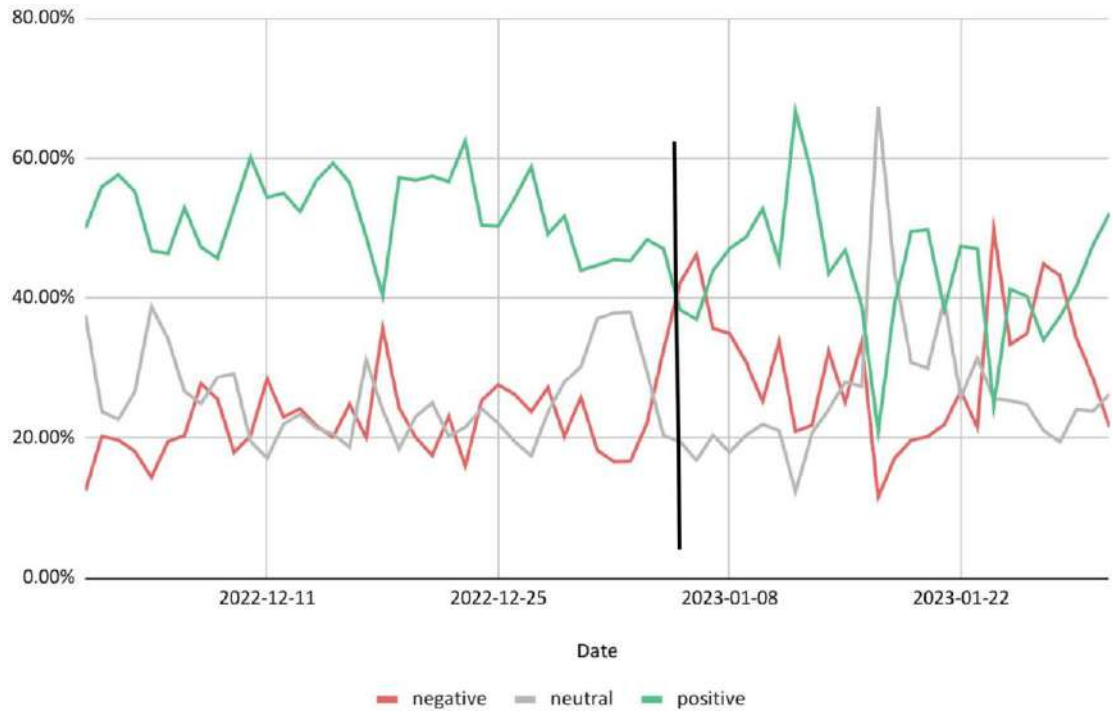

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Figure 4. Sentiment in education per day. e vertical line is plotted on January 5, 2023, which was the day when the proportion of negative tweets was greater than the proportion of positive tweets for the first time.

for educational processes) if users recognize their bene ts22. e critical topic of how educators could integrate ChatGPT into teaching–learning processes (e.g., teachers in their lessons) was addressed only in a few tweets.

This is interesting as the didactically meaningful integration of AI tools such as ChatGPT into teaching–learning processes at schools and universities will certainly be a key question for education research, teacher education, and daily practice. Moreover, as strong policy decisions such as complete bans also inform public opinion, they might render it hard for scienti c opinions on opportunities of new technologies such as ChatGPT to be heard. For instance, some of the most critical educational and scienti c challenges, like inequalities, heterogeneity, and adaptivity that might be alleviated with AI tools, were not at the core of the public debate.

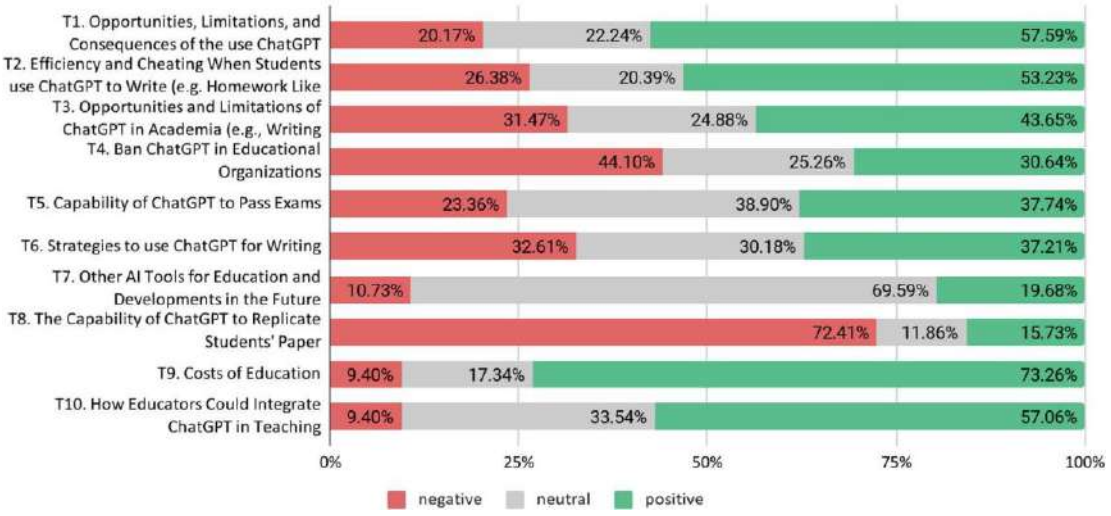

Figure 5. Sentiment in education by topic.

Finally, zooming into the sentiments of education-related topics (RQ3), we found that, for instance, the costs of education and how educators could use ChatGPT for teaching were discussed positively (e.g., the possibility of saving time). In contrast, whether ChatGPT can replicate student papers has been discussed negatively. e negative sentiment among tweets on the replication of papers from students by ChatGPT was fed, among oth- ers, by statements in which it was expressed that a technology like ChatGPT cannot replace humans in writing believable human-like text (e.g., with the charm of humans writing). However, research shows that people quickly think they can distinguish human text from AI text due to overcon

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dence when they cannot but are merely guessing (e.g.,52,53). As awareness (measured by Tweet volume) grew, the range of sentiments increased. is likely re ects a broader audience becoming aware of the technology beyond early adopters and the increased time to consider the potential positive and negative consequences. It also may re ect an increased opportunity to use the tool, resulting in both an awareness of its potential and an ability to learn rsthand about its weaknesses.

Limitations and future research. e results of this study must be interpreted considering at least the following limitations. First, although we have thoroughly prepared the data for the analyses, problems arise due to bots. Bots are computer programs that perform automated tasks, such as automatically retweeting tweets with a speci c hashtag. Bots are challenging to detect because their behavior constantly changes as technology advances40. We used heuristics and text-based approaches to identify and remove tweets posted by bots from our data but cannot guarantee that tweets from bots are still present in the data used. Second, due to our limitation of Tweets to those in English, our geographical focus is around 57% North America. us, our ndings may not be generalizable to other regions. ird, insight into the sample used for this study is limited by the informa- tion available through the Twitter API. For instance, we could not accurately determine whether politicians, academics,

entrepreneurs, or opportunists tweeted. However, we were able to provide some general insights into the sample by analyzing, for instance, the sample's experience with Twitter (operationalized by Twitter sign-up date) or the users' reach (operationalized by number of followers; see Figs. D and E and Table A in the appen- dix). Fourth, we analyzed only the rst two months of conversations on Twitter a er the release of ChatGPT.

is means that subsequent discussions based on more experience with ChatGPT (educational stakeholders had more time to gure out strengths and weaknesses and use ChatGPT for, e.g., teaching–learning scenarios) or that included GPT4 were not considered. However, it was precisely the approach of this study to capture the unvarnished, rather unre ective reaction of humans to groundbreaking technological innovations. Moreover, this study goes beyond previous ndings on human reactions to ChatGPT, some of which only focused on the rst few days a er the release of ChatGPT

Our research approach was designed to address the overall international response of humans to the release of ChatGPT, which encourages numerous potential future research directions. First, it would be interesting better to understand the interplay between science and public opinion. For instance, it would be interesting to investigate whether it is possible to nd any indications that Twitter users refer to science in their statements on ChatGPT. For instance, users may cite research papers in the tweets (e.g., compared to

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COVID-19 vaccina- tions, where public opinions on bene ts and risks were driven by scientists' daily explanation of new preprint research ndings). Moreover, it would be interesting to gain insights into what scientists initially said about the potentials and risks of GPT and especially ChatGPT, and if these opinions are re ected in public opinion. Second, research needs to address the pedagogical qualities of human-AI interaction, which did not play a role in the global response on Twitter in our data. While recent research aligns with this nding, for instance, examining institutional websites to see what the references to ChatGPT refer to54, research that examines how AI-powered

programs like ChatGPT can be used didactically meaningful and learning-e ective (i.e., for high-quality teach- ing and learning). is may also include studies about best practices for using ChatGPT in teaching–learning situations, such as teaching e ectiveness (e.g., cognitive activation, feedback), cognitive load, o oading, and adaptivity. ird, future research can address speci c scenarios of using GPT in the classroom. is could include studies examining how ChatGPT could lead to innovative forms of instruction, for instance, asking, "What can ChatGPT do that we would never have been able to do before (e.g., have it write ve di erent essays on a topic and let it discuss with learners about which one is the best and why)?". Also, whereas people on Twitter were discussing using ChatGPT to cheat, studies should examine the distinction between learning and performance (e.g., learning to write versus doing a homework writing assignment). With a performance mindset, one can always cheat (e.g., use a calculator for homework). However, the main issue is not passing an exam or presenting an essay. It is about conveying knowledge on how to pass the exam or write an essay. ese examples illustrate how a global human response to technological innovation might di er from a more scienti cally informed response. However, human responses can help scientists to identify these blind spots in discussions better to explore and communicate them in the future. Finally, this study only provides insight into the initial human reactions to ChatGPT (the rst 2 months a er the release of ChatGPT). erefore, future work is encouraged to gain insight into the long-term e ects of ChatGPT. is could include exploring subgroup e ects for subjects such as art, music, literature, STEM, and history, as learning about literature (e.g., writing styles or foreign languages) might a ord entirely di erent GPT scenarios than learning about STEM. Furthermore, we encourage researchers to conduct surveys and interview studies targeting various stakeholder groups to gain additional insights into the use of ChatGPT and their perceived challenges and a ordances. Indeed, a steady stream of questionnaire-based studies of varying quality has emerged quickly in the rst months of 2023, o ering valuable insights into how certain user groups perceive and interact with ChatGPT. However, while providing meaningful and interesting

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ndings, these studies are limited to certain user groups with speci c local contexts and certain aspects of their user experiences—aspects identi ed and studied through their respective questionnaires. For example, typical studies of this category analyzed the perceptions and expectations of 50 senior Computer Engineering students in Abu Dhabi55, 2100 students from a Ghanaian university56, or 288 participants from a convenience sample study at an Indian university57. Compared to these questionnaire studies on narrow and focused user groups, our research approach is much broader and more globally oriented to address research questions that these smaller, targeted questionnaire studies cannot adequately address. Speci cally, we sought a comprehensive, worldwide compilation of active user responses (not passive answers to prede ned questions) to ChatGPT in its initial weeks of existence. is was a speci c time window when user reactions might have been still spontaneous and unin uenced by the repeated pro and con arguments about GPT that have since then permeated media coverage. Nevertheless, there are quite a few similarities regarding the positive and negative evaluations that Twitter uses expressed in the initial phase of ChatGPT and that di erent user groups later reported in questionnaire studies. Soon it will probably be interesting to analyze the trajectories of di erent user perceptions and expectations regarding generative AI systems such as ChatGPT over the years. However, studying these trajectories requires a sequence of snapshots at di erent points in time, as we provided in our study for the birth period of ChatGPT.

Conclusion

To conclude, ChatGPT is perhaps unique in how it exploded into the conversation and is only comparable to digital tools such as the Internet and computers that have proven to be of similar transformative magnitude.

e availability of social media, particularly Twitter, allowed many people to learn about and discuss generative AI quickly. ChatGPT was also particularly impressive in its capabilities, far more functional, accessible, and conversational than other publicly available large language models. is ability for a worldwide conversation in real-time about the exploration of a potentially transformative digital tool is illustrated by the over half a mil- lion daily tweets we see only two months a er ChatGPT’s release. is rapid awareness in a space with an active academic user base allowed educators to participate in learning about and exploring the use of this new tool (and for many, over an academic break period when they perhaps had time and capacity more than usual). For these reasons, it is comprehensible that education is the third most frequent topic of Tweets during this period, following how to access the tool, general AI, and sample prompts (use cases). Twitter allows technologically savvy educators to discuss new tools, share best practices, and try on policy positions among their peers. Twitter may not be representative of

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typical teachers. However, those using social media are likely to be among early adopters and thought leaders on using educational technology in their schools, so their Tweets may be a bellwether of things to come. When investigating new tools such as ChatGPT, communicating with peers can open our eyes to their challenges and opportunities. Hopefully, these conversations will continue into more di erentiated and educationally relevant discussions as we gain more experience with generative AI tools.

Data availability

e datasets generated and analyzed during the current study are not publicly available as we use Twitter data that cannot be completely anonymized without signi cant e ort (i.e., individuals are identi able through the tweets) but are available from the corresponding author on a reasonable request.

Received: 20 April 2023; Accepted: 7 September 2023

References

1. UNESCO. Beijing Consensus on arti cial intelligence and education. United Nations Educational, Scienti c and Cultural Organization (2019).

2. Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfe er, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., Kasneci, G. ChatGPT for good? On opportunities and challenges of large language models for education. Learn. Indiv. Di . 103, 102274. https://doi.org/10.1016/j.lindif.2023.102274 (2023).

3. Warren, T. Microso to demo its new ChatGPT-like AI in Word, PowerPoint, and Outlook soon. e Verge. https://www.theve rge.com/2023/2/10/23593980/microso -bing-chatgpt-ai-teams-outlook-integration (2023).

4. Rudolph, J., Tan, S., & Tan, S. ChatGPT: Bullshit spewer or the end of traditional assessments in higher education? J. Appl. Learn. Teach. 6(1). https://doi.org/10.37074/jalt.2023.6.1.9 (2023).

5. Rogers, E. M. Di usion of innovations (4th ed.). Free Press (2010).

6. Brown, T. B., Mann, B., Ryder, N., Subbiah, M., Kaplan, J., Dhariwal, P., Neelakantan, A., Shyam, P., Sastry, G., Askell, A., Agarwal, S., Herbert-Voss, A., Krueger, G., Henighan, T., Child, R., Ramesh, A., Ziegler, D. M., Wu, J., Winter, C., Amodei, D. Language models are few-shot learners. https://doi.org/10.48550/ARXIV.2005.14165 (2020).

7. Ouyang, L., Wu, J., Jiang, X., Almeida, D., Wainwright, C. L., Mishkin, P., Zhang, C., Agarwal, S., Slama, K., Ray, A., Schulman, J., Hilton, J., Kelton, F., Miller, L., Simens, M., Askell, A., Welinder, P.,

ISBN Number: 978-93-95305-78-5

Christiano, P., Leike, J., & Lowe, R. Training language models to follow instructions with human feedback. https://doi.org/10.48550/ARXIV.2203.02155 (2022).

8. Baidoo-Anu, D. & Owusu Ansah, L. Education in the era of generative arti cial intelligence (AI): Understanding the potential bene ts of ChatGPT in promoting teaching and learning. SSRN Electron. J. https://doi.org/10.2139/ssrn.4337484 (2023).

9. Zhang, B. Preparing educators and students for ChatGPT and AI technology in higher education: Bene ts, limitations, strategies, and implications of ChatGPT & AI Technologies. https://doi.org/10.13140/RG.2.2.32105.98404 (2023).

10. Deng, J., & Lin, Y. e bene ts and challenges of ChatGPT: An overview. Front. Comput. Intell. Syst. 2(2), 81–83. https://doi.org/ 10.54097/fcis.v2i2.4465 (2023).

11. Hattie, J. & Timperley, H. e power of feedback. Rev. Educ. Res. 77(1), 81–112. https://doi.org/10.3102/003465430298487 (2007).

12. Wisniewski, B., Zierer, K., & Hattie, J. e power of feedback revisited: A meta-analysis of educational feedback research. Front. Psychol. 10, 3087. https://doi.org/10.3389/fpsyg.2019.03087 (2020).

13. Anders, B. A. Why ChatGPT is such a big deal for education. C2C Digital Mag. 1(18). https://scholarspace.jccc.edu/c2c_online/ vol1/iss18/4 (2023).

14. Lo, C. K. What Is the Impact of ChatGPT on education? A rapid review of the literature. Educ. Sci. 13(4), 410. https://doi.org/10. 3390/educsci13040410 (2023).

15. Sok, S. & Heng, K. ChatGPT for education and research: A review of bene ts and risks. SSRN Electron. J. https://doi.org/10.2139/ ssrn.4378735 (2023).

16. Pavlik, J. V. Collaborating with ChatGPT: Considering the implications of generative arti cial intelligence for journalism and media education. J. Mass Commun. Educ. 78(1), 84–93. https://doi.org/10.1177/10776958221149577 (2023).

17. Sallam, M. e utility of ChatGPT as an example of large language models in healthcare education, research and practice: Systematic review on the future perspectives and potential limitations [Preprint]. Health Inf. https://doi.org/10.1101/2023.02.19.23286155 (2023).

18. Trust, T., Whalen, J. & Mouza, C. Editorial: ChatGPT: Challenges, opportunities, and implications for teacher education. Contemp. Issues Technol. Teach. Educ. 23(1), 1–13 (2023).

19. Kohnke, L., Moorhouse, B. L., & Zou, D. ChatGPT for language teaching and learning. RELC J. 003368822311628. https://doi.org/ 10.1177/00336882231162868 (2023).

20. Fishman, B. J. Possible futures for online teacher professional development. In C. Dede, A. Eisenkra , K. Frumin, & A. Hartley (Eds.), Teacher learning in the digital age. Online professional development in STEM education (pp. 3–31). Harvard Education Press (2016).

21. Zhai, X. ChatGPT for next generation science learning. SSRN Electron. J. https://doi.org/10.2139/ssrn.4331313 (2023).

22. Marangunić, N. & Granić, A. Technology acceptance model: A literature review from 1986 to 2013. Univ. Access Inf. Soc. 14(1), 81–95. https://doi.org/10.1007/s10209-014-0348-1 (2015).

23. Fishbein, M., & Ajzen, I. Belief, attitude, intention, and behavior: An introduction to theory and research (Addison-Wesley, 1975).

24. Fishbein, M. A theory of reasoned action: Some applications and implications. Nebr. Symp. Motiv. 27, 65–116 (1979).

25. Ajzen, I. e theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50(2), 179–211. https://doi.org/10.1016/0749-5978(91) 90020-T (1991).

26. Ajzen, I. e theory of planned behavior: Frequently asked questions. Hum. Behav. Emerg. Technol. 2(4), 314–324. https://doi.org/ 10.1002/hbe2.195 (2020).

27. Scherer, R., Siddiq, F. & Tondeur, J. e technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. Comput. Educ. 128, 13–35. https://doi.org/10.1016/j. compedu.2018.09.009 (2019).

28. Valor, C., Antonetti, P., & Crisafulli, B. Emotions and consumers' adoption of innovations: An integrative review and research agenda. Technol. Forecast. Soc. Change 179, 121609. https://doi.org/10.1016/j.techfore.2022.121609 (2022).

29. Lerner, J. S., Li, Y., Valdesolo, P. & Kassam, K. S. Emotion and decision making. Annu. Rev. Psychol. 66(1), 799–823. https://doi. org/10.1146/annurev-psych-010213-115043 (2015).

30. Bagozzi, R. P., Gopinath, M. & Nyer, P. U. e role of emotions in marketing. J. Acad. Mark. Sci. 27(2), 184–206. https://doi.org/ 10.1177/0092070399272005 (1999).

31. Haque, M. U., Dharmadasa, I., Sworna, Z. T., Rajapakse, R. N., & Ahmad, H. I think this is the most disruptive technology: Explor- ing Sentiments of ChatGPT Early Adopters using Twitter Data. https://doi.org/10.48550/ARXIV.2212.05856 (2022).

32. Stokel-Walker, C. AI bot ChatGPT writes smart essays—Should professors worry? Nature, d41586-022-04397-7. https://doi.org/ 10.1038/d41586-022-04397-7 (2022).

33. Calabrese, C., Ding, J., Millam, B. & Barnett, G. A. e uproar over gene-edited babies: A semantic network analysis of CRISPR on Twitter. Environ. Commun. 14(7), 954–970. https://doi.org/10.1080/17524032.2019.1699135 (2020).

34. Fütterer, T. et al. Was bewegt Lehrpersonen während der Schulschließungen?—Eine Analyse der Kommunikation im Twitter- Lehrerzimmer über Chancen und Herausforderungen digitalen Unterrichts. Z. Erzieh. 24, 443–477. https://doi.org/10.1007/s11618- 021-01013-8 (2021).

35. Mahdikhani, M. Predicting the popularity of tweets by analyzing public opinion and emotions in di erent stages of Covid-19 pandemic. Int. J. Inf. Manag. Data Insights 2(1), 100053. https://doi.org/10.1016/j.jjimei.2021.100053 (2022).

36. Rosenberg, J. M., Borchers, C., Dyer, E. B., Anderson, D. & Fischer, C. Understanding public sentiment about educational reforms:

e next generation science standards on Twitter. AERA Open 7, 233285842110242. https://doi.org/10.1177/23328584211024261 (2021).

37. Fischer, C. et al. Mining big data in education: A ordances and challenges. Rev. Res. Educ. 44(1), 130–160. https://doi.org/10.3102/ 0091732X20903304 (2020).

38. Howard, P. N. & Kollanyi, B. Bots, #Strongerin, and #Brexit: Computational propaganda during the UK-EU Referendum. SSRN Electron. J. https://doi.org/10.2139/ssrn.2798311 (2016).

39. Davis, C. A., Varol, O., Ferrara, E., Flammini, A., & Menczer, F. BotOrNot: A System to Evaluate Social Bots. In Proceedings of the 25th International Conference Companion on World Wide Web - WWW '16 Companion, 273–274. https://doi.org/10.1145/28725 18.2889302 (2016).

40. Cresci, S. A decade of social bot detection. Commun. ACM 63(10), 72–83. https://doi.org/10.1145/3409116 (2020).

41. Grootendorst, M. BERTopic: Leveraging BERT and c-TF-IDF to create easily interpretable topics. Zenodo https://doi.org/10.5281/ zenodo.4430182 (2020).

42. Grootendorst M. BERTopic: Neural topic modeling with a class-based TF-IDF procedure. arXiv:2203.05794v0571. Available online at: https://arxiv.org/pdf/2203.05794.pdf (2022).

43. Anwar, A., Ilyas, H., Yaqub, U., & Zaman, S. Analyzing QAnon on Twitter in context of US elections 2020: Analysis of user mes- sages and pro les using VADER and BERT topic modeling. DG.O2021: e 22nd Annual International Conference on Digital Government Research, 82–88. https://doi.org/10.1145/3463677.3463718 (2021).

ISBN Number: 978-93-95305-78-5

44. Egger, R. & Yu, J. A topic modeling comparison between LDA, NMF, Top2Vec, and BERTopic to demystify Twitter posts. Front. Sociol. 7, 886498. https://doi.org/10.3389/fsoc.2022.886498 (2022).

45. Hutto, C. & Gilbert, E. VADER: A parsimonious rule-based model for sentiment analysis of social media text. Proc. Int. AAAI Conf. Web Soc. Med. 8(1), 216–225. https://doi.org/10.1609/icwsm.v8i1.14550 (2014).

46. Elbagir, S., & Yang, J. Sentiment analysis on Twitter with Python's natural language toolkit and VADER sentiment analyzer. IAENG Trans. Eng. Sci. 63–80. https://doi.org/10.1142/9789811215094_0005 (2020).

47. Borchers, C., Rosenberg, J. M., Gibbons, B., Burch eld, M. A., & Fischer, C. To scale or not to scale: Comparing popular sentiment analysis dictionaries on educational Twitter data. Fourteenth International Conference on Educational Data Mining (EDM 2021), Paris (2021).

48. Ince, J., Rojas, F. & Davis, C. A. e social media response to Black Lives Matter: How Twitter users interact with Black Lives Matter through hashtag use. Ethn. Racial Stud. 40(11), 1814–1830. https://doi.org/10.1080/01419870.2017.1334931 (2017).

49. Marcec, R. & Likic, R. Using Twitter for sentiment analysis towards AstraZeneca/Oxford, P zer/BioNTech and Moderna COVID- 19 vaccines. Postgrad. Med. J. 98(1161), 544–550. https://doi.org/10.1136/postgradmedj-2021-140685 (2022).

50. Hu, K. ChatGPT sets record for fastest-growing user base—Analyst note. https://www.reuters.com/technology/chatgpt-sets-record- fastest-growing-user-base-analyst-note-2023-02-01/#:~:text= e%20report%2C%20citing%20data%20from,analysts%20wrote% 20in%20the%20note (2023).

51. Tate, T. P., Doroudi, S., Ritchie, D., Xu, Y., & Warschauer, M. Educational research and AI-generated writing: Confronting the coming Tsunami [Preprint]. EdArXiv. https://doi.org/10.35542/osf.io/4mec3 (2023).

52. Gunser, V. E., Gottschling, S., Brucker, B., Richter, S., Çakir, D. C., & Gerjets, P. e pure poet: How good is the subjective cred- ibility and stylistic quality of literary short texts written with an arti cial intelligence tool as compared to texts written by human authors? Proceedings of the First Workshop on Intelligent and Interactive Writing Assistants (In2Writing 2022), 60–61. https://doi. org/10.18653/v1/2022.in2writing-1.8 (2022).

ISBN Number: 978-93-95305-78-5

53. Köbis, N. & Mossink, L. D. Arti cial intelligence versus Maya Angelou: Experimental evidence that people cannot di erentiate AI-generated from human-written poetry. Comput. Hum. Behav. 114, 106553. https://doi.org/10.1016/j.chb.2020.106553 (2021).

54. Veletsianos, G., Kimmons, R., & Bondah, F. ChatGPT and higher education: Initial prevalence and areas of interest. EDUCAUSE Review. https://er.educause.edu/articles/2023/3/chatgpt-and-higher-education-initial-prevalence-and-areas-of-interest (2023).

55. Shoufan, A. Exploring students' perceptions of ChatGPT: ematic analysis and follow-up survey. IEEE Access 11, 38805–38818. https://doi.org/10.1109/ACCESS.2023.3268224 (2023).

56. Bonsu, E. M. & Ba our-Koduah, D. From the consumers' side: Determining students' perception and intention to use ChatGPT in Ghanaian higher education. J. Educ. Soc. Multicult. 4(1), 1–29. https://doi.org/10.2478/jesm-2023-0001 (2023).

57. Raman, R., Mandal, S., Das, P., Kaur, T., Jp, S., & Nedungadi, P. University students as early adopters of ChatGPT: Innovation di u- sion study [Preprint]. In Review. https://doi.org/10.21203/rs.3.rs-2734142/v1 (2023).

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

SUSTAINABLE EDUCATION AND YOUTH EMPOWERMENT: FOUNDATIONS FOR A FUTURE CIVIL SOCIETY

Ms. Rashi Bhati, Assistant Professor, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh
Dr. Diwakar Chaudhary, Assistant Professor, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh
Ms. Akanksha Pandey, MBA Student, Department of Management, Mangalmay Institute of Management and Technology, Greater Noida, Uttar Pradesh

While sustainability is at the center of many government agendas, there is a great risk of entrusting strategic decisions to those lacking in sustainability expertise. It is therefore necessary to ensure that universities are the green engines of sustainable communities. The present study administered a questionnaire to students enrolled in a Management Engineering programme at an Italian university, to collect their perceptions of and opinions on sustainability and energy issues. Students completed the questionnaire twice: once prior to beginning and once at the end of term. The results showed that students held more sustainable attitudes at the end of term, and perceived sustainable education and youth confidence as the building blocks of future society. They also observed that decarbonisation of the Italian energy system and national energy independence would require the signifi development of renewable systems and interventions to promote energy effi In addition, they recognised subsidies for green production, energy communities, diffiated waste collection and professional skills training as crucial. The sustainable university should support younger generations by encouraging student engagement in real-world projects and the development of long-term, structured teacher–student relationships.

Amidst ongoing unsettling events, including a global pandemic and a war in Ukraine, the challenge of sustain- ability remains central[1,2]. In addition, there are many problems related to health, human rights and the environ- ment, including malnutrition and food insecurity[3], as well as water shortage[4,5]. e Sustainable Development Goals (SDGs) o er a pathway to reconciling economic growth with environmental concerns, through a highly interconnected framework of analysis[6]. All countries must develop policies and trackable objectives to support the achievement of these goals[7].

e dilemma of intergenerational sustainability refers to the challenge of determining whether one will sacri ce in the present for the sake of future generations[8]. On World Youth Day in 2000, Pope John Paul II de ned sustainability as the pursuit of the unsel sh[7], with the following call to action: 'You will defend life at every moment of its earthly development, you will strive with all your energy to make this earth more and more habitable for all'. Around the world, universities and research centres have taken up this

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call; and while much progress has been made, more must be done to support young sustainability scholars, whose work is o en team- based and outreach-oriented

While sustainability is not a new topic in the literature[10,11], a framework is still needed to comprehensively cover all 17 SDGs and their multiple areas of analysis[12]. Some authors have proposed a tetrahedron framework with students positioned at the centre, and student competence, teaching methodology, professors and alliances placed at the vertices[13]. Generally, institutional initiatives and campus operations are the two main channels through which higher education institutions (HEIs) promote sustainability[14].

Previous research has attempted to develop methodologies to assess sustainability learning practices in HEIs[15]. In particular, scholars have emphasised the 'living lab' model, which involves both top-down and bottom-up strategies[16]. is implies that the implementation of SDGs at the university level should be driven by institu- tional, thematic, structural and personal/individual forces[17]. Additionally, some studies have underlined that the online presence of universities, the internationalisation of universities, and nancial resources for research and infrastructure from regional governments are relevant internal/external factors for achieving the SDGs[18]. Students' collaborative problem-solving competency may also play an important role[19].

[1]Department Studies, Monitoring and International Relations, Gestore dei Servizi Energetici GSE S.P.A., Rome, Italy. [2]Department of Law and Economics, UnitelmaSapienza University of Rome, Rome, Italy. [3]Department of Computer, Control and Management Engineering, Sapienza University of Rome, Rome, Italy. *email: idiano.dadamo@uniroma1.it

Universities may promote transformative innovation[20] through their curricula, as well as by engaging in joint initiatives with the local community[21]. Indeed, sustainable entrepreneurship support programmes linked with universities have the potential to spill over into regional development[22]. Furthermore, educational and extracur- ricular programmes are helpful for promoting students' green skills[23]. Several studies have underlined the need to strengthen students' knowledge and proactivity regarding sustainable development[24], and a related need to develop appropriate curricula and government initiatives to address the green transition[25]. ese ndings bear particular weight for university students in scienti c programmes[26] such as engineering[27], as such students may underestimate their role in

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addressing social inequalities. us, sustainability should be discussed within these programmes in order to introduce students to the challenges they are likely to face in their professional work[28].

In line with this, the present study measured the impact of a sustainability course on student perceptions at an Italian university. Data were collected by means of a questionnaire that was administered twice: once prior to and once at the end of the course. e questionnaire aimed at collecting student opinions on and perceptions of sustainability issues relevant to the material discussed in the course.

Methods

e present study adopted a behavioural methodology, in line with the classi cation proposed by Sovacool et al.[29]. More speci cally, it took a multidisciplinary approach, fusing ideas from numerous disciplines (e.g., psychology, engineering, economics). Questionnaires are commonly implemented to assess consumer[30,31] and producer[32] attitudes and behaviours in many elds (see, e.g., Balest & Stawinoga[33]; Svenningsson et al.[34]). Similar to Menon and Suresh[35], the present study deployed this methodology to collect information from a sample of students.

e investigation proceeded across four phases: (i) a rst dra of the questionnaire was written, based on the relevant literature; (ii) the questionnaire was validated; (iii) the questionnaire was administered to students prior to and at the end of the course; and (iv) a panel discussed the main results. e rst two phases occurred *ex ante* (i.e., pre–data collection). e initial questionnaire was reviewed by a small panel of experts/academics in the eld of sustainable management. is panel was selected from the Scopus database, which veri ed panel- lists' high scienti c impact and experience (of at least 10 years). e panel validated the questionnaire items, in terms of their relevance to the topic and clarity, as well as the entire questionnaire, in terms of its overall length. Based on the panel feedback, some items were eliminated and minor changes were made.

Once the questionnaire was nalised, it was administered to a sample of 66 students enrolled in a master's degree programme (mainly the Management Engineering) at the University of Rome La Sapienza. Speci cally, students were taking an optional course with a strong focus on sustainability, entitled 'Economics and Manage- ment of Energy Sources and Services'. Students were asked to complete the questionnaire twice: (1) prior to begin- ning and (2) a er completing the full course. e aim was to observe whether attending the course signi cantly a ected students' sustainability attitudes and behaviours. ough it was not possible to control for previous knowledge, the questionnaire aimed at assessing the 'treatment e ect' stimulated by the information provided during the course. erefore, it was assumed that any background knowledge

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possessed by students would play a marginal role in determining the main ndings, consistent with the transformative learning approach[36]. Fol- lowing the nal administration of the questionnaire, some of the main results were presented to the students, stimulating discussion and debate that produced further insight into students' reasoning.

Students' average age was 23.7 years, and approximately 64% were male; 39% were student-workers and 82% lived with their families of origin. With respect to their geographical place of origin, 85% came from the central macro-region of Italy (see questions 1–6 in Supplementary Appendix A). Data were collected by means of a questionnaire with approximately 40 items (reported in Supplementary Appendix B and discussed in the following section). e questionnaire was sent to students via email, and students were given 5 days to complete it. e data collection proceeded in two phases: in the pre-course phase, students answered the questionnaire based on their prior knowledge; in the post-course phase, students answered the same questionnaire with the information they had gained in the course. Following the post-course phase (i.e., in the nal class session), responses were discussed with the students to collect further qualitative data. Questionnaires were administered in February and May 2022.

Ethics statement. Given that the research is a non-experimental voluntary survey, no ethical approval is necessary. Furthermore, the self-administered survey that is non-experimental in nature was conducted under complete anonymity for the participants. No personal or sensitive information that can be used to identify the respondents were collected. Besides, the consent of the respondents to partake in the online survey were seek before the survey was executed by including an electronic informed consent in the online survey form.

Results

e present study combined a conventional methodological approach with an innovative approach to application. While the concept of sustainability evokes opportunities for younger generations, the needs and opinions of youths are not always heard, and issues around sustainability have only recently gained space within educational curricula. us, the present study administered a questionnaire to explore how and whether students' responses changed a er taking a course on sustainability. All questionnaire items pertained to topics that were covered in the educational course.

A er the post-course phase, the results were presented to and discussed with the students. During this discussion, the students expressed a strong interest in sustainability, whilst emphasising its complexity. ey decried rhetoric, common phrases and projects in which sustainability is discussed without practical application. ey also understood that, while the sustainability challenge is not simple, it is crucial for the future,

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particularly in light of European policies. ey were ready to support change if they were given the tools and could develop the skills to meet the challenge. While the remainder of this section analyses students' questionnaire responses in detail, in general, students' attitudes at the end of the course were more aligned with sustainability, relative to their attitudes at the beginning of the course. Supplementary Appendix B presents all of the questionnaire items, together with the student responses.

General data. erst block of items concerned general sustainability (e.g., the de nition of sustainability) and its behavioural aspects (e.g., individual sustainability behaviours). In general, many individuals are unclear about the meaning of sustainability, tending to link it to only the environment[37–39]. erefore, the course curricu- lum sought to clarify that sustainability has three dimensions: social, environmental and economic. While the vast majority of the students were clear at the beginning of the course that sustainability encompasses these three spheres, approximately 9% were convinced that it only involved environmental aspects; however, these students changed their opinion a er taking the course (see question 9 in Supplementary Appendix A).

Sustainability behaviours. e literature shows that pro-environmental attitudes relate to certain char- acter aspects, including altruism[40,41]. erefore, students were asked to assess their degree of altruism. Approxi- mately 75% described themselves as more altruistic than sel sh (see question 7 in supplementary Appendix A). Additionally, six questionnaire items were designed to measure students' sustainable behaviours (i.e., vol- unteering, playing sports, engaging with nature, using sustainable products, recycling, and taking public trans- portation. See questions 10–16 in supplementary Appendix A). e decision to include these items was based on previous research showing associations between: (i) playing sports and volunteering and greater sustain- able behaviour[42,43], and (ii) engagement with nature and improved stakeholder engagement[44]; as well as the use of recycling, using sustainable products and taking public transportation as proxies of pro-environmental attitudes[45]. An index was created to average student scores on these six items and assess any correlation with character aspects (i.e., altruism). As seen in Fig. 1, a higher degree of altruism corresponded with greater sustain- able behaviours.

In more detail, the analysis sought to uncover whether and how the distribution of responses related to indi- vidual items changed a er the course (all responses were measured using a Likert scale ranging from 1 (*never*) to 5 (*always*)) (see Fig. 2).

e only signi cant change emerged in the use of sustainable products, for which average scores increased from 2.9 to 3.1 over the course period. e main reason o ered for the infrequent use of sustainable products

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was their prohibitive cost. In fact, students perceived these items as 'luxury goods' and, generally, such products were only used by students with medium to high incomes. e correlation between income and the use of sustainable products has already been noted in the literature[46,47], and there is a risk that, without e ective interventions, sustainable products will only be purchased by those in higher income brackets. Concerning the other sustainable behaviours, the course did not seem to have a signi cant impact, as the mean values remained virtually unchanged. However, it is important to note that most students claimed to frequently sort their waste (4.5). is is an interesting nding, since it was obtained in Rome, where waste man- agement performance is unsatisfactory. In particular, there is a need in Rome for both on-site facilities for waste disposal and a signi cant reduction in the amount of waste delivered outside the region[48]. Finally, the intermedi- ate rating (2.9) recorded for the use of public transportation can be read in several ways: (i) the pandemic may have led many students to reduce their use of very crowded modes of transportation, and (ii) students may have been discouraged from using public transportation due to the poor time reliability.

Because sustainability is relevant to present and future generations, students were asked whether they were, in general, more anchored in the present or projected into the future. e majority (64%) of students tended to

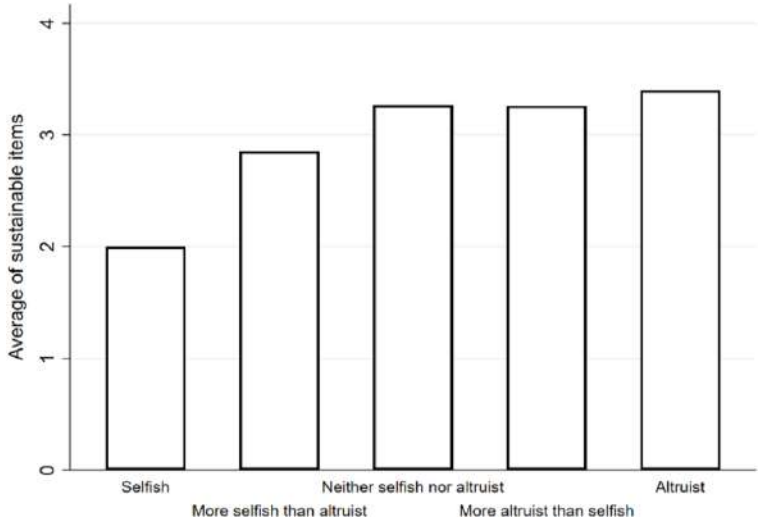

Figure 1. Mean values for each degree of altruism, in relation to the index of sustainable behaviours.

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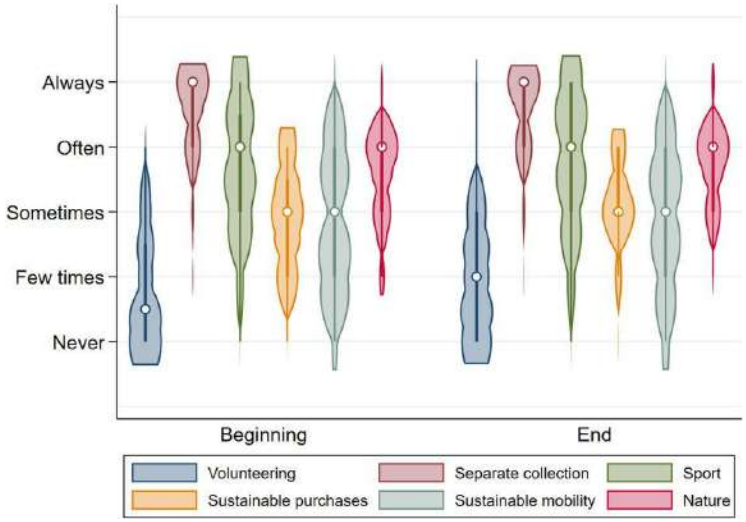

Figure 2. Distribution of responses related to sustainability behaviours, divided between the beginning and the end of term. White dots represent median values.

Values at the beginning of term were (mean values in parentheses): 1.5 (1.8) for volunteering, 5 (4.3) for recycling, 4 (3.7) for playing sports, 3 (2.9) for using sustainable products, 3 (2.8) for taking public transportation, and 4 (3.5) for engaging with nature. Values at the end of term were (mean values in parentheses): 2 (1.9) for volunteering, 5 (4.5) for recycling, 4 (3.8) for playing sports, 3 (3.1) for using sustainable products, 3 (2.9) for taking public transportation, and 4 (3.7) for engaging with nature. look to the future (see question 8 in supplementary Appendix A). Sustainability behaviours do not preclude living in the present, but merely call for a frugal attitude, so that resources can be maintained for future generations.

Economics of sustainable energy. e second block of questionnaire items concerned more speci c energy issues discussed in the course. ese items assessed students' willingness to pay (WTP) for green items and their particular behaviours as both producers and consumers (see questions 17–20 in supplementary Appendix A). A scenario was given in which a kWh of energy obtained from renewable sources was sold at 19.1 cent€/kWh, with a green premium of 2.4 cent€/kWh. In a second scenario, a kWh of energy from renewable sources was sold at 20.2 cent€/kWh, with a green premium of 6.6 cent€/kWh. ese scenarios were based on the price conditions that existed prior to the war between Russia and Ukraine.

Figure 3 shows how students changed their evaluations of these scenarios between the beginning and the end of the course. In particular, three important ndings emerged. First, at the beginning of the course, students assigned, on average, the same price for buying and selling fossil energy (panel A; for

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fossil energy, the initial and nal average values were 15.3 and 13.6 cent€/kWh, respectively, for purchasing; and 16.1 and 16.7 cent€/ kWh, respectively, for selling). is signals misinformation related to the price di erence between purchased and sold energy. At the end of the course, students evaluated this type of energy as 'inferior', recording a lower WTP than both the initially stated WTP and the WTP for renewables (panel B; for renewable energy, the initial and nal average values were 19.6 and 20.2 cent€/kWh, respectively, for purchasing; and 18.0 and 19.1 cent€/ kWh, respectively, for selling).

Second, there was no signi cant variation between students' WTP for renewable energy between the begin- ning and the end of the course. is implies that students were able to assign the correct value to this type of energy from the beginning. ird, the WTP value of 6.6 cent€/kWh that emerged in the present study is slightly lower than the values of 8 cent€/kWh and 10 cent€/kWh that were previously recorded in Spain and Italy, respectively[49]. However the study conducted in Spain and Italy considered a reference sample characterised by older individuals. e fact that students mainly lived with their families and did not pay their energy bills themselves likely in uenced the present result.

Subsidies for energy. Subsidies are a controversial topic. On the one hand, they are deemed necessary for the green transition, by reducing production costs for sustainable items to a point that they are competitive with those of fossil-based products (without considering externalities). On the other hand, their use must be metred to prevent any increase in public debt or the price paid by the nal consumer. Students were asked to express their opinion on a 5-point scale about the importance of subsidies for both renewable and fossil-based energy (see questions 21–24 in supplementary Appendix A). In addition, they were asked to report the extent to which they agreed (on a 5-point scale) that they should produce energy themselves, in the absence of subsidies (see question 40 in supplementary Appendix A). Students indicated that they were generally 'undecided' on this latter point, though their indecision fell at the maximum value of the range (3.5). Regarding their evaluation of subsidies, they assigned a high value to subsidies for energy from renewable sources (4.5). For energy from fossil sources, their approval for subsidies for self-consumption changed from 'sometimes' to 'rarely' (2.7 vs. 2.2); this variable showed the greatest change between the beginning and the end of the course (Fig. 4).

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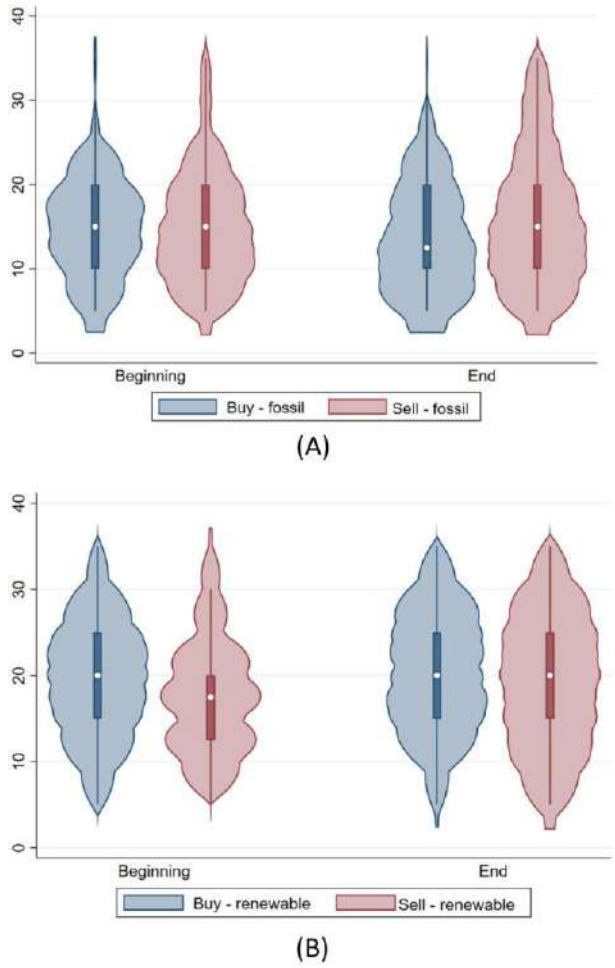

Figure 3. WTP values for the purchase and sale of energy produced from fossil sources (A) and renewable sources (B).

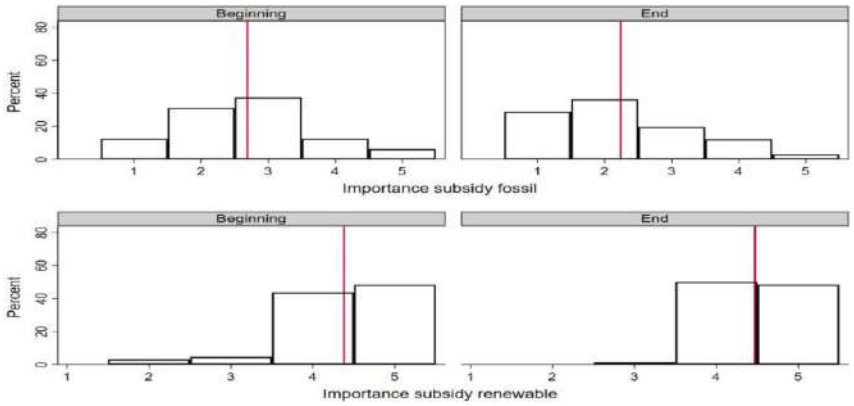

Figure 4. Distribution of responses on the importance of subsidies for the production of energy from fossil or renewable sources. Red lines represent the mean values of 2.7 (beginning) and 2.2 (end) for energy from fossil sources and 4.4 (beginning) and 4.5 (end) for energy from renewable sources.

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Students were also asked to estimate the appropriate subsidy levels (within a range of 0–6 cent€/kWh and see questions 25–26 in supplementary Appendix A). As can be seen in Fig. 5, any di erence in opinion vanished when students assigned these numerical values.

Citizen involvement in the energy transition may require subsidies for energy that is produced and self-consumed. In the present study, this value was quanti ed as 4.6 cent€/kWh for energy from renewable sources and

1.8 cent€/kWh for energy from fossil sources (decreasing by 0.5 cent€/kWh, consistent with the previous gure). Interestingly, the subsidy for the self-consumption of renewable energy was valued as high from the beginning of the course, signalling students' sensitivity to the issue of sustainable self-consumption. In a similar vein, the equivalent subsidy for energy from fossil sources was valued as low from the beginning, and it decreased at the end of the course. is implies that students became even more aware that energy from fossil sources should be disincentivised. However, the di erence in value associated with the subsidies for the production and self- consumption of green energy versus fossil energy was 2.8 cent€/kWh. e literature reports higher values for subsidies for the self-consumption of renewable energy: 3 cent€/kWh for Spain and 4 cent€/kWh for Italy (of note, in this research, only subsidies for energy from renewable sources were claimed) [49].

e International Energy Agency reports that, globally, subsidies for fossil sources amount to approximately 400 billion USD, and action must be taken to reduce this sum. To support the green transition, the state of the art must be communicated more widely and subsidies must be established. Regarding taxes, the present study found that students favoured them for giving economic weight to externalities. In particular, students felt that penalties should be higher for businesses than for citizens (4.3 vs. 3.9 and see questions 29–30 in supplementary Appendix A). However, they considered both penalties signi cant, in alignment with the European Commission, which has placed green taxes at the centre of its agenda.

Energy communities, sustainable certifications and sustainable competitive advantage. Stu- dents were also asked to express their opinion on the importance of energy communities, certi cations and competitive advantages. ese variables showed the same and a maximum increase between the beginning and the end of the course (+ 0.4) (see Fig. 6 and see questions 21, 22 and 28 in supplementary Appendix A).

Energy communities, while a fairly new concept, found enthusiastic support from students (i.e., registering an average value of 4 at the beginning and 4.4 at the end of the course). Stakeholder engagement, with shared models showing how the economic bene ts are distributed, emerged as an enabling factor[50].

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Regarding sustain- able certi cations, students had a clear understanding of these and, in fact, assigned them a very high value (i.e.,

3.9 at the beginning and 4.3 at the end of the course). However, they noted that a limitation of such certi cations is that their cost is typically passed on to the consumer. Certi ed products were not always linked to a higher WTP, especially for those in lower income brackets. Finally, students deemed the competitive advantage associ- ated with the use of green sources very relevant (i.e., 3.8 at the beginning and 4.2 at the end of the course). e beginning of the war in Ukraine coincided with the course, and classroom re ections emphasised that individuals and companies that had installed renewable energy systems were not only experiencing fewer spillover e ects related to in ation, but also seeing increased savings on their energy bills.

Energy-related policies. While a large proportion of engineering students (42%), who would be expected to support the use of technology, noted that current technologies should be su cient to meet the sustainability challenge, an equal proportion of students saw an additional change in behaviour as necessary to decarbonize the Italian system (see question 42 in supplementary Appendix A). Accordingly, the students did not favour a

Figure 5. Average values assigned to subsidies for the self-consumption of energy from fossil and renewable sources. Black bars represent the average values at the beginning of the course and grey bars represent the average values at the end of the course. All values are expressed in cent€/kWh.

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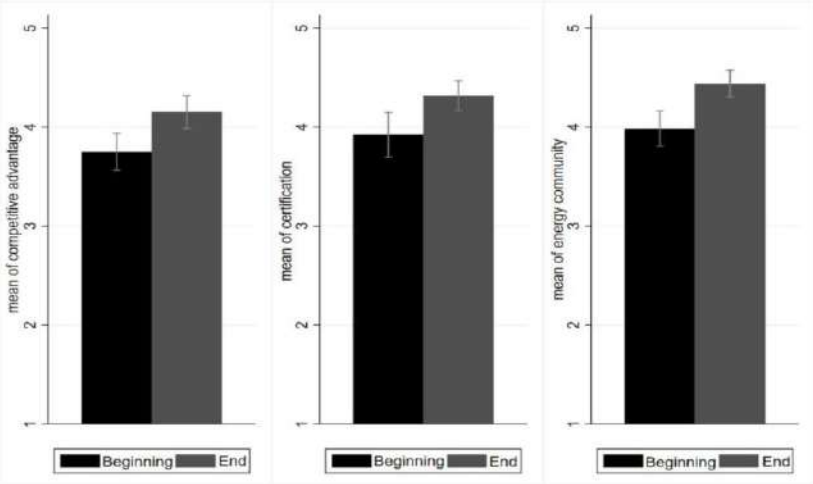

Figure 6. Mean values for the importance of energy communities, sustainable certi cations and competitive advantage. Black bars represent values recorded at the beginning of the course and grey bars represent values recorded at the end of the course.

Values range from 1 to 5, according to the Likert scale. policy based totally on electri cation. Another highly debated topic was Italy's strong energy dependence on foreign countries, and particularly Russia (noting that the funds that had previously been invested in foreign energy could have instead been invested in the development of green energy). For that reason, students were asked to assess (on a 5-point scale) the extent to which they considered the use of renewable sources important for mitigating geopolitical risk (see question 27 in supplementary Appendix A). Based on their responses, the students understood that some non-choices of the past had resulted in very large costs in the present. ey rec- ognised that short-sighted policies and 'no' committees—related to 'not in my term of o ce' (NIMTO) and 'not in my back yard' (NIMBY) attitudes—had resulted in signi cant costs of not doing. us, the idea emerged that geopolitical risks could be reduced through the use of renewables (3.9). However, in assessing whether the use of renewables could positively impact the environment (see question 32 in supplementary Appendix A), even though the students agreed that this was likely (4.4), they stressed that care must be taken to avoid an economic rebound e ect, emphasizing that the use of green sources could not justify energy waste. At the start of the course, the students were generally 'undecided' about this aspect; while at the end of the course, the dominant attitude was 'strongly disagree' (2.3 vs. 2.7 and see question 35 in supplementary Appendix A). is value must still be reduced. Approximately 65% of the students considered energy e ciency interventions as relevant as the use of renewables in e orts to achieve climate neutrality (see question 41 in supplementary Appendix A). Furthermore, the students felt that green energy could contribute to changing consumption habits by exploit- ing economic bene ts (3.9, see question 34 in

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supplementary Appendix A). In addition, approximately 80% of the students believed that society (in general) and value chain actors had the greatest impact on sustainable development (see question 43 in supplementary Appendix A). In contrast, approximately 18% placed the highest responsibility on consumers, while attributing minimal responsibility to the local community and no responsi- bility to workers.

Green marketing. e most perplexing student response concerned greenwashing. In fact, students were asked whether greenwashing helps sustainable development (see question 39 in supplementary Appendix A).

is question was originally included in the questionnaire to mislead students, since, upon rst encounter, the term 'greenwashing' may suggest something positive to those who are unfamiliar with its true de nition. e results showed that students' attitudes shi ed from 2.8 (i.e., 'undecided') at the beginning of the course to 2.4 (i.e., 'strongly disagree') at the end of the course. ere are at least two potential interpretations for this. First, the Ending may be interpreted as positive, as the value reduced over the course period and the nal summary judgment also changed. However, the second interpretation is that the rating of 2.4 still represents an excessive value, in need of further re ection. Some students may not have wanted to o er their true opinion on an 'uncomfort- able' topic, and instead provided an 'uncomfortable' answer under the conditions of anonymity, despite knowing the real meaning of the term greenwashing. is idea emerged during the discussion of the nal results, in which no student ordered a plausible explanation or justi cation of the greenwashing nding. Also noteworthy is the high rate of student absence (approximately 25%) on a weekly basis. However, this impact could not be meas- ured, considering the anonymity with which the questionnaires were completed. In addition, regarding distance learning support, students considered the internet in uential for sustainability (3.9, see question 38 in supple- mentary Appendix A). ey also perceived digital development as necessary, elaborating that such development needed to be calibrated to actual need.

Sustainable education. the importance of sustainable education received the most support (see question 31 in Supplementary Appendix A), and was the only variable that received a 'fully agree' rating (i.e., 4.5 at the beginning and 4.7 at the end of the course) (Fig. 7). is represents a core nding. e students also attributed much importance to the development of new professional gures (4.5, see question 33 in Supplementary Appen- dix A). In fact, this variable was rated as the second most relevant, alongside waste collection and subsidies for green energy. e students felt that sustainability courses might change production systems and make students more attractive on the job market. Finally, their perception of the

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relevance of the younger generation to sustain- ability was unexpected. Speci cally, students were asked to report the extent to which they agreed that students are able to develop a sustainable plan (see questions 36–37 in Supplementary Appendix A), and they rated this factor as 3.6 with regards to university students and 2.9 with regards to high school students. is suggests that they lacked con dence in not only their current generation, but also the younger generation. Students elaborated that the course had underlined the complexity of sustainability and, as a result, they doubted that their peers were up to the challenge of realising it. In this regard, students emphasised the importance of sustainable educa- tion and the development of sustainability projects. However, they noted that the course they had just completed was an elective, and not mandatory. Also, the younger generation was perceived to have less knowledge about sustainability.

Discussion

e present study, in accordance with the literature, emphasised the central role played by students in contribut- ing to the sustainability challenge[13,51]. Speci cally, the results showed that the sustainability course was essential for changing students' sustainability attitudes and behaviours. e ndings support the model of a sustainable community based on stakeholder engagement, which can fundamentally change even industrial systems[44]. How- ever, sustainable communities require support from HEIs[26], which in turn need to connect to the outside world[52] and embrace change, on the basis of dynamic competencies. Some authors have suggested rethinking the role of universities within society[53] by strengthening their connection with local realities in order to increase their resilience[54], without neglecting the importance of their internalization[55]. In this vein, empathy and trust have been identi ed as critical for achieving a cooperative model[56].

Works on sustainability o en attend to the environmental component, rst, before applying this to a fuller analysis. In fact, the quantitative approach is instrumental to a broader sustainability analysis[57], by measuring the impact of a diversity of applications and the need for critical thinking[58]. is inevitably recalls the idea of creative abrasion as a model of innovation. However, new ideas and approaches are needed in order to increase sustainable skills[59,60]. e present work moves in a di erent direction, as most of the proposed values allow for evidence to be collected in relation to progress.

e choice to focus on energy was not secondary. By metaphor, a university course needs energy to be completed. While the literature shows the decisive role played by social trust in contributing to

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sustainability in Europe[61], a recent study highlighted the need for new e orts in this context[62]. is latest work (similar to the present work) considered only a small reference sample. Nevertheless, tomorrow's engineers will be required to not only problem solve[19], but also to consider social dimensions[27] in order to achieve models that meet the needs of both individuals and organizations. University education may play a signi cant role in developing these skills and competencies in the next generation[63], by educating students on green issues[64] and encouraging them to identify solutions to current problems.

Conclusions

e sustainability challenge has not only led to a di erent approach to the creation of products and services, but it has also promoted the development of new social models. Previous research has explored the topic of sustain- ability within HEIs, where there are ongoing e orts to provide the right skills for future graduates. e present study focused on Management Engineering students at the University of Rome La Sapienza, who were enrolle

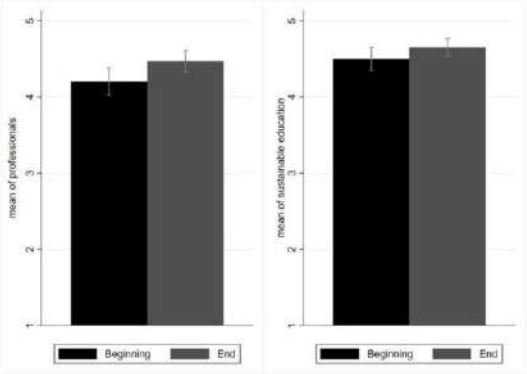

Figure 7. Mean values for sustainable education and the need for new professionals to support the green transition. Black bars represent values recorded at the beginning of the course and grey bars represent values recorded at the end of the course.

Values range from 1 to 5, according to the Likert scale in an Economics and Management of Energy Sources and Services course. e course curriculum introduced tools for addressing social inequalities, seizing economic opportunities and tackling environmental challenges within sustainable energy systems. In particular, management engineering students, educated on strategic, eco- nomic and management topics, have the potential to contribute signi cantly to the green transition, through their aptitude for problem-solving.

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In the present study, students' attitudes toward sustainability issues improved over the course. More specically, several findings can be highlighted: (i) students were strongly interested in sustainability, but understood it to be highly complex; (ii) students did not link sustainability to a simple challenge; (iii) students associated sustainable products/services with higher prices, which they could not always a ord; (iv) students' engagement with nature was relevant to their sustainable attitudes, but could become less relevant over time, due to profes- sional commitments; (v) students reported a WTP for green energy, whether produced and self-consumed or sold; (vi) students considered it appropriate to tax businesses and citizens for unsustainable behaviour; (vii) students considered subsidies important (particularly a bonus for the production and self-consumption of green energy); (viii) students considered energy communities central for the green transition; (ix) students did not necessarily report a higher WTP for products with a sustainable certi cation; (x) students recognised the need for domestic energy production; (xi) students acknowledged the need for changes in consumer habits; and (xii) students highlighted the need for the development of new professionals.

Sustainable education and the development of youth con dence in HEIs may encourage innovation in eco-systems and support the growth of local economies, through collaboration with businesses and public adminis- trators. To support these ends, HEIs must not only update their educational curricula, but also strengthen their connection with the outside world. e complexity of the sustainability challenge can only be addressed through shared knowledge, resources and expertise. Within this framework, long-term, structured teacher–student rela- tionships must be developed.

e present study was limited by the fact that it considered a course within only one programme of study. However, the eld experiment and the speci cs of the educational programme determined this choice. An addi- tional limitation is that no questions tested students' knowledge of the institutional context and energy crisis. Furthermore, the study sample was small (i.e., 66 students), and some of the results may have been in uenced by student non-attendance. Nonetheless, one of the strengths of the study is that the model can be easily replicated in similar settings and in other disciplines, perhaps while modifying/adding certain questionnaire items to suit the relevant programme of study.

Complex challenges require clear strategies with synergy between senior and junior parties. Students are at the heart of the university, and young people are at the heart of future civil society.

Data availability

All data generated or analysed during this study are included in this published article [and its supplementary information les].

ISBN Number: 978-93-95305-78-5

References

1. Pereira, P., Bašić, F., Bogunovic, I. & Barcelo, D. Russian–Ukrainian war impacts the total environment. *Sci. Total Environ.* **837**, 155865 (2022).
2. Elavarasan, R. M. *et al.* Impacts of COVID-19 on sustainable development goals and e ective approaches to maneuver them in the post-pandemic environment. *Environ. Sci. Pollut. Res.* **29**, 33957–33987 (2022).
3. Osendarp, S. *et al.* Act now before Ukraine war plunges millions into malnutrition. *Nature* **604**, 620–624 (2022).
4. Garg, K. K. *et al.* Identifying potential zones for rainwater harvesting interventions for sustainable intensi cation in the semi-arid tropics. *Sci. Rep.* **12**, 3882 (2022).
5. Smith, T. B., Vacca, R., Mantegazza, L. & Capua, I. Natural language processing and network analysis provide novel insights on policy and scienti c discourse around sustainable development goals. *Sci. Rep.* **11**, 22427 (2021).
6. Miola, A. & Schiltz, F. Measuring sustainable development goals performance: How to monitor policy action in the 2030 Agenda implementation? *Ecol. Econ.* **164**, 106373 (2019).
7. D'Adamo, I., Gastaldi, M., Imbriani, C. & Morone, P. Assessing regional performance for the sustainable development goals in Italy. *Sci. Rep.* **11**, 24117 (2021).
8. Shahen, M. E., Kotani, K. & Saijo, T. Intergenerational sustainability is enhanced by taking the perspective of future generations. *Sci. Rep.* **11**, 2437 (2021).
9. Hernandez-Aguilera, J. N. *et al.* Supporting interdisciplinary careers for sustainability. *Nat. Sustain.* **4**, 374–375 (2021).
10. Pauliuk, S. Making sustainability science a cumulative e ort. *Nat. Sustain.* **3**, 2–4 (2020).
11. Zhou, H., Wei, L., Wang, D. & Zhang, W. Environmental impacts and optimizing strategies of municipal sludge treatment and disposal routes in China based on life cycle analysis. *Environ. Int.* **166**, 107378 (2022).
12. Leal Filho, W. *et al.* Sustainable Development Goals and sustainability teaching at universities: Falling behind or getting ahead of the pack?. *J. Clean. Prod.* **232**, 285–294 (2019).
13. Zamora-Polo, F. & Sánchez-Martín, J. Teaching for a better world: Sustainability and Sustainable Development Goals in the con- struction of a change-maker university. *Sustainability* **11**, 4224 (2019).
14. Lambrechts, W., Van Liedekerke, L. & Van Petegem, P. Higher education for sustainable development in Flanders: Balancing between normative and transformative approaches. *Environ. Educ. Res.* **24**, 1284–

1300 (2018).

15. Albareda-Tiana, S., Vidal-Raméntol, S. & Fernández-Morilla, M. Implementing the sustainable development goals at University level. *Int. J. Sustain. High. Educ.* **19**, 473–497 (2018).
16. Purcell, W. M., Henriksen, H. & Spengler, J. D. Universities as the engine of transformational sustainability toward delivering the sustainable development goals. *Int. J. Sustain. High. Educ.* **20**, 1343–1357 (2019).
17. Leal Filho, W. *et al.* A framework for the implementation of the Sustainable Development Goals in university programmes. *J. Clean. Prod.* **299**, 126915 (2021).
18. Blasco, N., Brusca, I. & Labrador, M. Drivers for Universities' contribution to the Sustainable Development Goals: An analysis of Spanish public universities. *Sustainability* **13**, 89 (2021).
19. Dieu, H. D. T., Kim, O. D. T. & Bich, H. N. V. Sustainable development of collaborative problem solving competency for technical students through experiential learning (a case study in planning skills subject at Ho Chi Minh city University of Technology and Education). in *2018 4th International Conference on Green Technology and Sustainable Development (GTSD)*. 505–510. https://doi. org/10.1109/GTSD.2018.8595682 (2018).
20. El-Jardali, F., Ataya, N. & Fadlallah, R. Changing roles of universities in the era of SDGs: Rising up to the global challenge through institutionalising partnerships with governments and communities. *Health Res. Policy Syst.* **16**, 38 (2018).
21. Perello-Marín, M. R., Ribes-Giner, G. & Pantoja Díaz, O. Enhancing education for sustainable development in environmental university programmes: A co-creation approach. *Sustainability* **10**, 158 (2018).
22. Wagner, M., Schaltegger, S., Hansen, E. G. & Fichter, K. University-linked programmes for sustainable entrepreneurship and regional development: how and with what impact?. *Small Bus. Econ.* **56**, 1141–1158 (2021).
23. Sady, M., Żak, A. & Rzepka, K. e role of universities in sustainability-oriented competencies development: Insights from an empirical study on Polish universities. *Admin. Sci.* **9**, 62 (2019).
24. Pereira Ribeiro, J. M. *et al.* Green Campus Initiatives as sustainable development dissemination at higher education institutions: Students' perceptions. *J. Clean. Prod.* **312**, 127671 (2021).
25. Alvarez-Risco, A. *et al.* Expectations and interests of university students in COVID-19 times about sustainable development goals: Evidence from Colombia, Ecuador, Mexico, and Peru. *Sustainability* **13**, 3306 (2021).
26. Leal Filho, W. *et al.* Towards symbiotic approaches between universities, sustainable development, and

ISBN Number: 978-93-95305-78-5

cities. *Sci. Rep.* **12**, 11433 (2022).

27. Sánchez-Carracedo, F., Sureda, B., Moreno-Pino, F. M. & Romero-Portillo, D. Education for sustainable development in Spanish engineering degrees. Case study. *J. Clean. Prod.* **294**, 126322 (2021).
28. France, J., Milovanovic, J., Shealy, T. & Godwin, A. Engineering students' agency beliefs and career goals to engage in sustainable development: di erences between rst-year students and seniors. *Int. J. Sustain. High. Educ.* (2022) **(e-pub ahead-of-print)**.
29. Sovacool, B. K., Axsen, J. & Sorrell, S. Promoting novelty, rigor, and style in energy social science: Towards codes of practice for appropriate methods and research design. *Energy Res. Soc. Sci.* **45**, 12–42 (2018).
30. Malissiova, E. *et al.* Organic food: A study of consumer perception and preferences in Greece. *Appl. Food Res.* **2**, 100129 (2022).

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

THE ROLE OF BIOTECHNOLOGY IN DEVELOPING SUSTAINABLE BIOFUELS

Reena Mol S
Dept of Biotechnology
Sree Narayana Arts and Science College, Kumarakom, Kottayam

Abstracts

The growing energy crisis around the world, coupled with growing apprehensions over climate change, has provided for catalyzing the hunt for alternative fossil fuels and in finding renewable fuel sources. Biotechnology has become one of the main players in attaining this goal by developing sustainable production and optimization of renewable sources of energy. This paper focuses on the role of biotechnology in the development of biofuels, advancing genetic engineering, microbial engineering, and optimization of enzymes. This involves innovations like genetically modified feedstocks, engineered microorganisms, and improved enzyme processes, all designed to improve efficiency in the production of biofuel, minimize negative impacts on the environment, and increase scalability. The paper discusses different types of biofuels, such as first-, second-, and third-generation biofuels, considering their sustainability and the role of biotechnology in optimizing their production. Biotechnology has much promise in making biofuels cleaner energy. Despite this, some challenges persist with regard to its economic feasibility, scalability, and ecological implications. This paper does an in-depth literature review and analytical evaluation to assess the current state and future prospects of biotechnology in biofuel development, shedding light on the critical role of biotechnology in achieving a sustainable energy future.

1. INTRODUCTION

The global reliance on fossil fuels has resulted in significant environmental degradation, including the release of greenhouse gases (GHGs) that contribute to climate change, and the disruption of ecosystems through practices like deforestation and habitat loss. Fossil fuel extraction and combustion release carbon dioxide (CO2) and other GHGs into the atmosphere, exacerbating global warming. This has created a pressing need for alternative energy sources that can help mitigate these negative impacts and support global decarbonization efforts. Transitioning away from fossil fuels is crucial to achieving sustainability targets and reducing the carbon footprint of energy consumption. In this context, sustainable biofuels, derived from biomass such as agricultural residues, algae, and forestry waste, offer a promising solution. Because of these characteristics, the production of biofuels from a vast range of feedstocks, most of which

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are not in competition with food crops and do not entail significant changes in land use, makes this energy source highly preferable to fossil fuels. Thus, it would bring down GHG emissions, while supporting an alternative, sustainable energy system.

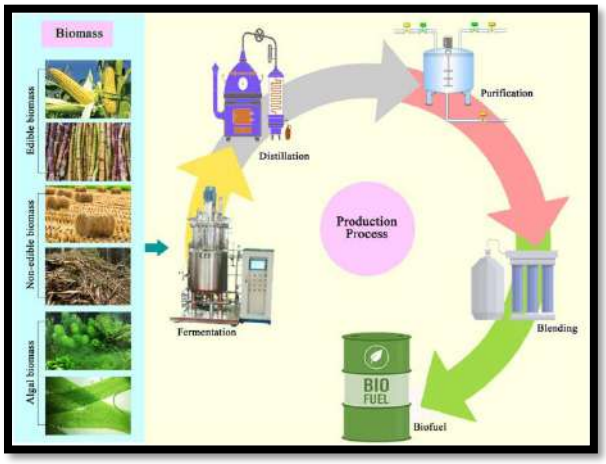

Figure 1.1: Biotechnology In Developing Sustainable Biofuels

Biotechnology therefore is key to the optimization of biofuel production since it offers some of the current limitations facing biofuel technologies. The traditional sources of biofuel, for example ethanol, include food crops like corn or sugarcane which pose problems relating to food security, land utilization, and conflicts with other demands of agriculture. On the other hand, sustainable sources of biofuel are produced from non-food biomass sources that do not pose similar stressors on the food system. Genetically modified organisms (GMOs) that are engineered to better convert the biomass into fermentable sugars or oils represent other innovative solutions available through biotechnology in order to improve the efficiency of biofuel production. Gene variations can also make it more resistant to environmental stressors, such as extreme temperatures or low levels of nutrients, thereby increasing the yield of production and decreasing the production cost. Advanced techniques like CRISPR-Cas9 gene editing and metabolic engineering enable fine-tuning of microbial strains for higher efficiencies in biofuel production and thus open new possibilities for upscaling of biofuel technologies.

By enhancing the productivity and sustainability of biofuels, biotechnology can play a crucial role in accelerating the transition to a sustainable energy system. Continued research and innovation can ensure that these biotechnological advancements make biofuels more competitive and scalable as an alternative to fossil fuels. As the world strives to fulfil decarbonization goals and transition away from finite and polluting energy sources, biotechnology plays a leading role in developing technologies that can aid in a clean, renewable, and sustainable future for energy.

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2. LITERATURE REVIEW

Liu et al. (2021) gave an overview of the potential of biofuels in transitioning toward a sustainable energy future. The authors underscored the necessity of replacing fossil fuels with renewable energy sources in the face of environmental and socio-economic challenges. Biofuels were considered as a viable alternative, with their production driven by advanced biotechnology innovations. The paper was focused on synthetic biology as a means of improving the yields of biofuels and reducing the costs of production through the engineering of microbial platforms capable of converting biomass into high-value fuels. The paper also addressed the scalability of biofuel production and its integration into existing energy infrastructure. The study underlined the need for policy support and global collaboration to overcome technological and market barriers**.**

Sindhu et al. (2019) considered the prospect of biomass as a feedstock for biofuel production and its impact on sustainable development. The authors discussed different types of biomasses, including agricultural residues, forestry waste, and dedicated energy crops, highlighting their availability and cost-effectiveness. Technological advancement in biomass conversion processes, such as thermochemical, biochemical, and hybrid methods, was also analyzed. The chapter also highlighted environmental benefits from the production of biofuel, including reduced greenhouse gas emissions and valorization of waste. However, it also recognized challenges associated with feedstock logistics, optimization of the process, and market competitiveness and offered recommendations on how to overcome these challenges**.**

Maharjan et al. (2024) discussed advanced biofuels, such as second- and third-generation biofuels, as a sustainable solution for energy. The authors discussed why advanced biofuels are more preferred over first-generation biofuels: feedstock diversity and reduced competition with food crops. The paper briefly reviewed the latest developments in feedstock processing technologies, including lignocellulosic biomass pretreatment, algae cultivation, and microbial engineering, and discussed the important role of advanced biofuels in reducing carbon emissions and enhancing energy security. Furthermore, the research called for the incorporation of renewable energy sources like solar and wind in biofuel production systems to make them more sustainable**.**

Lokko et al. (2018) explored biotechnology and the bioeconomy, highlighting their importance in ensuring inclusive and sustainable industrial development. The authors examined the capability of biotechnology to power the bioeconomy. They looked at potential applications in the production of biofuels, bioplastics, and other renewable chemicals from biomass. Genetically modified crops and engineered microorganisms provided better yields and efficiency on the biomass side. Innovation was

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promoted through public-private partnerships and research and development investments. The paper addressed challenges, including regulatory barriers, public acceptance, and equitable access to biotechnology innovations, with recommendations to achieve a balanced and inclusive bioeconomy**.**

Chandel et al. (2020) discussed the significance of renewable chemicals and biofuels for a feasible bioeconomy. The main focus of the authors was on the resource utilization efficiency as well as the potential economic viability through the coupling of biofuel production with biorefineries. They discussed several potential renewable chemicals from biomass resources: bioethanol, biobutanol, and bioplastics, and market potential. The paper further revealed the environmental benefits involved in seeking a bioeconomy, through the reduction of waste and carbon neutrality. Additionally, the developed policy frameworks, incentives, technological innovations through collaboration with stakeholders, feedstock availability as well as the cost of production meant to influence the uptake of biofuels were elaborated**.**

3. TYPES OF BIOFUELS AND THEIR SUSTAINABILITY

Biofuels are categorized into three generations:

- **First-Generation Biofuels**

  These are derived from food crops, including corn, sugarcane, and soybeans, through fermentation and transesterification. Although they were among the first biofuels, they have ethical and sustainability issues, especially in the "food versus fuel" debate. This is because the use of food crops for fuel production can lead to competition for agricultural resources, increased food prices, and potential food insecurity, especially in developing regions.

- **Second-Generation Biofuels**

  These are derived from non-food biomass sources including agricultural residues, for example wheat straw, corn stover, forestry waste, and other lignocellulosic materials. Second-generation biofuels are perceived as much more sustainable than the first-generation types as they consume waste and non-edible feedstocks, which don't compete with food productions. Some challenges still face these biofuels include an enormous cost of developing biomass pretreatment and conversion technologies.

- **Third-Generation Biofuels**

  These are produced from algae and other microorganisms. Algae can be cultivated on non-arable land, require minimal freshwater resources, and show high productivity in oil and biomass yield. This generation is most promising as it has possibilities to achieve minimized land usage and less environmental effect with high efficiency but remains a technical challenge to scale up the production of algal biofuels.

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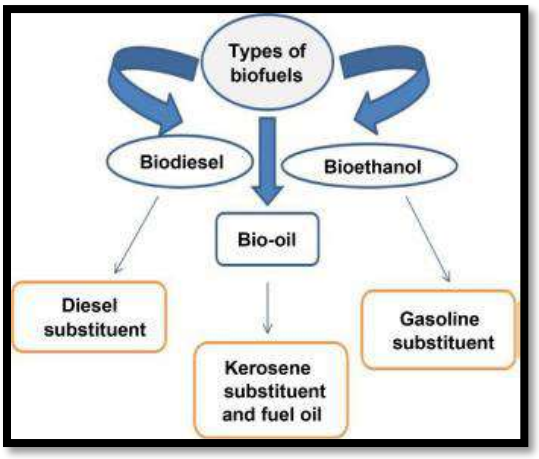

Figure 1.2: Types Of Biofuels

Table 1: Comparison of Biofuel Generations

Generation	Source	Features	Sustainability	Challenges
First	Food crops (corn, sugarcane)	Early biofuels; "food vs. fuel"	Impacts food security	Competes with food production
Second	Non-food biomass, waste	Waste-to-energy approach	Reduces food competition	High cost, complex processes
Third	Algae, microorganisms	High yield, minimal land use	Highly efficient, eco-friendly	Expensive, scaling is difficult

4. ROLE OF BIOTECHNOLOGY IN BIOFUEL DEVELOPMENT

The role of biotechnology in biofuel development involves optimizing microorganisms for efficient biomass conversion. Genetic engineering increases the ability of microbes to produce ethanol, biodiesel, and other biofuels from renewable sources. Advanced bioprocessing technologies improve yield, reduce costs, and make biofuel production more sustainable. Biotechnology also aids in developing second and third-generation biofuels from non-food crops and waste materials.

4.1.Genetic Engineering of Feedstocks

Plant genetic modification, also referred to as genetically modified organisms, is employed in increasing biomass yield and lowering environmental inputs like water and fertilizers for the production of biofuel. Many biofuel crops such as switchgrass and miscanthus are engineered to contain a higher percentage of cellulose in their cells, which helps the biomass more in the process of converting biomass to biofuel

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because cellulose plays a critical role in that conversion. These changes contribute to better efficiencies in the conversion of biomass, reduce the inputs needed, and also increase the overall yield for biofuels.

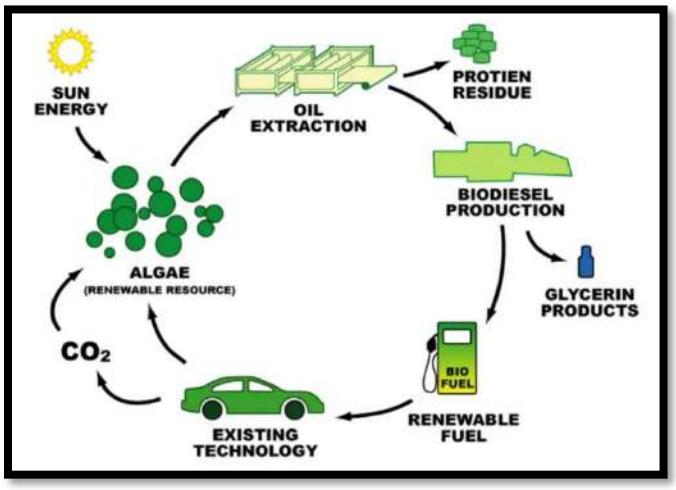

Figure 1.3: The Role of Feedstocks in Biofuel Production

4.2.Microbial Engineering

Advances in synthetic biology have made it possible to engineer microorganisms, such as bacteria and yeast, to produce biofuels. Microbial engineering is the process of altering microorganisms, including Escherichia coli and Saccharomyces cerevisiae, to improve their capacity to produce biofuels, such as ethanol, butanol, and biodiesel. The engineered strains yield more biofuel and are resistant to production inhibitors, such as acids or alcohols, which normally decrease efficiency. This improves the overall performance of microorganisms in biofuel production, making it more cost-effective and scalable.

4.3. Enzyme Optimization

The process of enzymatic hydrolysis is essential to break down lignocellulosic biomass, such as wood and straw, into fermentable sugars that can further be converted into biofuels. Biotechnological breakthroughs have led to the identification and improvement of enzymes, such as cellulases and hemicellulases, which degrade difficult to digest cellulose and hemicellulose structures present in plant material. Improving these enzymes reduces production costs, and the overall process of producing biofuels becomes cheaper and faster.

4.4.Algal Biotechnology

Microalgae are being exploited as a viable source of biofuels today because they carry a high level of lipids along with a maximum growth rate, and genetic manipulation has improved lipid production in the algae by regulating the metabolic pathway that produces such precursors in the form of biodiesel or biogas. This makes algae a very attractive feedstock for biofuels because they can produce large amounts of oil

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quickly, and can be grown in environments where traditional crops may not thrive, thus reducing land-use competition.

5. ANALYTICAL EVALUATION OF BIOTECHNOLOGY'S IMPACT

Analytical assessment of the influence of biotechnology on society requires consideration of the contributions made by this sector in agriculture, medicine, and environmental sustainability. This includes measuring improvements in crop yield, disease resistance, and genetic modifications for improved health outcomes. The environmental impact is measured through the reduction of waste, pollution, and resource usage. Further, economic analysis focuses on cost-effectiveness, market growth, and the creation of new biotechnological industries.

5.1.Economic Feasibility

Biotechnological innovations in the production of biofuels, for instance, have led to reduced costs associated with the process in some sectors, such as increased yield and optimized processes. However, these high initial costs in research and technology development alongside scaling challenges raise a huge barrier to the economies. This chapter examines the cost-benefit analysis of biotechnology-based biofuels relative to fossil fuels and biofuels from feedstocks.

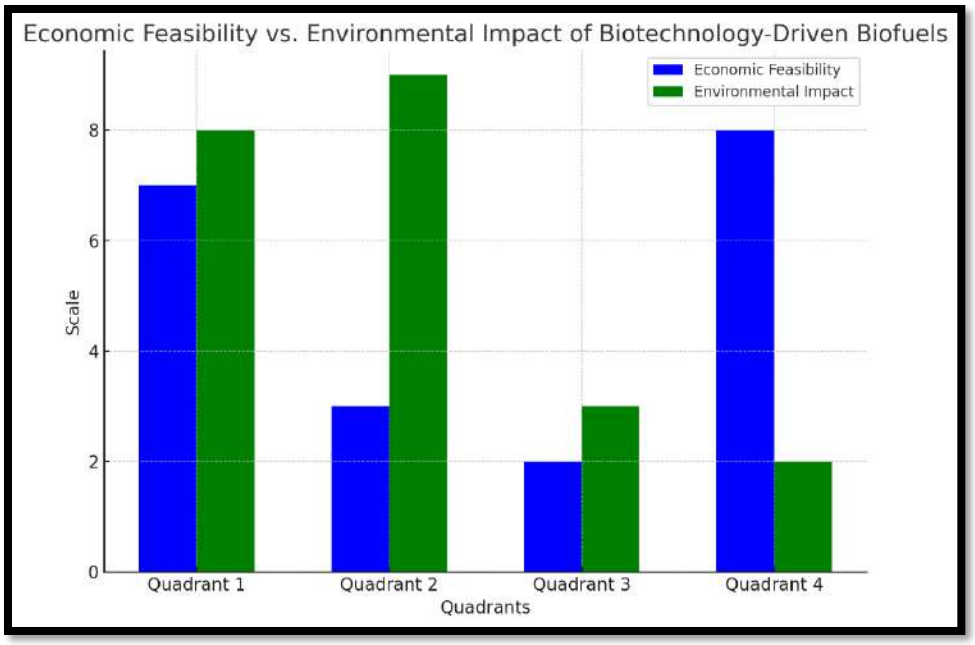

Figure 1.4: Economic Feasibility

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5.2.Scalability Challenges

Scaling up laboratory-scale innovations to commercial production levels is one of the significant challenges faced by feedstock availability, bioreactor design, and supply chain logistics. All these are the significant barriers between the lab-based process and large-scale biofuel production.

Key challenges include:

- **Feedstock Availability:** Sourcing enough biomass or algae to meet demand at an industrial level.
- **Bioreactor Design:** Designing efficient bioreactors that can handle large quantities of feedstock and microorganisms.
- **Supply Chain Logistics:** Efficient harvesting, transport, and processing of biofuels from diverse feedstocks.

5.3.Environmental Impacts

Advancements in biofuel biotechnologies significantly help in reducing negative environmental impacts especially through the reductions in greenhouse gas emissions and generation of wastes. Comparatively, fossil fuels produced via biotechnological means lower greenhouse gas emissions, as fewer inputs of fossil fuel are used to produce these. However, risks of unknown ecological effects due to GMO have led to further worries about ecological destruction in wild organisms. Only stringent monitoring and regulations can work out such risk effects.

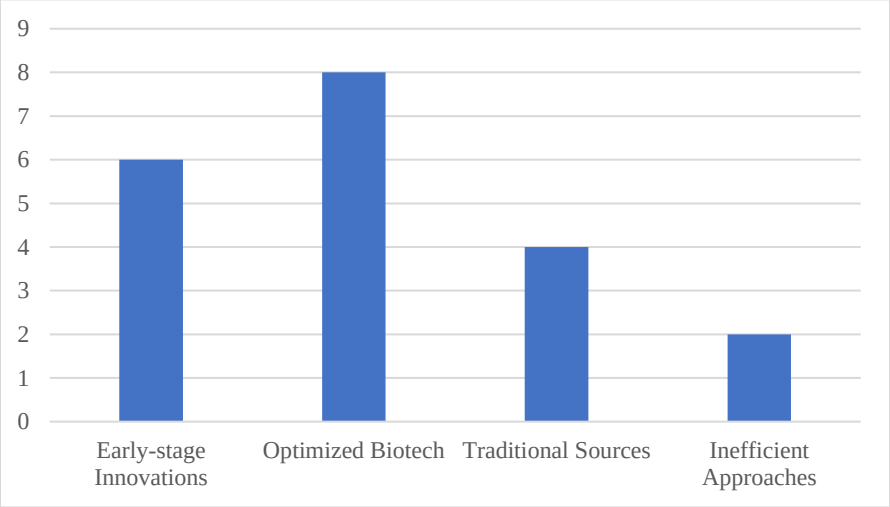

Figure 1.5: Biotechnology-Driven Biofuels

6. FUTURE PROSPECTS AND INNOVATIONS

Biofuel production would experience a substantial transformation with emergent technologies coming to the rescue in the next couple of years. CRISPR-Cas9 gene editing and metabolic engineering would solve two long-standing and key challenges confronting the efficiency of production, economies of scale and

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sustainability of biofuel. The very possibility of fine-tuning biological organisms like microbes - bacteria, yeast, algae- for degradation of biomass for more efficient processes of biofuels is introduced by CRISPR-Cas9. By fine-tuning the genetic makeup of these microorganisms, one can generate better strains to convert raw materials into biofuels more effectively, thus reducing costs in the production process and making biofuels a more viable alternative to fossil fuels. This is complemented by metabolic engineering through the redesigning of metabolic pathways of organisms to optimize the production of biofuels. This process includes a modification of biochemical networks in microbes for enhanced yield of biofuels, lower levels of production of unwanted by-products, and improved resistance to environmental stressors like temperature shifts, high toxic concentrations, or other adverse conditions often found during industrial biofuel production. When combined, CRISPR-Cas9 and metabolic engineering have the potential to revolutionize the biofuel industry by significantly lowering production costs, maximizing feedstock utilization, and enhancing the scalability of biofuel production processes. The novelty of these advances is not just that they should make biofuels more price-competitive compared to traditional fossil fuels but will also contribute towards a more sustainable energy future: reducing dependency on non-renewable resources, and mitigating the environmental impacts associated with consumption. These technologies are, therefore, on the verge of revolutionizing the biofuel industry into a much more efficient, cost-effective, and environmentally friendly sector that will meet global energy demands in a sustainable manner.

7. CONCLUSION

Biotechnology significantly contributes to developing sustainable biofuels by promoting biological processes and optimizing resources toward more efficient and effective fuel production. Innovations such as genetic engineering, CRISPR-Cas9 gene editing, and metabolic engineering contribute to the current significant advancements being made in biofuel technology as it continues to address the historical challenges that have prevented large-scale biofuel production. These technologies make it possible to accurately modify microorganisms so they are better able to break down biomass, to produce biofuels more efficiently, and to resist environmental stresses. This can then lead to higher yields, lower production costs, and improved sustainability-all key to making biofuels a competitive and reliable alternative to fossil fuels. Even though there are some challenges such as high production cost and lack of scalability, ongoing research and innovations in the technology are leading the way for these barriers to be overcome. Through this, biotechnology will fill the gap between laboratory-scale advancement and large-scale industrial applications, contributing to the realization of a sustainable energy future and minimizing

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dependence on fossil fuels and encouraging environmental stewardship. Continued development and integration of such biotechnological solutions will go a long way toward an improved shift towards sustainability, a much cleaner and environmentally friendlier energy system, with further improved security and diminished impacts from conventional sources of energy. The ultimate secret to the door that could lead the world towards a much cleaner, much greener future lies in biotechnology.

REFERENCES

1. *Liu, Y., Cruz-Morales, P., Zargar, A., Belcher, M. S., Pang, B., Englund, E., ... & Keasling, J. D. (2021). Biofuels for a sustainable future. Cell, 184(6), 1636-1647.*
2. *Sindhu, R., Binod, P., Pandey, A., Ankaram, S., Duan, Y., & Awasthi, M. K. (2019). Biofuel production from biomass: toward sustainable development. In Current developments in biotechnology and bioengineering (pp. 79-92). Elsevier.*
3. *Maharjan, A., Kim, M. R., Choi, W., Kim, H. C., & Park, J. H. (2024). Advanced biofuels: a path to sustainable energy. Sustainable Energy & Fuels, 8(15), 3247-3265.*
4. *Lokko, Y., Heijde, M., Schebesta, K., Scholtès, P., Van Montagu, M., & Giacca, M. (2018). Biotechnology and the bioeconomy—Towards inclusive and sustainable industrial development. New biotechnology, 40, 5-10.*
5. *Chandel, A. K., Garlapati, V. K., Jeevan Kumar, S. P., Hans, M., Singh, A. K., & Kumar, S. (2020). The role of renewable chemicals and biofuels in building a bioeconomy. Biofuels, Bioproducts and Biorefining, 14(4), 830-844.*
6. *Khan, N., Sudhakar, K., & Mamat, R. (2021). Role of biofuels in energy transition, green economy and carbon neutrality. Sustainability, 13(22), 12374.*
7. *Correa, D. F., Beyer, H. L., Fargione, J. E., Hill, J. D., Possingham, H. P., Thomas-Hall, S. R., & Schenk, P. M. (2019). Towards the implementation of sustainable biofuel production systems. Renewable and Sustainable Energy Reviews, 107, 250-263.*
8. *Aguilar, A., Twardowski, T., & Wohlgemuth, R. (2019). Bioeconomy for sustainable development. Biotechnology Journal, 14(8), 1800638.*
9. *Manikandan, S., Subbaiya, R., Biruntha, M., Krishnan, R. Y., Muthusamy, G., & Karmegam, N. (2022). Recent development patterns, utilization and prospective of biofuel production: Emerging nanotechnological intervention for environmental sustainability–A review. Fuel, 314, 122757.*
10. *Srivastava, N., Srivastava, M., Gupta, V. K., Manikanta, A., Mishra, K., Singh, S., ... & Mishra, P. K. (2018). Recent development on sustainable biodiesel production using sewage sludge. 3 Biotech, 8, 1-11.*

ISBN Number: 978-93-95305-78-5

11. *Ahmad, A., Banat, F., Alsafar, H., & Hasan, S. W. (2022). Algae biotechnology for industrial wastewater treatment, bioenergy production, and high-value bioproducts. Science of The Total Environment, 806, 150585.*
12. *Hasan, M., Abedin, M. Z., Amin, M. B., Nekmahmud, M., & Oláh, J. (2023). Sustainable biofuel economy: A mapping through bibliometric research. Journal of Environmental Management, 336, 117644.*
13. *Yong, J. J. J. Y., Chew, K. W., Khoo, K. S., Show, P. L., & Chang, J. S. (2021). Prospects and development of algal-bacterial biotechnology in environmental management and protection. Biotechnology advances, 47, 107684.*
14. *Raheem, A., Prinsen, P., Vuppaladadiyam, A. K., Zhao, M., & Luque, R. (2018). A review on sustainable microalgae based biofuel and bioenergy production: Recent developments. Journal of cleaner production, 181, 42-59.*
15. *Bradu, P., Biswas, A., Nair, C., Sreevalsakumar, S., Patil, M., Kannampuzha, S., ... & Gopalakrishnan, A. V. (2022). Recent advances in green technology and Industrial Revolution 4.0 for a sustainable future. Environmental science and pollution research international, 1.*

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

प्रकरण

ग्रामीण एवं शहरी क्षेत्र के किशोरों की आक्रामक व्यवहार पर अध्ययन

डॉ समीना कुरैशी

असिस्टेंट प्रोफेसर

जे ई एस कॉलेज, फरहदा, बिलासपुर, छत्तीसगढ

संक्षेपीकरण (Abstract) :– आक्रमकता एवं हिंसा एक ऐसा व्यवहार है जो मनुष्य तथा पशुओं दोनों में पाया जाता है। अतः आक्रमक व्यवहार एक सार्वजनिक घटना है। बालक की अच्छी अथवा बुरी रूचियाँ तथा आदतें विद्यालय में ही विकसित होती है। विद्यालय में जिन बातों अथवा वस्तुओं को अच्छा अथवा बुरा कहते हैं, बालक भी उन्हें वैसा ही कहने लगता है। इस प्रकार विद्यालय में रहते हुए बालकों (किशोरों) के अंदर अच्छी अथवा बुरी रूचियाँ तथा आदतें आगे चलकर बालकों (किशोरों) के चरित्र को प्रभावित करती है। मनुष्य भिन्न परिस्थितियों में भिन्न–भिन्न प्रकार का सामाजिक व्यवहार करता है। सामाजिक जगत में व्यक्तियों द्वारा प्रदर्शित किये जाने वाले सामाजिक व्यवहार में आक्रमकता और हिंसा का व्यवहार भी सहज रूप से देखा जा सकता है। आक्रमक व्यवहार के लक्षण दैनिक जीवन में देखे जा सकते हैं।

महत्वपूर्ण शब्द (Key Words) :– ग्रामीण एवं शहरी क्षेत्र,किशोर, आक्रामक व्यवहार ।

1. **परिचय (Introduction)** :– सामाजिक जगत में व्यक्तियों द्वारा प्रदर्शित किये जाने वाले सामाजिक व्यवहार में आक्रमकता और हिंसा का व्यवहार भी सहज रूप से देखा जा सकता है। आक्रमक व्यवहार के लक्षण दैनिक जीवन में देखे जा सकते हैं। इस प्रकार आक्रमक व्यवहार के विभिन्न पक्ष एवं प्रकार होते हैं। पहले यह सोच थी कि आक्रमक स्वाभाव अथवा अवसाद का होना किसी व्यक्ति के जीवन पर निर्भर करता है। किंतु एक नये शोध से पता चला है कि इसकी जड़ घर में होने वाली परवरिश और विद्यालय शिक्षा में छिपी है। सकारात्मक और नकारात्मक ढ़ंग की परवरिश किसी बच्चे के मानसिक स्वास्थ्य पर असर डालती है। इस प्रकार उसके गुण विकसित होते हैं। उग्र स्वभाव का बना देगी या फिर गलत रास्ते पर वह चला जायेगा। भावनात्मक प्रतिक्रिया या भावनात्मक अशांति और दुश्मनी के आधार पर हताशा की वजह से या वातावरण एक ;।तवनेपनदहद्ध के आक्रमक में एक ठोस कारक सिद्ध होती है। आक्रमकता को दूसरे दृष्टिकोण से देखा जाये तो किसी व्यक्ति का शत्रुतापूर्ण और विनाशकारी व्यवहार ही आक्रमकता है जिसका अर्थ एक आत्ममुखर एवं वह बल जो उसके आक्रमक स्वभाव की अभिव्यक्ति है।

2. **संबंधित साहित्य की समीक्षा (Review Related Literature)** :– संबंधित साहित्य के विश्लेषणात्मक अध्ययन के बिना शोधकर्ता अंधकार में भटकता रहेगा और संभवतः जो कार्य हो चुके हैं, उन्हें व्यर्थ में दुहरायेगा। अतएव समय, ऊर्जा तथा साधनों की बचत के लिये आवश्यक है कि सभी उपलब्ध साहित्य का विस्तृत व गहन अध्ययन किया जाए।

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- **माथुर, कुसुम अलका और सिन्हा, एस.पी. (2002)**

''जेन्डर व स्वअनावरण के कार्य के रूप में आक्रमकता की दिशा एवं प्रतिक्रिया प्रारूप''।

परिणामों से ज्ञात होता है कि आक्रमकता के अति दण्डात्मक, दण्डगत एवं अदण्डात्मक दिशाओं, उच्च व निम्न स्वअनावरण के अवरोध–दमन, अहम–प्रतिरक्षक व आवश्यकता स्थिति प्रतिक्रिया प्रारूप में सकारात्मक अंतर पाया गया।

- **प्रसाद, निरंजन व कुमार, शैलेन्द्र (2009)**

''क्या आक्रमकता अपराधिता की ओर अग्रसित करती है? एक इन्द्रयानुभाविक सत्यापन''।

यह पाया गया कि व्यक्ति अपराधियों ने अनुगमन किया जबकि अन्य अपराधियों ने सकारात्मक रूप से आक्रमकता का निम्नतम स्तर प्रदर्शित किया।

- **फिशमैन, फ्लेयर जी (1965)**

''नैराश्य की प्रतिकूल स्थितियों के अंतर्गत आक्रमकता की अभिव्यक्ति एवं अनुमोदन की आवश्यकता''।

इस अध्ययन में अनुमोदन की आवश्यकता जिसका मापन मारलोव क्रउन के सामाजिक वांछनीय मापनी के द्वारा किया गया है व आक्रमकता के मध्य संबंध की जाँच 60 महाविद्यालयीन महिलाओं पर की गई है। आक्रमकता को प्रकाशित करने वाले दो प्रकार के नैराश्य का प्रयोग किया गया अविहित व विहित। निम्न अनुमोदन की आवश्यकता वाले प्रयोज्यों की तुलना में कुंठित के विरूद्ध उच्च अनुमोदन की आवश्यकता वाले प्रयोज्यों ने अल्प आक्रमकता की अभिव्यक्ति की।

3. उद्देश्य एवं परिकल्पनाएँ (Objective and Hypothesis) :–

अध्ययन का उद्देश्य (Objective of the Study) :– लघुशोध प्रबन्ध हेतु चयन को समस्या में निम्नलिखित महत्वपूर्ण उद्देश्य की पूर्ति अपेक्षित है। प्रस्तुत अध्ययन हेतु निम्न उद्देश्य निर्धारित किए गए हैं –

प्रस्तुत लघुशोध अध्ययन निम्न उद्देष्य निर्धारित किये गये हैं जो इस प्रकार हैं –

1. ग्रामीण एवं शहरी शासकीय विद्यालयों के विद्यार्थियों के आक्रमक व्यवहार का अध्ययन करना।
2. ग्रामीण शासकीय विद्यालयों के छात्र एवं छात्राओं के आक्रमक व्यवहार का अध्ययन करना।
3. शहरी शासकीय विद्यालयों के छात्र एवं छात्राओं के आक्रमक व्यवहार का अध्ययन करना।

अध्ययन की परिकल्पना (Hypothesis of the Study) :–

प्रस्तुत शोध में समस्या की सार्थकता के परीक्षण हेतु निम्न परिकल्पना की रचना मापनी गई है:–

H_1 ग्रामीण एवं शहरी शासकीय विद्यालयों के विद्यार्थियों के आक्रमक व्यवहार में सार्थक अंतर नहीं पाया जायेगा।

H_2 ग्रामीण शासकीय विद्यालयों के छात्र एवं छात्राओं के आक्रमक व्यवहार में सार्थक अंतर नहीं पाया जायेगा।

H_3 शहरी शासकीय विद्यालयों के छात्र एवं छात्राओं के आक्रमक व्यवहार में सार्थक अंतर नहीं पाया जायेगा।

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4. प्रणाली एवं प्रक्रिया (Methodology and Procedure) :–

विधि (Method) :– प्रस्तुत शोध अध्ययन में कक्षा 11वीं के छात्र–छात्राओं का चयन उद्देशीय न्यादर्श विधि द्वारा किया गया है।

जनसंख्या (Population) :– इस शोध अध्ययन के लिए शोधकर्ता ने दुर्ग शहर के कक्षा 11वीं के सी.जी. तथा सी. बी.एस.ई. विद्यार्थियों का चयन किया है।

न्यादर्श (Sampling) :– प्रस्तुत शोध अध्ययन में उद्देशीय न्यादर्श विधि द्वारा कक्षा 10वीं में अध्ययनरत् 50 ग्रामीण . तथा 50 शहरी विद्यार्थियों का चयन किया गया है।

विस्तार एवं सीमांकन (Scope And Delimitation) :– प्रस्तुत अध्ययन में केवल दुर्ग शहर तक ही सीमित हैं। प्रस्तुत अध्ययन में 6 शालाओं को लिया गया है। प्रस्तुत अध्ययन में कक्षा 11वीं के विद्यार्थियों को लिया गया है।

उपकरण (Tools) :– प्रस्तुत शोध में विद्यार्थियों के आक्रमक व्यवहार को जानने हेतु **डॉ जी.पी. माथुर** एवं **डॉ. राजकुमारी भटनागर** की मापनी का उपयोग किया गया है।

सांख्यिकीय प्रविधि (Statistical Techniques) :– इस अध्ययन में मध्यमान, प्रमाणिक विचलन एवं 'टी' मूल्य का प्रयोग किया गया है।

5. विश्लेषण एवं चर्चा (Analysis and Discussion) :–

प्रमाणित कल्पनाएँ (Verification of Hypothesis) :–

H_1 ग्रामीण एवं शहरी शासकीय विद्यालयों के विद्यार्थियों के आक्रमक व्यवहार में सार्थक अंतर नहीं पाया जायेगा।

उपर्युक्त परिकल्पना को सत्यापित करने के लिए प्राप्त आँकड़ों (प्राप्तांकों) को ग्रामीण एवं शहरी शासकीय विद्यालयों के छात्र एवं छात्राओं में विभाजित किया गया है। प्राप्त आँकड़ों का मध्यमान प्रमाणिक विचलन एवं "टी" मूल्य ज्ञात किया गया है।

ग्रामीण एवं शहरी शासकीय विद्यालयों के विद्यार्थियों के आक्रमक व्यवहार का तुलनात्मक अध्ययन का सांख्यिकीय विवरण

क्र.	तुलनात्मक समूह	प्रदत्तों की संख्या (N)	मध्यमान (M)	प्रमाणिक विचलन (SD)	टी मूल्य (t)
1.	ग्रामीण एवं शहरी शासकीय विद्यालयों के छात्र	50	207.66	34.38	1.18

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2.	ग्रामीण एवं शहरी शासकीय विद्यालयों की छात्राएँ	50	215.54	31.47	
df = 98 P > 0.05 स्तर पर सार्थक अंतर नहीं है।					

सारणी से स्पष्ट होता है कि ग्रामीण एवं शहरी शासकीय, विद्यालयों के छात्रों" के लिए N = 50, M = 207.66 और SD = 34.38 है तथा "ग्रामीण एवं शहरी शासकीय विद्यालयों की छात्राओं" के लिए N = 50, M = 215.54 और SD = 31-47 है।

अतः df = 98 पर ज. मान = 1.18 प्राप्त हुआ जो df = 98 तथा सार्थकता स्तर 0.05 पर आवश्यक ज. मान 1.98 से कम है। अतः ग्रामीण एवं शहरी शासकीय, विद्यालयों के विद्यार्थियों के आक्रमक व्यवहार में सार्थक अंतर नहीं है।

अतः शून्य परिकल्पना स्वीकृत होती है।

H_2 ग्रामीण शासकीय विद्यालयों के छात्र एवं छात्राओं के आक्रमक व्यवहार में सार्थक अंतर नहीं पाया जायेगा।

ग्रामीण शासकीय विद्यालयो के छात्र एवं छात्राओं के आक्रमक व्यवहार का तुलनात्मक अध्ययन का सांख्यिकीय विवरण

क्र.	तुलनात्मक समूह	प्रदत्तों की संख्या (N)	मध्यमान (M)	प्रमाणिक विचलन (SD)	टी मूल्य (t)
1.	ग्रामीण शासकीय विद्यालयों के छात्र	25	203.92	37.15	1.21
2.	ग्रामीण शासकीय विद्यालयों के छात्रा	25	215.64	30.02	
df = 48 P > 0.05					

सारणी से स्पष्ट होता है कि उपर्युक्त परिकल्पना को सत्यापित करने के लिए प्राप्त आँकड़ों (प्राप्तांकों) को ग्रामीण शासकीय विद्यालय के छात्र एवं छात्राओं में विभाजित किया गया है। प्राप्त आँकड़ों का मध्यमान, प्रमाणिक विचलन एवं "टी" मूल्य ज्ञात किया गया है।

"ग्रामीण शासकीय विद्यालयों के छात्रों" के लिए N = 25, M = 203.92 और SD = 37.15 है तथा "ग्रामीण शासकीय विद्यालयों की छात्राओं" के लिए N = 25, M = 215.64 और SD = 30.02 है।

अतः df = 48 पर ज. मान = 1.21 प्राप्त हुआ जो df = 48 तथा सार्थकता स्तर 0.05 पर आवश्यक ज. मान 2.01 से कम है। अतः ग्रामीण शासकीय विद्यालय के छात्र एवं छात्राओं के आक्रमक व्यवहार में सार्थक अंतर नहीं है।

अतः शून्य परिकल्पना स्वीकृत होती है।

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H_3 शहरी शासकीय विद्यालयों के छात्र एवं छात्राओं के आक्रमक व्यवहार में सार्थक अंतर नहीं पाया जायेगा।

सारणी से स्पष्ट होता है कि उपर्युक्त परिकल्पना को सत्यापित करने के लिए प्राप्त आँकड़ों (प्राप्तांकों) को शहरी शासकीय विद्यालय के छात्र एवं छात्राओं में विभाजित किया गया है। प्राप्त आँकड़ों का मध्यमान, प्रमाणिक विचलन एवं "टी" मूल्य ज्ञात किया गया है।

शहरी शासकीय विद्यालय के छात्र एवं छात्राओं के आक्रमक व्यवहार का तुलनात्मक अध्ययन का सांख्यिकीय विवरण

क्र.	तुलनात्मक समूह	प्रदत्तों की संख्या ;छद्ध	मध्यमान ;डद्ध	प्रमाणिक विचलन ;क्द्ध	टी मूल्य ;जद्ध
1.	शहरी शासकीय विद्यालयों के छात्र	25	211.4	34.36	0.42
2.	शहरी शासकीय विद्यालयों के छात्रा	25	215.44	32.76	
df = 48 P > 0.05 स्तर पर सार्थक अंतर नहीं है।					

सारणी से स्पष्ट होता है कि "शहरी शासकीय विद्यालयों के छात्रों" के लिए N = 25, M = 211.4 और SD = 34.36 है तथा "शहरी शासकीय विद्यालय की छात्राओं" के लिए N = 25, M = 215.44 और SD = 32.76 है।

अतः df = 48 पर ज. मान = 0.42 प्राप्त हुआ जो df = 48 तथा सार्थकता स्तर 0.05 पर आवश्यक ज. मान 2.01 से कम है। अतः शहरी शासकीय विद्यालय के छात्र एवं छात्राओं के आक्रमक व्यवहार में सार्थक अंतर नहीं है।

अतः शून्य परिकल्पना स्वीकृत होती है।

संदर्भित ग्रन्थ (References)

- शर्मा आर. ए. (2013), *शिक्षा अनुसंधान के मूल तत्व एवं शोध प्रक्रिया"*, आर.लाल. बुक डिपो, बेगम ब्रिज रोड, मेरठ, पेज नं. 2, 4.
- माथुर, डॉ. एस.एस (2009) *"शिक्षा मनोविज्ञान"*, विनोद पुस्तक मंदिर आगरा–2, पृष्ठ 60
- शर्मा, आर.ए. (2008) *"शिक्षा अनुसंधान"* प्रकाशक– विनय रखेजा ब्व आर.लाल बुक डिपो निकट गवर्नमेण्ट कॉलेज, मेरठ – 250001 पृष्ठ 1–28, 29–53,

ISBN Number: 978-93-95305-78-5

- पचौरी, डॉ गिरीश (2008) *"शिक्षा के मनोविज्ञान आधार"* प्रकाशक– विनय रखेजा ब्व आर.लाल बुक डिपो निकट गवर्नमेण्ट कॉलेज, मेरठ – 250001 पृष्ठ 65–83, 116–124, 239–243
- त्रिपाठी, लाल बचन, (2008) *"आधुनिक सामाजिक मनोविज्ञान"*, प्रकाशक– एच.पी. भार्गव बुक हाउस, 4/230, कचहरी घाट, आगरा 282004 पृष्ठ 327–360
- वर्मा, श्रीवास्तव (2007, 2008) *"आधुनिक सामान्य मनोविज्ञान"*, प्रकाशक– अग्रवाल पाब्लिकेषन निर्भय नगर, गैलाना रोड आगरा – 7 पृष्ठ 490–506–, 523–531
- राय, पारसनाथ (2007) *"अनुसंधान परिचय"*, प्रकाशक–लक्ष्मी नारायण अग्रवाल अनुपम प्लाजा – 1, ब्लॉक न. 50 संजय प्लेस, आगरा 282 002

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

PHARMACOLOGICAL POTENTIALS OF AQUEOUS EXTRACT OF SYZYGIUM CUMINI: A REVIEW

Sandhaya Sahrma*[1],
[1]Associate Professor,
Radha Govind College of Pharmacy,
2 Km ahead R.T.O. on Kundarki road,
Moradabad-244001, Uttar Pradesh, India

Correspondence to Author:
Sandhaya Sharma
Associate Professor
Radha Govind College of Pharmacy
2 km ahead R.T.O. on kundarki road,
Moradabad, Uttar Pradesh, India
sandhayasharma24@gmail.com

ABSTRACT

Syzygium cumini, generally bearing small black-purple drupes, is indigenous to Indian subcontinent and has diverse biological activities. It is also known as "jambul" & "kala jamun" in India. It belongs to the family Myrtaceae, the members of which have often antidiabetic, antiinflammatory, anti-pyretic, anti-oxidant, antimicrobial, anticancer, antidyslipidemic, antibacterial activities. *Syzygium cumini* has traditionally been used for its rich nutrition and medicinal value. It has diverse pharmacological actions. Different parts of plant (like bark, leaves, seeds, fruit etc.) have been used medicinally in treatment of various diseases. Seeds of *Syzygium cumini* have showed as antiinflammatory, antioxidant, antibacterial, antidiabetic antifertility, antiplaque, radioprotective, neuropsychopharmacological, and nephroprotective and antidiarrhoeal activities. Leaves of *Syzygium cumini* have been used for their antibacterial & antidysentric actions. Seeds of *Syzygium cumini* have been used as antibacterial, anti- inflammatory, antioxidant, & anticancer. Bark of *Syzygium cumini* has been used as diuretic. The ripe fruits of *Syzygium cumini* were found to have cardiovascular effects like hypotensive, vasorelaxant & antihypertensive in rats. *Syzygium cumini* has been used in diabetes since ages. Apart from this, it has also shown anti-allergic, anti-fungal, antibacterial, anticancer, anticlastogenic, antidiarrhoeal, antifertility, antihyperlipidemic, antihypertensive, radioprotective, chemoprotective, a hepatoprotective effects. This review will provide a platform for future researchers to describe the existing data on the information on traditional and medicinal use of the *Syzygium cumini* plant. The health-beneficial effects of S. cumini are mainly attributed to various phytoconstituents such as tannins, alkaloids, steroids, flavonoids, terpenoids, fatty acids,

ISBN Number: 978-93-95305-78-5

phenols, minerals, carbohydrates and vitamins present in the fruit. This review paper presents an overview of experimental evidence for the pharmacological potential of S. cumini.

Keywords- *Syzygium cumini*, Antiinflammatory, Anti-pyretic, Anti-oxidant, Antimicrobial, Anticancer, Antidyslipidemic and Antibacterial.

INTRODUCTION

Numerous medicinal plants are present in a collection of herbal preparations of the Indian traditional health care system (Ayurveda) named Rasayana. From the ancient time, plants have been playing a key role for the betterment of mankind presenting as an extraordinary source of natural medicine. The complexity in formulating chemical based drugs as well as their health related side effects and uprising cost has led worldwide researchers to focus on medicinal plant research. Bangladesh has a vast repository of diverse plant species where about five thousand plants species have been claimed as having significant medicinal values. The researched papers on medicinal plants publishing from last few decades mention the activities of different plant bioactive compounds that are used widely in the treatment of various human ailments *Syzygium cumini* belongs to the family Myrtaceae. Commonly it is known as a amblang, Jambul, Jambolan and Kala Jamun in India. *Syzygium cumini* is recommended as a safe drug in various diseases by health organizations in the world [1]. This plant is used for treatment and in prevention of different diseases in Homoeopathy practice from more than one fifty years back in different countries. This plant especially restoration the body weight and inhibits the excessive blood glucose levels, as well as recovery in the activities of antioxidant enzymes like catalyze, peroxidase and super oxide dismutase. Fruits are used in pimples emaciation, prickly heat, diabetes Inspidius, and urinary system to cure number of diseases such as urinary tract infections, cystolithiasis, dysuria. Syzygium was an important medicinal plant since long and therefore, scientists are also curious to prove the Pharmacological and phytochemical actions. *Syzygium cumini* plant bark is rough and dark grey colour becoming light grey colour with smoother higher up. The wood of the plant is water proof and leaves have a turpentine, pinkish, dark green with a yellow midrib when mature. The leaves of this plant are used for live stock [2]. The whole plant is having the good nutritional values. This plant starts flowering from February to May, plant flowers are fragrant and small about six mille meters in diameter. The fruits develop by April to July [3]. *Syzygium Cumini* fruits are oblong dark grey colour and fruits are combination of sweet, sour and stringent in flavor.

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BOTANICAL DESCRIPTION AND TAXONOMY

Syzygium cumini is an evergreen tree that grows up to 25 meters (80 feet) tall, with grayish white stems and coarse and discolored lower bark. The leaves are simple, opposite, elliptic to oblong, smooth, glossy, and somewhat leathery. The midrib of the leaves is prominent and yellowish Also, the leaves are 5 to 15 centimeters long and 2 to 8 centimeters broad. The base is cuneate or round; apex is short, rounded, or obtuse; edges are toothed; stalk is slender and light yellow; veins are fine, close together, parallel, and gland dotted The flowers are white to pinkish, about 1 centimeter (0.5 inch) across with four petals and many stamens. The calyx is cup-like, about 4 millimeters long, and tooted. The petals adhere and fall together as a small disk. The stamens are many and almost the same length as calyx .The fruits are ovoid, 1-seeded berry, with a length of 2 centimeters (0.8 inch), dark purple red, shiny, with white to lavender flesh. The Philippine description of the fruit's shape is from oval to elliptic, length from 1.5 to 3.5 centimeters, and color from dark purple to black. The fruit has a combination of sweet, mildly sour, and astringent flavor, and it tends to color the tongue purple. Also, because of the dark violet color of the fruit, it gives the impression of the olive tree fruit, both in shape and weight.

Fig.- Syzygium cumini (L) Skeels.

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Scientific classification [6]

Kingdom: Plantae

Unranked: Angiosperms

Unranked: Eudicots

Unranked: Rosids

Order: Myrtales

Family: Myrtaceae,

Genus: Syzygium

Species: Cumini

Binomial name: Syzygium cumini (L) Skeels.

Origin of Jamun and Its Distribution

- Being native to India, Ceylon and Burma and also to the Andaman Islands, it is available throughout Indian plains up to 1300 m of height.
- It is grown as a wild and semi-wild tree In different states of India including Uttar Pradesh, Punjab, Haryana, Gujarat, Maharashtra, Madhya Pradesh, Chhattisgarh, Bihar, Karnataka, Jharkhand, Andhra Pradesh and Tamil Nadu.
- In addition to S. cumini other major species of Jamun in India is S.jumbos known as rose apple or safed jamun which is found in South India, Assam and West Bengal.
- Other various species of minor importance include S.javanica (water apple), S.fruticosum, S. densiflora and S. Uniflora.

Floral Biology of Jamun

Syzygium cumini (Jamun tree botanical name) is generally seen that inflorescence in Jamun is borne in the axils of its leaves on the branch let and the flowering starts in the first week of March and can last upon the first week of April. Jamun flowers are light yellow in colour and are hermaphrodite (that have complete or partial reproductive organs and can produce gametes associated with both male and female sexes). According to studies, the maximum anthesis i.e. 18.71 percent to 43.08 percent and dehiscence were seen between 10 am and 12 noon. Also, the maximum receptivity of stigma was observed one day after a thesis.

Flowers are seen regular, bisexual having 5 free sepals and petals with 8 stamens and a simple style. It is known that anthesis starts at about 8 am and takes 10 hours to complete. The maximum numbers of flowers open between 5 pm to 6 pm. In some flowers, anthesis could be seen between 5 am to 6 am in the

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morning. Jamun is a cross-pollinated crop and the pollination is performed by houseflies, honey bees and wind. It is seen that only 12-15 percent flowers reach the maturity stage and the flower and fruit drop are present in 3 stages.

Propagation of Jamun

Propagation of Jamun can be done through seeds which are highly recalcitrant in nature. The freshly extracted seeds are generally sown for raising seedlings. The seeds germinate within two weeks and these can then be transplanted during monsoon season in the field. Also other methods of propagation such as budding methods are known to be successful and patch budding can be performed in the months of March in semiarid areas. In addition, soft wood grafting is adopted mostly in Karnataka and Gujarat in the months of June and August, respectively.

Using Biotechnology, the nodal segments, epicotyls segments and shoot apices of the plant have been used as the explants for micro propagation. The regenerated plantlets are then acclimatized and transferred to the soil successively.

Breeding Objective of Syzygium Cumini (Jamun Tree Botanical Name)

- It is performed to achieve a high yielding variety of the plant.
- For attaining early maturing varieties.
- It also improves physico-chemical properties such as fruit weight, pulp content, acidity, TSS, etc.
- To achieve resistance against flower and fruit drop.

Selection

- Today, there are numerous seedling strains of Jamun available in India that provides a great scope for selection of better cultivars.
- An important criterion for selection is the oval/oblong fruit shape, deep purple or bluish black colour, more pulp, larger size, small stone, earliness, sweetness and juiciness.

Table1. Pharmacological actions of Syzygium cumini

S.No	ts of the Plant	Fractions	Pharmacological Action

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1.	Stem Bark	Aqueous Methanolic	Hypoglycemic, hypolipidemic, antidiarrheal.
2.	Leaves	Aqueous methanolic, ethanolic, butanolic and essential oil	Action on local inflammations, anthelmintic, antiseptic buccal, astringent, increases in the number of erythrocytes, and T lymphocytes.
3.			Modulation of purinergic system in DM 2, in erythrocytes submitted to hyperglycemia, acute ethanol intoxication, anti-inflammatory, digestive, astringent, protection against toxicity caused by carbon tetrachloride in vivo and[a] hypoglycemic activity in vitro.
			Decreased urinary volume, urinary albumin, renal hypertrophy, and glucose.
4.	Fruits	Aqueous	Gastrointestinal, hypoglycemic, antipyretic and cardioprotective treatment. In vivo: increases insulin levels in control and diabetic

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			rabbits. In vitro: it stimulates the insulin secretion of the islets of Langerhans and inhibits the insulinase activity. Cardio protector in pesticide-induced toxicity, protector against isopreterenol-induced myocardial damage.
5.	Seeds	Methanolic, ethanolic Aqueous Hydroalcoholi c, ethanolic, Chloroformic, petroleum ether, and methanolic	They are considered the most effective in hydroalcoholic, experimental DM models developed in vivo, attenuating/reversing several parameters affected by this disease even in short treatment periods.

CONCLUSION

Syzygium cumini is widely used by the traditional healers for the treatment of various diseases. In recent years, ethno medicinal studies received much attention as this brings to light the numerous little known and unknown medicinal virtues especially of plant origin which needs evaluation on modern scientific lines such as phytochemical analysis, pharmacological screening and clinical trials 89. In the present review, the literature about botanical, pharmacognistical, phytochemical and pharmacological activities have been given comprehensively.

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The plant is having antidiabetic, antioxidant, antiviral, neuropsychological, antifertility, anti-inflammatory, antidiarrhoeal activity, hepatoprotective, anti-allergic activity, and gastroprotective activity. A literature survey also pin points the fact that although the number of diseases for which *S. cumini* finds use as a medicine is fairly large its therapeutic efficacy has been assessed only in few cases with few models. Therefore, it is imperative that more clinical and pharmacological studies should be conducted to investigate the unexploited potential of this plasma.

REFRENCES

1. Jadhav V.M., Kamble S.S. and Kadam V.J. Herbal medicine, Syzygium cumini a review. Res J. Pharmacy, 2009; 2(8): 1212-1219.
2. Janick Jules and Paull sd fb Robert E. (2008). The Encyclopedia of Fruit & Nuts. CABI International, United Kingdom, 1-160. ISBN: 978-0-85199-638-7.
3. Chen Jie and Craven Lyn A. (2017). Syzygium in Wu, Zhengyi; Raven, Peter H. & Hong, Deyuan, Flora of China (online), eFloras.org, retrieved 2015-08-13.
4. Patel Soncharan, Shanmugarajan T.S., Somasundaram. and Maity Niladri, Protective effect of Syzygium cumini seeds against doxorubicin induced cardio toxicity in rats International Journal Of Pharmacy & Life .2010;1(2):23
5. Oliver.B, 1880, Oral hypoglycemic plants in west Africa, J.Ethnopharmacol,2:119-127.
6. Bhanumathy, M., Shivaprasad, H.N., Manohar, D., and Nargund, L.V.G. Anti-fatigue Activity of Extracts of *Syzygium cumini* Leaves. *International Journal forPharmaceutical Research Scholars*, 2013; 2 (1):24-29
7. Modi DC, Patel JK, Shah BN and Nayak BS: Pharmacognostic Studies of the Seed of *Syzygium Cumini* Linn; Pharma Science Monitor. An International Journal of Pharmaceutical Sciences 2010; 1(1): 20-26.
8. The Ayurvedic Pharmacopoeia of India. New Delhi: Ministry of Health and Family Welfare 1999; 54-59.
9. Patel D, Gidwani B, Sarwa K and Kaur CD: Shri Rawatpura Sarkar Institute of Pharmacy Kumhari, Durg (C.G.). A comprehensive review on the Anti-diabetic Activity of *Momordica Charantia* and *Syzygium Cumini* Seeds.
10. Jadhav VM, Kamble SS and Kadam VJ: Herbal medicine: *Syzygium cumini*: a review. Journal of Pharmacy Research 2009; 2(8): 1212-1219.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

THE ROLE OF HOPE AND DESPAIR IN SHAPING THE RESILIENCE AND FRAGILITY OF HUMAN RELATIONSHIPS IN *A Thousand Splendid Suns*

Shagufa
Research Scholar
Department of English
Baikunthi Devi Kanya Mahavidyalaya,
Dr. Bhimrao Ambedkar University, Agra.

Abstract:

In *A Thousand Splendid Suns*, Khaled Hosseini explores how the interplay between hope and despair shapes the relationships of the central characters, particularly Mariam and Laila. Set against the backdrop of war-torn Afghanistan and patriarchal oppression, the novel reveals how hope provides resilience in the face of hardship, while despair threatens to fracture bonds, leading to isolation. This paper examines how moments of hope and despair influence the sustainability of Mariam's and Laila's relationship, as well as their relationship with Rasheed. Through key moments in the novel, it shows that hope, however fragile, is essential for emotional survival and the transformation of relationships, even in a world marked by trauma and suffering.

Keywords: Hope, Despair, Human Relationships, Resilience.

Introduction

Khaled Hosseini's *A Thousand Splendid Suns* is a powerful portrayal of the struggles and suffering endured by the women of Afghanistan, a theme that resonates deeply throughout the novel. In this emotional and evocative work, Hosseini focuses on the lives of two women, Mariam and Laila, who are bound together by tragedy, hardship, and a shared fight for survival in the face of a deeply patriarchal society. Set against the backdrop of Afghanistan's turbulent history, including the fall of the monarchy, the rise of the Taliban, and the impact of years of war, the novel brings to life the brutal realities faced by its characters. Rebecca Stuhr in her book *Reading Khaled Hosseini,* (2009) dedicated to Khaled Hosseini explores the tradition, custom, culture, ethnicity and current happenings of Afghanistan. She offers an overview of Khaled works by stating, "Hosseini writes compelling stories through which he questions assumptions and breaks apart stereotypes through the strengths and weaknesses of his characters" (Stuhr 77-78).

In Khaled Hosseini's *A Thousand Splendid Suns,* the themes of hope and despair are pivotal in shaping the relationships between the central characters, particularly Mariam and Laila. Set against the backdrop of a war-torn Afghanistan, where the characters are subjected to patriarchal oppression and

ISBN Number: 978-93-95305-78-5

constant social upheaval, the novel explores how these emotional forces influence the resilience and fragility of human bonds. Hope, though fragile, emerges as a force that enables survival, while despair, equally powerful, often threatens to dismantle the emotional connections that the characters hold dear. Through the intricate relationships between Mariam, Laila, and Rasheed, Hosseini highlights the complex roles that hope and despair play in determining the trajectory of human relationships in a context defined by trauma, loss, and suffering.

The research article has been written using qualitative methodology for which some secondary sources like journals and books have been used for appropriate references. The research methodology is used in such a way so that some in-depth themes could get highlighted as per the reader's convenience. An effort has also been made to introduce the reader to some innovative thoughts which are present in the depth of this novel.

This paper aims to examine how hope and despair shape the relationships between the central characters in *A Thousand Splendid Suns*, particularly Mariam and Laila. It explores how these emotional forces contribute to the resilience and fragility of their bond. The paper also investigates hope as a source of emotional survival in a society marked by trauma and oppression, while analyzing how despair, especially through Rasheed's abuse, leads to emotional collapse and isolation. Furthermore, the paper highlights the transformative power of hope in the evolving solidarity between Mariam and Laila, showing how it acts as resistance against patriarchal oppression. Ultimately, this analysis highlights the complex role of hope and despair in the survival and emotional transformation of human relationships in the novel.

Hope in the novel is not just a fleeting emotional response, but a driving force that sustains the characters through their darkest moments. Mariam's life, marked by rejection and abuse, is at times defined by a desire for acceptance and a longing for something better. Even in the face of deep despair, her hope is reignited when she forms a bond with Laila, whose youthful optimism and dreams of a better future offer Mariam a new sense of purpose and belonging. This connection between them becomes a source of resilience, as their shared experiences of pain and survival bind them together. Similarly, for Laila, hope becomes an essential part of her will to survive after the loss of her parents and the destruction of Kabul. Her connection to Mariam, forged through their mutual suffering, provides her with emotional strength and hope for a brighter future, particularly for her children. In this way, hope is integral not only to their survival but also to their emotional and psychological resilience, enabling them to transcend the immediate despair of their lives.

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On the other hand, despair is a constant and overpowering presence that threatens the emotional stability of the characters. For Mariam, despair stems from the abusive relationship with Rasheed, her feelings of illegitimacy, and the societal rejection she faces. Despite brief moments of hope, Mariam's sense of worthlessness often leads her to emotional withdrawal, leaving her feeling isolated and unworthy of love or connection. Laila, too, faces overwhelming despair following the deaths of her parents and the collapse of her world. Initially, she holds onto hope for a better life, but the weight of Rasheed's cruelty and the emotional isolation she endures pushes her toward resignation. Despair becomes a tool of emotional destruction, slowly eroding the bonds between the women and creating a sense of emotional collapse. Rasheed's despair, fueled by grief and anger from the loss of his own son, becomes the catalyst for his abusive behavior, driving him to dominate and control Mariam and Laila. His inability to process his pain and trauma leads to violent outbursts, perpetuating a cycle of abuse and emotional destruction. In this way, despair not only affects individual characters but also destabilizes the relationships they try to form. Alladeepa Maurya in her investigation analyses the fusion of love, sacrifice and violence in the Khaled Hosseini's *A Thousand Splendid Suns*. The researcher highlights the significance of love and human relationships for the betterment of humanity through the character of Laila and Mariam and states, "Hosseini's A Thousand Splendid Suns gives an overview of violence and the plight of two resilient women in the environment of violence, massacre and bombardment has been brought into focus" (Maurya 326).

Despite the overwhelming presence of despair, hope plays a critical role in sustaining and strengthening relationships. The relationship between Mariam and Laila, for instance, shifts from initial suspicion and rivalry to a deep, transformative bond. As they endure the oppressive conditions imposed by Rasheed, their shared hope for a better life enables them to resist and challenge their circumstances. Mariam, who once viewed Laila as a threat, comes to see her as a daughter and a source of emotional support. This shift from rivalry to solidarity is crucial to their survival, as hope becomes the foundation for their bond. The two women come to rely on each other, not only for physical survival but also for emotional strength. Their relationship exemplifies how hope can transcend even the most difficult of relationships, transforming the dynamics of power and control into a source of mutual care and support.

Mariam's and Laila's bond also reflects the transformative power of hope. As they grow closer, they find solace in each other's presence, despite the harshness of their circumstances. Their relationship symbolizes the possibility of healing and redemption, particularly for Mariam, who sees her relationship with Laila as a way to transcend her painful past. Mariam's hope for a better future for Laila's children, as well as her deep love for Laila, provides her with the strength to make the ultimate sacrifice for their

ISBN Number: 978-93-95305-78-5

wellbeing. Mariam's act of selflessness, culminating in her tragic death, underscores how hope, even in its most fragile form, can lead to moments of profound emotional transformation. In her final moments, Mariam finds peace knowing that her sacrifice will secure a future for Laila and her children, reinforcing the idea that hope can provide the strength to endure even the greatest of losses.

However, the impact of despair is also evident in Rasheed's downfall. His unresolved grief, combined with his sense of failure, manifests as violent and controlling behavior. Rasheed's inability to find hope or redemption in his life leads to emotional devastation, not only for himself but also for those around him. His despair becomes self-destructive, as it isolates him from the very people he seeks to control. His abusive nature ultimately leads to his death, illustrating how unchecked despair can result in the emotional disintegration of relationships and personal destruction. In contrast to Mariam's and Laila's resilience, Rasheed's inability to process his own suffering highlights the destructive power of despair, which not only isolates individuals but also unravels the relationships they hold most dear.

The relationship between Mariam, Laila, and Rasheed ultimately reveals how hope and despair interact to shape the emotional dynamics of the story. While Rasheed's despair leads to violence and eventual destruction, the hope between Mariam and Laila sustains their bond, allowing them to endure their suffering and find emotional strength. Mariam's hope for Laila's future becomes the catalyst for her transformation, and her final act of love and sacrifice demonstrates how hope can lead to personal redemption. Despite the constant presence of despair, it is hope that allows these women to transcend their circumstances and form a lasting emotional connection.

In conclusion, *A Thousand Splendid Suns* provides a powerful exploration of the role of hope and despair in shaping the resilience and fragility of human relationships. Through the evolving bond between Mariam and Laila, the novel demonstrates how hope can transcend the forces of trauma, oppression, and despair to create lasting connections. While despair threatens to unravel the characters' emotional stability, it is hope that it provides the strength necessary for survival, healing, and transformation. Ultimately, Hosseini's novel emphasizes the power of hope in sustaining human relationships and underscores the potential for emotional resilience even in the face of overwhelming adversity.

Works Cited

Hosseini, Khaled. *A Thousand Splendid Suns*. Riverhead Books, 2007.

Maurya, Alladeepa. "Matrix of Violence, Love and Sacrifice: A Critical Study of Khaled Hosseini's *A Thousand Splendid Suns*." *International Journal of Science Technology and Management,* vol. 4, no. 11, 2015.

Stuhr, Rebecca. *Reading Khaled Hosseini*. Santa Barbara, Calif: Greenwood Press, 2009.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

FUTURES IN FLUX: REIMAGINING NATURE AND CRISIS THROUGH THE LENS OF LITERATURE AND SCIENCE

Shibin Varghese
Assistant professor,
St Xavier's Arts and Science college, Calicut, Keala.
MA English Literature, UGC NET in English Literature
togetshibin@gmail.com

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Abstract

This interdisciplinary study explores how literature and science & technology address and represent nature, climate change, and ecological crises. Literature provides a platform for dramatizing the human experience of environmental challenges, offering emotional and cultural dimensions that complement the empirical data and innovations from science and technology. Through genres such as climate fiction (Cli-Fi), eco-dystopias, and speculative narratives, literary works such as Richard Powers' *The Overstory* and Margaret Atwood's *Oryx and Crake* portray humanity's fraught relationship with nature, the consequences of technological overreach, and the urgency of ecological stewardship.

Conversely, advancements in climate science, ecological modeling, and green technology inform these narratives, providing realism and fostering public awareness. Innovations such as AI, geoengineering, and

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renewable energy solutions are critically examined in both scientific discourse and imaginative literature, reflecting their dual potential as saviors and disruptors of ecological balance. Scientific texts like Elizabeth Kolbert's *The Sixth Extinction* and geoengineering studies inspire creative works while contributing to the broader discourse on the Anthropocene.

This study highlights the mutual enrichment of these fields, demonstrating that literature humanizes science while scientific advancements ground literary imagination in plausible futures. By integrating narrative and empirical approaches, this examination offers a nuanced perspective on the cultural, ethical, and technological dimensions of addressing environmental crises, aiming to foster interdisciplinary collaboration and inspire solutions to global challenges.

Review of Literature

The literature surrounding the examination of representations of nature, climate change, and ecological crises through the lens of literature and science & technology is rich and multifaceted. This body of work brings together literary analysis, environmental science, and technological discourse to explore how human society engages with environmental issues. It highlights the interplay between narrative imagination and scientific inquiry, as well as how these fields inform one another in addressing global ecological challenges.

Findings

2. **Representations in Literature**

1.1 Romanticism to Modernism

a. Early depictions of nature, such as those by Romantic poets like William Wordsworth and Samuel Taylor Coleridge, celebrate its beauty and restorative power.

b. Modern works reflect environmental degradation, portraying landscapes as fragile and endangered.

1.2 Nature as a Character:

In some works, nature is personified or given agency, emphasizing its power and resilience. Example: The ocean in Amitav Ghosh's *The Hungry Tide* becomes a living force reflecting ecological tensions.

1.3 Climate Change Narratives:

Cli-Fi (Climate Fiction): A growing genre that dramatizes the impact of climate change, blending speculative fiction with real-world science.

Example: Kim Stanley Robinson's *New York 2140* imagines a future where rising sea levels reshape urban life, grounded in scientific plausibility.

1.4 Eco-Dystopias:

Works like Octavia Butler's *Parable of the Sower* depict societal collapse due to ecological crises, highlighting the human cost of environmental neglect.

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2.Representations in Science and Technology

2.1 Scientific Contributions:

Climate Models and Data:

a) Advances in climate modeling and satellite data visualization have informed realistic representations of environmental change in literature.

Example: Nonfiction works like Elizabeth Kolbert's *The Sixth Extinction* present scientific findings in a narrative format, bridging the gap between research and public understanding.

Ecological Science:

a) Understanding ecosystems and biodiversity loss has inspired authors to explore interconnectedness in nature, as seen in Richard Powers' *The Overstory*.

2.2 Technological Innovation:

Green Technologies:

a) Renewable energy, carbon capture, and geoengineering are common themes in speculative fiction, exploring both promise and peril.

Example: Paolo Bacigalupi's *The Windup Girl* imagines a future shaped by genetic engineering and biotechnological advancements.

2.3 Artificial Intelligence and Big Data:

a) Technologies like AI are increasingly used in scientific research on climate change, influencing literature that speculates on their societal implications.

Example: Ted Chiang's *Exhalation* collection includes stories exploring humanity's relationship with AI and environmental sustainability.

3. Science & Technology and Ecological Representation

In parallel, science and technology play a crucial role in shaping how climate change and ecological crises are represented, both in literary works and in scientific discourse. Paul Crutzen's concept of the "Anthropocene"—a proposed geological epoch defined by human impact on Earth's systems—has informed numerous literary representations of environmental degradation. The term is widely discussed in both academic and popular scientific literature, with books like Elizabeth Kolbert's *The Sixth Extinction: An Unnatural History* (2014) examining the historical and scientific roots of current environmental crises, particularly biodiversity loss and human-driven climate change.

Technological advancements and their ethical implications are central to both scientific exploration and fictional depictions of environmental futures. For instance, geoengineering—the deliberate modification of Earth's environment to counteract climate change—has been a topic of both scientific research and speculative fiction. Neal Stephenson's *Termination Shock* (2021) imagines the global consequences of large-scale geoengineering, raising questions about who controls such technologies and what unintended consequences they may produce. This

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intersection of technological innovation and environmental representation in literature is also explored in Paolo Bacigalupi's *The Windup Girl*, where biotechnology is both a salvation and a curse for a world ravaged by environmental collapse.

4. Bridging the Gap: Literature as a Tool for Scientific Advocacy

Literature and science & technology also engage in a mutually reinforcing relationship. Science often informs literary works, providing a factual basis for speculative narratives about the future, while literature humanizes the scientific discourse, making climate data, environmental changes, and technological interventions more relatable and engaging. This connection is critical in shaping public discourse and policy.

For example, Bill McKibben's *The End of Nature* (1989) was one of the first books to discuss climate change in the broader context of human environmental impact, using accessible language to bring complex scientific data to the general public. Similarly, Rachel Carson's *Silent Spring* (1962) catalyzed environmental movements by detailing the dangers of pesticides in a compelling narrative that blended scientific research with personal storytelling.

Communicating Complexity:

Literature can translate complex scientific concepts into engaging narratives, fostering public understanding and empathy for environmental issues.

Example: Climate science underpins Barbara Kingsolver's *Flight Behavior*, which explores the disruption of monarch butterfly migration as a metaphor for broader ecological instability.

Ethical Questions:

Both literature and science grapple with the ethical implications of technological solutions to environmental crises.

Example: Geoengineering, a controversial climate intervention, is critically examined in fiction like Neal Stephenson's *Termination Shock*.

1. Key Theoretical Frameworks and Future Directions

The theoretical frameworks used in examining the relationship between literature, climate change, and science often draw from ecocriticism, posthumanism, and postcolonial theory. Posthumanist perspectives, as articulated by Donna Haraway and others, challenge anthropocentric views and call for a broader understanding of how humans fit into the ecological fabric of the Earth. These ideas are increasingly explored in contemporary literature and scientific discussions, advocating for the recognition of non-human actors in environmental decision-making.

Postcolonial criticism also offers valuable insights into how climate change disproportionately affects marginalized communities. Rob Nixon's *Slow Violence and the Environmentalism of the Poor* (2011) discusses the concept of "slow violence," where the gradual, often invisible impacts of environmental degradation, such as rising sea levels or resource scarcity, disproportionately affect vulnerable communities in the Global South.

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Conclusion

The literature on "Futures in Flux: Reimagining Nature and Crisis through the Lens of Literature and Science" is vast and growing, highlighting the need for interdisciplinary approaches to tackle environmental challenges. While science provides the data and innovations required to address these crises, literature offers the emotional and ethical contexts needed to inspire action and empathy. Both fields continue to evolve and inform each other, and together, they are instrumental in fostering a deeper understanding of the urgent ecological challenges facing humanity. As the effects of climate change become increasingly apparent, this body of work remains essential in shaping both public consciousness and policy.

Bibliography

1. Powers, Richard. *The Overstory.* W.W. Norton & Company, 2018.
2. Robinson, Kim Stanley. *New York 2140.* Orbit, 2017.
3. Stephenson, Neal. *Termination Shock.* William Morrow, 2021.
4. Kimmerer, Robin Wall. *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge, and the Teachings of Plants.* Milkweed Editions, 2013.
5. Oreskes, Naomi, and Erik M. Conway. *The Collapse of Western Civilization: A View from the Future.* Columbia University Press, 2014.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

MEDIA CONSUMPTION PATTERNS AMONG CHILDREN IN ANDHRA PRADESH: THE ROLE OF TELUGU REALITY AND COMEDY TV SHOWS

Upadrista Esther Sankeerthana
Research Scholar
Journalism and Mass communication
B.E.S.T Innovation University, Ananthapur
Esther.upadrista@gmail.com

Abstract

The media consumption habits of children will be explored on the basis of their being influenced by Telugu reality and comedy TV shows in Andhra Pradesh. Using a quantitative approach, data from 100 children aged 8–16 years are utilized using a structured questionnaire. This paper aims to analyze the viewing habits, assess the impacts on cognition, and socialize, and probe into what role these shows have played in sustaining cultural identity and regional language usage. The results show that media consumption increases with age, and the highest engagement was found among boys in the 14–16 age group. About 60% of children watched such shows for 5–15 hours per week, with notable variations in viewing intensity. The programs positively affected children's language skills (75% agreement) and peer interactions (65% agreement). However, 45% of respondents indicated that there was less academic concentration due to this reason, thereby depicting the kind of distraction involved with media consumption. More importantly, these shows also highly contributed towards reinforcement of cultural identity (75%), enhanced interest in the Telugu language (80%), and respect towards traditions (75%). This implies that reality and comedy shows of Telugu entertainment media perform both the role of entertainment media and a channel of cultural and social development and are raising alarms with regard to academic performance. In this sense, the present research will prove fruitful in ascertaining optimum creation of contents for children's education and developing healthy media usage patterns.

Keywords: Media Consumption, Among Children, Andhra Pradesh, Telugu Reality, Comedy, Tv Shows

1.INTRODUCTION

The consumption pattern regarding media among children is changing dramatically. Over the past few years, this change has been stimulated by technological change, the emergence of new digital platforms, and changes in content. One of the most striking impacts of these changes has been the growing influence of regional television shows, especially those that are produced in local languages. The consumption of Telugu reality and comedy television shows has emerged as a significant part of children's media engagement in the Indian state of Andhra Pradesh. The vibrant entertainment styles, humorous content,

ISBN Number: 978-93-95305-78-5

and family-friendly narratives make these shows important for shaping the social and cultural dynamics among children in the region.

This shift with the growth in the Indian television industry, primarily regional content, has made media interaction by children different from other parts of India. The high viewership and its ability to shape and mold children cognitively as well as socially in Andhra Pradesh through various Telugu reality and comedy-based TV shows exemplify this assertion. Many often present an intrinsic mix of entertaining and educating subjects with aspects of local culture, languages, and forms of humor. This has made them a popular medium for children, offering amusement and learning. Moreover, family-oriented shows also fit well into the traditional values of the region, making them a favorite for children of various age groups.

However, in this case of excessive television use, especially through programs meant to be funny and entertaining, several questions arise on the potential outcomes for children in terms of behavioral change, socialization, and learning. Content presented on the media platforms represents certain norms, ideals, and attitudes that would influence children's perception of reality. These shows can profoundly influence the emotional development and social interactions of the young viewers as a result of the role played by humor, comedy, and competition. Furthermore, the growing media exposure can also have an effect on children's attention span, academic performance, and physical well-being.

This study attempts to understand the emerging patterns of children's media usage in Andhra Pradesh, in particular with regards to Telugu reality and comedy TV shows. Through the assessment of the choices, actions, and attitudes of children towards such programs, the research hopes to gain insight into how these influence their daily routines, social behavior, and intellectual development. By this investigation, one could rightly depict how regional television content would rightly form the minds of young viewers in Andhra Pradesh in the face of a highly saturated media scenario.

1.1 Television as a Cultural and Educational Tool

Television goes a long way in molding the social as well as academic growth of children. As a means of mass communication, it is a window to a variety of things that can mold children's values, behaviors, and interactions with people. Educational programs work to improve mental abilities in a child, where entertainment content consists of reality as well as comedies that actually introduce cultural anecdotes and regional linguistics. Subsequently, students become more aligned with the social culture and folklore of the society. In the case of Andhra Pradesh, reality TV shows and other comedy shows function as a means through which Telugu reality and comedies teach more about the culture, as well as familiarity with the telugu language to the children themselves.

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1.2 Rise of Telugu Reality and Comedy TV Shows

The reality and comedy show in Telugu have gained significant prominence in the entertainment scenario in Andhra Pradesh. These are shows that include elements of competition, humor, and local culture, which appeal to a huge audience, particularly children. Such programs are more popular because they offer interesting content that appeals to regional values, traditions, and language. Telugu reality and comedy shows provide children with relatable characters and themes that will connect them to their cultural heritage while offering social interaction and entertainment. The immense popularity of the shows indicates how regional television influences contemporary entertainment trends and media consumption.

1.3 Research Objectives

1. To analyze the media consumption patterns of children in Andhra Pradesh, focusing on Telugu reality and comedy TV shows.
2. To assess the impact of Telugu reality and comedy TV shows on children's cognitive and social development in Andhra Pradesh.
3. To explore the role of Telugu reality and comedy TV shows in shaping children's cultural identity and regional language usage in Andhra Pradesh.

2. REVIEW OF LITREATURE

Chirumamilla (2019) discussed the changing nature of regional television channels in South India, highlighting how these platforms had served not only as mediums of entertainment but also as considerable cultural forces. The research underlined the multiple layers of television production so that content creation, engagement, and audience activity became interwoven with regional identity, well representing the dynamic nature between local cultures and television programming. It underscored the meteoric rise of regional television channels in South India that had, through more localized and relatable, culturally resonant content-including the reality and comedy shows which children loved-it had redifned the media landscape.

Desai (2021), regional language television does not only serve the local audience but also fulfills the need for content that mirrors the culture, way of living, and vernacular. He showed how the shows in regional language had become crucial for reaching the child and family audience, specifically in the states of Andhra Pradesh, providing entertainment with a sense of cultural representation. Through her analysis, Desai presents this framework to think through what television had done in giving voice to regional language, satire, and cultural values, which are integral to the way children perceive media in the state.

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Golwalkar and Mishra (2023) comment that audience perception also changed with time. Regional content on digital platforms was no longer just an entertainer but reflected local culture, identity, and values. The study concluded that younger viewers especially wanted content in regional languages because it was more relatable and culturally relevant. This further added to the significance of regional television and OTT content in molding media consumption in India. It has been critical to understand the interplay between traditional and digital media, especially concerning the regionalization of media consumption in Andhra Pradesh, wherein Telugu shows became an integral part of children's entertainment.

Jalarajan and Suresh (2023) also discussed the political and cultural implications of this upsurge in local content and found that this was associated with a desire for self-representation and identity affirmation. For children in Andhra Pradesh, the change in the content of television had had immense implications because most of the local productions were a channel for cultural transmission. It researched the role played by television programs, particularly comedies and reality shows, in local values, humor, and dialects that helped them find an important role in the socialization of children and young people. The authors summarized their work as the basis of entertainment from television content like reality and comedy shows that shaped the children's understanding of their culture and interaction.

3. RESEARCH METHDOLOGY

This paper will use the quantitative research methodology to analyze children's media usage patterns in the Indian state of Andhra Pradesh, with specific reference to Telugu reality and comedy TV programs. The methodology involves gathering number data through questionnaires that are subsequently used for structured and quantifiable analysis.

3.1 Research Design

A cross-sectional survey design will be adopted for the data collection of children who live in different regions of Andhra Pradesh. The three primary objectives of the survey will include media consumption pattern analysis, evaluation of its effects on cognitive and social development, and understanding the impact on cultural identity and language use.

3.2 Sampling Method

The study will carry out simple random sampling. Simple random sampling, in which a child is just as likely as any other to be chosen in the selection of participants, leads to the increase of chances toward a representative sample. A sample of 100 children aged 8 to 16 years-old who regularly follow Telugu reality and comedy television shows will form the sample of the study. Participants will be taken from both the urban and the rural areas for a proper blend of media usage behavior.

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3.3 Data Collection Tool

A structured questionnaire will be devised for collecting the data from participants. The questionnaires will comprise a mix of closed-ended questions and Likert scale questions. Questions will relate to the following issues:

1. Time spent watching TV, with a focus on Telugu reality and comedy TV shows.
2. Preferences for various types of shows and their effects on social interactions and peer relationships.
3. Views on cultural identity, utilization of language, and the impact of television programs on children's behavior, attitudes, and knowledge.

3.4 Variables

- **Independent Variables:** Frequency and types of Telugu reality and comedy TV shows watched, age, gender, and socio-economic background of the children.
- **Dependent Variables:** Cognitive development, social behavior, cultural identity, and language usage.

3.5 Data Analysis

Descriptive statistics in the form of frequency distributions, mean, and standard deviation would be used to analyze the data obtained from the survey to identify patterns of media consumption. Chi-square tests are some of the examples of inferential statistics used to determine how the variables under study (for example, age, gender, and socio-economic background) would affect children's media consumption patterns, cognitive development, and social behavior. Additionally, regression analysis may be done to gauge whether media consumption has a bearing on children's cultural identity as well as language use.

4. DATA ANALYSIS ANS RESULT

The study analyzed a survey of data from 100 children aged between 8 to 16, who regularly watched Telugu reality and comedy television shows. Analyzing media usage patterns, their cognitive and social impacts, as well as strengthening cultural identity have been the analysis focus.

4.1 Demographic

Table 1: Media Consumption by Age and Gender

Age Group	Average Hours Watched (per week)	Gender-Based Percentage (Male/Female)
8–10	8	45% / 55%
11–13	12	50% / 50%
14–16	14	60% / 40%

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Analysis of media usage across age groups and gender distinguishes unique child profiles in the Andhra Pradesh sample. An average 8 hours of time is spent every week watching reality and comedy programmes in Telugu for the group of children that falls between the ages of 8–10 years, wherein female viewers marginally out numbered males 55:45 percent respectively. For the age group 11–13 years, the average weekly viewing time increased to 12 hours with an equal balance between boys and girls, meaning there was equal interest in this demographic. The highest consumption was found among children aged 14–16 years, with an average of 14 hours per week, and here boys had a larger share at 60 percent as compared to girls at 40 percent. This trend indicates that with age, children are more likely to be attracted to such shows, and the older boys show a greater inclination toward this type of content. These patterns show the varying appeal of Telugu reality and comedy shows across different age groups and genders, which reflects the changing entertainment preferences of children as they grow up.

4.2 Media Consumption Patterns

Table 2: Frequency of Watching Telugu Reality and Comedy TV Shows

Frequency of Watching (Hours/Week)	No. of Children	Percentage (%)
Less than 5 hours	**20**	**20%**
5–10 hours	**35**	**35%**
10–15 hours	**25**	**25%**
More than 15 hours	**20**	**20%**

The number of hours children in Andhra Pradesh watch Telugu reality and comedy TV shows is a good indicator of the diversity of viewing habits. A large proportion of children, 35%, watched these shows for 5–10 hours per week, which reflects moderate consumption. About 25% of the children reported watching for 10–15 hours weekly, which indicates a high level of engagement with this content. Meanwhile, 20% of the children were on these shows for less than 5 hours a week. They are considered the least active viewing group. Yet another 20% claimed they viewed for over 15 hours a week. This group portrayed an intensive viewing pattern. These findings suggest that though children at large are in the moderate to high consumption category, a significant percentage consumes such content either in minimal or high quantity, reflecting wide variability in viewing behavior of the population.

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4.3 Impact on Cognitive and Social Development

Table 3: Self-Reported Cognitive and Social Impacts

Impact Type	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Improved language skills	30	45	15	5	5
Better peer interactions	25	40	20	10	5
Increased attention span	20	35	25	15	5
Reduced academic focus	15	30	20	25	10

Mixed results are reflected in the findings on the self-reported cognitive and social effects of watching Telugu reality and comedy TV programs by children in Andhra Pradesh. Most children (75%) strongly agreed or agreed that the program helped improve their language, thus indicating that reality and comedy contribute toward increasing the efficiency of communication through regional languages. Similarly, 65% children responded that they have better peer interaction as the side effect, indicating that perhaps shared experiences in viewing could create social networks.

However, only 55% respondents agreed or agreed strongly that this increased their focus, while 25% took a neutral stance and 20% disagreed, therefore the impact is less conclusive towards cognitive focus. On the contrary, 45% of kids agreed or strongly agreed that their attention to academics is reduced because of these shows that may indicate diversion associated with very high media consumption. Although the shows contribute positively to language development and social engagement, the findings underscore concerns about their impact on academic performance and sustained attention.

4.4 Cultural Identity and Language Usage

Table 4: Influence of TV Shows on Cultural Identity and Language

Variable	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Reinforced cultural identity	**40**	**35**	**15**	**5**	**5**

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Enhanced interest in regional language	**50**	**30**	**10**	**5**	**5**
Encouraged respect for traditions	**35**	**40**	**15**	**5**	**5**

The data highlighted significant influences from reality and comedy TV shows, by Telugu programs, on children's cultural identity and language use in Andhra Pradesh. Of the participants who were strongly convinced or convinced about the cultural identification of their kids being influenced in the process (75%), majorities claimed it helped create the sense of belonging and pride among the viewership of the content in terms of regional culture. In a similar context, 80% of the audience claimed that it has increased interest in the use of the Telugu language with these shows.

Further, 75% agreed or strongly agreed that these programs encouraged respect for traditions, emphasizing the contribution of these shows to the transmission and reinforcement of traditional values. Although a small minority (10%) were neutral or disagreed with these factors, the overall results indicate the significance of Telugu reality and comedy TV shows in molding the cultural understanding of children, in linguistic engagement, and in teaching them respect for local traditions.

5. DISCUSSION

Findings The results of the present study contribute significantly to an understanding of media use patterns by children in the state of Andhra Pradesh and specifically the usage of Telugu reality and comedy TV programs. The discussion in the following pages discusses the dominant themes arising from the data analysis.

5.1 Media Consumption Patterns

Children view Telugu reality and comedy shows significantly, where most of the children watch these programs for 5–10 hours a week. This average consumption level that is seen among 35% of the sample is quite ordinary in entertainment patterns. However, the fact that 20% of children view for more than 15 hours a week indicates that the audience might show overdependence in this particular sub group. The findings also indicate that the older the age group, the higher the media consumption, with 14–16-year-old children being more engaged. This pattern might reflect the increasing independence and the need for more relatable content as children mature.

5.2 Cognitive and Social Development

Reality and comedy Telugu TV shows are playing a bivalent role for children's cognitive and social developments. A higher percentage of participants 75% - reported that it enhanced their ability to speak

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the language, thus opening up avenues in regional language fluency. 65% more reported better communication among peers, further indicating that this show helps bring about shared experience and social attachment among them.

However, mixed reactions on the improvement of attention span and acceptance of decreased academic concentration by 45% of respondents raise concerns regarding potential distractions from academic activities. Such findings call for a balanced consumption of media to ensure maximum benefits without adverse effects on academic performance and cognitive focus.

5.3 Cultural identity and language usage

Among the many findings, perhaps the most powerful outcome is that the study demonstrates a robust effect of Telugu reality and comedy television shows on the cultural identity and language usage of children. Fully 75-80 percent of the children were of the opinion that these programs were reinforcing their cultural identity, arousing more interest in the Telugu language, and creating a respect for tradition. These results highlight regional media's place in the preservation of cultural heritage, as well as the pride and feeling of belonging towards the culture among young audiences.

The findings reveal that this form of programming not only entertains but also transcends to become a tool for cultural transmission and the inculcation of values as well as regional pride for the young generation. In the context of globalization, this form of cultural reinforcement transcends in areas of homogenized global content transcending regional identities.

5.4 Implications and Recommendations

The study underscores the importance of creating balanced media content that caters to children's entertainment needs while fostering cognitive, social, and cultural development. The findings suggest that policymakers, educators, and content creators should collaborate to develop programming that enhances positive outcomes, such as language development and cultural identity, while mitigating potential drawbacks, such as reduced academic focus.

Additionally, parents and guardians should be encouraged to monitor viewing habits and ensure a balanced media diet that includes educational content alongside entertainment. Future research could explore the long-term effects of such shows on children's development and extend the scope to include comparisons with other forms of media, such as OTT platforms.

6. CONCLUSION

This study brings out the important role Telugu reality and comedy TV shows play in forming the media consumption patterns of children in Andhra Pradesh. It was found that these shows were not only popular

ISBN Number: 978-93-95305-78-5

among children but also consumed moderately to highly, and influential in multiple dimensions of their development. But interestingly, statistics reveal positive roles of such channels in augmenting regional languages besides encouraging friendship chains and nurturing cultures. Almost ninety percent children had reported these very shows improved a sense of affiliation with cultural legacy, heightened interests in Telugu language, as well as nurtured their traditions. However, in the study there are also raised concerns, in particular about lack of academic engagement and inconclusive effects on the attention span of children. That means that consumption of such contents should be very balanced, focusing on entertainment while at the same time maximizing their educational value and minimizing such drawbacks. Overall, Telugu reality and comedy TV shows are more than entertainment; they act as a channel for cultural preservation and social engagement among children, with the need for careful content creation and consumption strategies in support of holistic child development.

REFERENCES

1. Chirumamilla, P. (2019). *Producing TV (s): The multitudinous life of television in south India* (Doctoral dissertation).
2. Desai, M. K. (2021). Introduction: Regional language television channels: an Indian story. In *Regional Language Television in India* (pp. 1-31). Routledge India.
3. Desai, M. K. (2021). *Regional language television in India*. CRC Press.
4. Golwalkar, S., & Mishra, M. (2023, January). Rise of Indian regional content on video streaming platforms: A study of audience consumption and perception of Indian regional content on OTT platforms. In *AIP Conference Proceedings* (Vol. 2523, No. 1). AIP Publishing.
5. Jalarajan, R. S., & Suresh, A. K. (2023). INDIAN TELEVISION AND THE RISE OF THE LOCAL. *Television Publics in South Asia: Mediated Politics and Culture*.
6. Jalarajan, R. S., & Suresh, A. K. (2024). Indian Television and the Rise of the Local: Televised Realities of Localized Sociocultural Experience. In *Television Publics in South Asia* (pp. 74-90). Routledge India.
7. Kaustubha, K. (Ed.). (2021). *Understanding World Media*. KK Publications.
8. Lakshminarayan, S. (2022). *Being Indian in the Time of Transnational Screen Media Cultures: An Urban Children's Study*. Temple University.
9. Mishra, S. (2020). From# MeToo to# MeTooIndia: News Domestication in Indian English Language Newspapers. Journalism Studies, 21(5), 659-677.
10. Munshi, S. (2020). *Prime time soap operas on Indian television*. Routledge India.

ISBN Number: 978-93-95305-78-5

11. Nag, D. (2023). Delineation of Tribes in Globalized Media: With Special Reference to Indian Cinema. *Revisiting Tribal Heritage and Contemporary Issues (volume 1)*, 165.
12. Nagamallika, G. (2021). The politics of Telugu television. In *Regional Language Television in India* (pp. 76-84). Routledge India.
13. Pejjai, N., & Tumu, S. P. The Impact of Censorship Laws on Artistic Freedom: A Study of the 'Chinthamani'Play in Telugu Theatre. *Vol. XX*, 132.
14. Rani, D. S., & Raj, R. I. (2022). A Study of English Movies Dubbed into Telugu: An Extension of Telugu Action Movies. *LITERARY ORACLE*, *6*(2), 106.
15. Rani, N. U. (2021). Growth and development of Kannada television. In *Regional Language Television in India* (pp. 150-163). Routledge India.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

ADVANCEMENTS IN CLOUD SECURITY: A STUDY ON POLICY-BASED ACCESS CONTROL AND DATA ENCRYPTION MECHANISMS

Vibharani Prasad
Research Scholar Computer Science And Application
P.K. University, Shivpuri (MP),
Rathvibh56@Gmail.Com
Dr. Rohita Yamaganti
Assoc. Professor,
Sreenidhi Institute of Science & Technology, Hyderabad (Ts)
Rohita.Yamaganti@Gmail.Com

ABSTRACT

As organizations increasingly adopt cloud computing, ensuring robust security measures has become paramount. This research presents a comprehensive case study on the implementation of Policy-Based Access Control (PBAC) and data encryption mechanisms to enhance cloud security. The study investigates the effectiveness of PBAC in restricting access to sensitive data based on user roles, demonstrating a significant reduction in unauthorized access attempts. Additionally, the research evaluates the use of Advanced Encryption Standard (AES256) for data at rest and Transport Layer Security (TLS) for data in transit, confirming the absence of data breaches during the evaluation period.Performance assessments indicate that while the integration of PBAC and encryption mechanisms introduces a minimal overhead—approximately a 7% increase in average response times—the system remains well within acceptable performance thresholds. Furthermore, the implementation of Azure Key Vault for encryption key management has proven effective, providing automated key rotation and stringent access control, ensuring that only authorized personnel have access to sensitive encryption keys.This study highlights the dual advantages of enhanced security and efficiency, underscoring the significance of continuous monitoring and auditing processes to ensure compliance and identify potential vulnerabilities. The findings reinforce the feasibility of utilizing PBAC and data encryption as integral components of a secure cloud infrastructure, advocating for a well-defined security framework in cloud environments. Through this case study, the research contributes to the growing body of knowledge on cloud security practices, offering insights into scalable and flexible implementations that align with organizational security objectives..

Keywords: ***Cloud Security, Policy-Based Access Control (PBAC), Data Encryption, AES256, TLS, Azure Key Vault***

ISBN Number: 978-93-95305-78-5

INTRODUCTION

A. Background and Motivation

In the era of digital transformation, cloud computing has emerged as a foundational technology, enabling organizations to leverage scalable computing resources, enhance operational efficiency, and drive innovation. Cloud computing offers on-demand access to a shared pool of configurable computing resources, such as networks, servers, storage, applications, and services, which can be rapidly provisioned and released with minimal management effort or service provider interaction (Mell & Grance, 2011). This paradigm shift has been instrumental in accelerating business processes, reducing costs, and fostering collaboration across different geographical locations.

Despite its numerous benefits, the widespread adoption of cloud computing has also introduced significant security challenges. As sensitive data and critical applications are migrated to cloud environments, ensuring their protection against unauthorized access, data breaches, and cyber-attacks becomes paramount. The dynamic and multi-tenant nature of cloud computing environments complicates the implementation of traditional security measures, necessitating the development of more sophisticated and adaptive security frameworks (Hashizume et al., 2013).

This research is motivated by the pressing need to enhance cloud security through innovative mechanisms that can effectively safeguard sensitive data and resources. The focus is on the implementation of policy-based access control (PBAC) and advanced data encryption mechanisms. PBAC allows organizations to define and enforce granular access policies, thereby restricting unauthorized access and mitigating potential security breaches (Hu et al., 2014). Meanwhile, data encryption mechanisms ensure the confidentiality, integrity, and availability of data, both at rest and in transit, by protecting it from unauthorized access and tampering (Goyal & Goyal, 2016).

B. Importance of Cloud Security

The importance of cloud security cannot be overstated in today's digital landscape, where data is considered one of the most valuable assets. Organizations across various sectors, including healthcare, finance, education, and government, rely heavily on cloud computing to store and process sensitive information. Consequently, any compromise in cloud security can lead to severe repercussions, such as financial losses, reputational damage, regulatory penalties, and loss of customer trust (Subashini & Kavitha, 2011).

One of the critical aspects of cloud security is ensuring that data remains confidential, meaning that it is accessible only to authorized users. Data breaches, where unauthorized entities gain access to sensitive

ISBN Number: 978-93-95305-78-5

information, pose a significant threat to this principle. For instance, high-profile data breaches involving cloud services have highlighted vulnerabilities that can be exploited by malicious actors (Chhabra & Dixit, 2013). These incidents underscore the need for robust access control mechanisms and encryption techniques to protect data from unauthorized access.

Additionally, data integrity is crucial in cloud environments. It ensures that data is accurate, consistent, and has not been altered in an unauthorized manner. Ensuring data integrity is essential for maintaining trust in cloud services and for the proper functioning of applications that rely on this data (Chen & Zhao, 2012). Encryption plays a vital role in maintaining data integrity by making it extremely difficult for unauthorized users to alter data without detection.

Furthermore, data availability, the assurance that data is accessible when needed, is another fundamental aspect of cloud security. Disruptions to data availability, whether due to cyber-attacks or service outages, can have severe operational impacts (Ardagna et al., 2015). By implementing policy-based access controls and robust encryption mechanisms, organizations can enhance the resilience of their cloud infrastructures, ensuring that data and applications remain available even in the face of security threats.

In summary, cloud security is a critical concern that requires comprehensive strategies to protect sensitive data and resources. The implementation of policy-based access control and data encryption mechanisms addresses key security challenges, enhancing the overall security posture of cloud environments. This research aims to provide valuable insights into these mechanisms, contributing to the development of more secure cloud computing infrastructures.

REFERENCES:

1. Goyal, S., & Goyal, P. (2016). Comparative study of symmetric and asymmetric cryptography techniques. International Journal of Advance Research in Computer Science and Management Studies, 4(3), 232238.
2. Mell, P., & Grance, T. (2011). The NIST definition of cloud computing.
3. Chhabra, S., & Dixit, C. (2013). Security issues in cloud computing. In 2013 International Conference on Computing Sciences (pp. 213217). IEEE.
4. Ardagna, C. A., Asal, R., Damiani, E., & Vu, Q. H. (2015). From security to assurance in the cloud: A survey. ACM Computing Surveys (CSUR), 48(1), 2.
5. Chen, D., & Zhao, H. (2012). Data security and privacy protection issues in cloud computing. In 2012 International Conference on Computer Science and Electronics Engineering (Vol. 1, pp. 647651). IEEE.
6. Subashini, S., & Kavitha, V. (2011). A survey on security issues in service delivery models of cloud computing. Journal of Network and Computer Applications, 34(1), 111.

ISBN Number: 978-93-95305-78-5

7. Hashizume, K., Rosado, D. G., FernándezMedina, E., & Fernandez, E. B. (2013). An analysis of security issues for cloud computing. Journal of Internet Services and Applications, 4(1), 5.
8. Hu, V. C., Ferraiolo, D. F., Kuhn, D. R., & Schnitzer, A. (2014). Policybased access control. In Encyclopedia of Cryptography and Security (pp. 911917). Springer.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

NEXT-GENERATION SECURITY FOR VEHICULAR SYSTEMS: A REVIEW OF CONTROLLER AREA NETWORK INTRUSION DETECTION

Vishal R. Deshmukh
Ph.D. Scholar
Department of CSE,
P. K. University, Shivpuri, MP, India.
deshmukh.vishal07@gmail.com
Prof. Dr. Indrabhan S. Borse
Ph.D. (Computer Engineering) Associate Professor,
Department of CSE,
P. K. University, Shivpuri, MP, India
indrabhan2000@gmaill.com

Abstract *– The rise of connected and autonomous vehicles has revolutionized modern transportation but has also exposed vehicular systems to unprecedented cybersecurity challenges. At the heart of these systems lies the Controller Area Network (CAN), a widely adopted protocol for in-vehicle communication that is increasingly targeted by cyberattacks. Intrusion Detection Systems (IDS) have emerged as a critical defense mechanism against CAN-based attacks, offering real-time monitoring and threat mitigation.This review examines the state-of-the-art advancements in IDS for CAN networks, providing a comprehensive analysis of traditional and next-generation methodologies. The study categorizes existing approaches, including signature- based, anomaly-based, and hybrid techniques, and evaluates their effectiveness in addressing contemporary attack vectors. Emerging technologies, such as machine learning, blockchain integration, and lightweight security protocols, are also explored for their potential to enhance IDS capabilities in resource-constrained vehicular environments. By identifying current challenges, research gaps, and future directions, this review aims to guide the development of robust and adaptive intrusion detection strategies, ensuring secure and resilient vehicular systems in the era of connected mobility. The study explores traditional rule-based approaches alongside modern techniques leveraging machine learning, anomaly detection, and lightweight cryptography. We categorize existing IDS frameworks based on their detection strategies, such as signature-based, anomaly- based, and hybrid approaches, while analyzing their suitability for resource-constrained vehicular environments.*

Keywords- Controller Area Network (CAN Controller Area Network Intrusion Detection Systems (CAN IDS) .

ISBN Number: 978-93-95305-78-5

INTRODUCTION

Introduction The rapid advancements in connected and autonomous vehicle technologies have revolutionized modern transportation systems, promising safer, more efficient, and convenient mobility. However, this connectivity also exposes vehicular systems to a range of cyber threats, posing significant risks to safety and security. Among the critical components of modern vehicles, the Controller Area Network (CAN) serves as the backbone of intra-vehicle communication, enabling seamless interaction between electronic control units (ECUs). Despite its importance, the CAN protocol was not originally designed with robust security features, making it vulnerable to cyberattacks such as spoofing, denial-of-service (DoS), and data injection. [1][2]

As the automotive industry transitions into the era of smart transportation, ensuring the security of the CAN has become a top priority. Intrusion detection systems (IDS) have emerged as a crucial defense mechanism, providing real-time monitoring and identification of malicious activities within the CAN. Over the years, researchers and practitioners have proposed various IDS techniques, ranging from traditional rule-based methods to cutting-edge machine learning algorithms. However, these solutions face challenges related to accuracy, adaptability, scalability, and resource constraints in vehicular environments. [2][3]

This review aims to provide a comprehensive examination of the current state of IDS for CAN, highlighting their methodologies, strengths, and limitations. The paper categorizes existing IDS approaches into signature-based, anomaly-based, and hybrid models, offering insights into their detection capabilities and applicability to evolving attack vectors. Furthermore, it identifies key research gaps and emerging trends, proposing directions for the development of next- generation IDS solutions that are tailored to the unique demands of vehicular systems.[4][5][6]

By consolidating existing knowledge and providing a critical analysis of contemporary approaches, this study seeks to support researchers, developers, and policymakers in enhancing the security of vehicular networks. The findings aim to contribute to the establishment of robust cybersecurity strategies, ensuring the safe deployment of intelligent transportation systems in the face of growing cyber threats.

ISBN Number: 978-93-95305-78-5

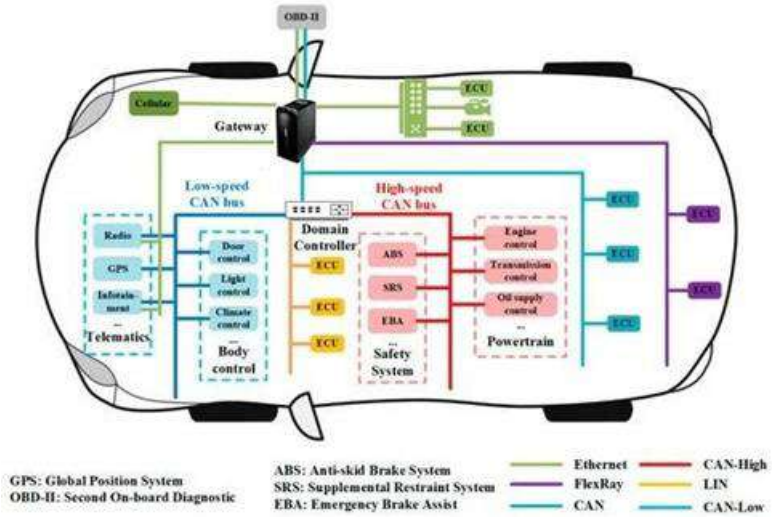

Fig. 1: Automotive Attack Surface [11]

Additionally, the review identifies critical research gaps and unresolved challenges, including issues of computational overhead, false positive rates, and adaptability to evolving attack vectors. By synthesizing current knowledge and outlining future directions, this paper aims to guide researchers, practitioners, and policymakers in their efforts to enhance vehicular network security.[11]

LITERATURE REVIEW

The increasing prevalence of cyberattacks targeting vehicular systems has driven extensive research into intrusion detection systems (IDS) for securing the Controller Area Network (CAN). This literature review examines the evolution of IDS approaches, categorizing them based on detection methodologies, technological advancements, and their applicability to vehicular environments.

1. **Signature-Based IDS**

Signature-based IDS approaches rely on predefined rules and patterns to detect known attack signatures. Research by Miller and Valasek (2013) highlighted vulnerabilities in CAN that could be exploited using predictable patterns, spurring the development of IDS to detect such attacks. While signature-based systems, such as the work by Muter et al. (2014), offer high accuracy for known threats, they lack adaptability to novel attack vectors, making them less effective in dynamic vehicular environments.[3][4

2. **Anomaly-Based IDS**

Anomaly-based systems focus on detecting deviations from normal network behavior. The work of Cho and Shin (2016) introduced a statistical anomaly detection framework for CAN traffic, leveraging timing and frequency analysis to identify irregularities. Similarly, Marchetti et al. (2017) explored entropy-based

ISBN Number: 978-93-95305-78-5

methods to detect anomalies in CAN traffic patterns. These systems are effective in identifying zero-day attacks but are prone to high false positive rates, necessitating further refinement. [5][6]

3. **Machine Learning-Based IDS**

Recent advancements in machine learning have significantly influenced IDS development. Gmiden et al. (2019) proposed a machine learning-based IDS that uses supervised learning to classify benign and malicious traffic. Other works, such as Taylor et al. (2020), explored deep learning models, including convolutional neural networks (CNNs) and recurrent neural networks (RNNs), to enhance detection accuracy and reduce false positives. However, the computational overhead associated with these methods presents challenges for deployment in resource-constrained vehicular systems. [7][8]

4. **Hybrid IDS Approaches**

Hybrid IDS solutions combine multiple detection techniques to achieve a balance between accuracy and adaptability. Kang et al. (2021) introduced a hybrid IDS that integrates anomaly-based detection with machine learning classifiers, achieving improved detection rates for sophisticated attacks. Such approaches leverage the strengths of different methodologies but often face challenges in terms of complexity and scalability. [9]

5. **Lightweight IDS for Resource-Constrained Systems**

Given the limited computational resources in vehicular ECUs, lightweight IDS solutions have gained attention. Work by Humayed and Luo (2022) proposed a lightweight cryptographic IDS framework tailored for CAN, prioritizing low latency and minimal resource utilization. These solutions address practical implementation concerns but often trade off advanced detection capabilities. [10]

6. **Trends in Emerging Technologies**

Emerging trends in IDS development include the use of blockchain for secure logging, federated learning to improve detection across distributed systems, and the integration of IDS with vehicle-to-everything (V2X) communication protocols. For example, Zhou et al. (2023) explored blockchain-enhanced IDS for CAN, enabling tamper-proof event tracking and collaborative anomaly detection across vehicles.[12]

7. **Research Gaps and Challenges**

Despite the progress, significant challenges remain in designing IDS for vehicular systems. Issues such as high false positive rates, limited scalability, and the ability to adapt to evolving attack vectors require further investigation. Additionally, balancing detection accuracy with computational efficiency remains a critical area of focus for researchers.[13]

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The paper a steady progression from traditional rule-based IDS to advanced machine learning and hybrid approaches. However, no single solution has yet achieved the ideal balance between accuracy, adaptability, and resource efficiency. This review highlights the need for continued innovation in IDS design to address the unique challenges posed by vehicular networks, ensuring robust security for the next generation of connected and autonomous vehicles. The security of Controller Area Networks (CAN) in modern vehicles has become a topic of critical importance due to the vulnerability of in- vehicle communication systems to cyber threats. Controller Area Network Intrusion Detection Systems (CAN IDS) have emerged as a crucial line of defense against potential intrusions. This literature review aims to analyze and synthesize the current state of research, methodologies, challenges, and future directions in the realm of CAN IDS.[14][15][16]

METHODOLOGY

This study employs a systematic review approach to analyze and synthesize existing research on intrusion detection systems (IDS) for securing the Controller Area Network (CAN) in vehicular systems. The methodology involves a structured process of data collection, classification, analysis, and synthesis to ensure comprehensive coverage of the topic and reliable insights into the state of the art.

1. Scope and Objectives

The primary objective of this review is to evaluate the current landscape of IDS for CAN, identify trends, challenges, and gaps, and propose future directions for research. The study focuses on:

- Categorizing IDS approaches (signature-based, anomaly-based, hybrid, etc.).
- Evaluating the effectiveness of IDS techniques in terms of accuracy, scalability, and adaptability.
- Identifying key research challenges and opportunities for innovation.

2. Literature Search and Data Collection

A systematic search was conducted using academic databases, including IEEE Xplore, ACM Digital Library, SpringerLink, and Scopus, to identify relevant studies. Keywords such as “CAN intrusion detection,” “vehicular security,” “automotive cybersecurity,” and “IDS for CAN” were used. The inclusion criteria were:

- Peer-reviewed articles published between 2010 and 2023.
- Studies focusing on IDS methodologies for CAN in vehicular systems.
- Articles providing quantitative evaluations of IDS performance.

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Exclusion criteria included articles unrelated to vehicular systems, studies without experimental evaluations, and publications in non-English languages.

3. **Classification Framework**

The collected literature was classified based on the following parameters:

- Detection Methodology: Signature-based, anomaly-based, hybrid, or machine learning.
- Evaluation Metrics: Accuracy, false positive rate, detection speed, and computational overhead.
- Implementation Context: Simulation, real- world deployment, or testbed validation.
- Technology Used: Machine learning models, cryptographic techniques, or emerging technologies such as blockchain.

4. **Data Analysis**

Each study was analyzed to extract:

- Methodology: The approach used for intrusion detection, including algorithms and frameworks.
- Performance: The reported effectiveness of the IDS in detecting intrusions under various conditions.
- Limitations: Identified challenges, such as scalability, adaptability to new attack vectors, and resource constraints.

The extracted data was systematically organized into tables and graphs to enable comparative analysis.

5. **Synthesis and Interpretation**

The findings from the literature were synthesized to provide insights into:

- The evolution of IDS for CAN from traditional rule-based approaches to advanced machine learning techniques.
- Emerging trends, such as lightweight cryptographic solutions and integration with V2X systems.
- Research gaps and the need for solutions addressing false positive rates, real-time detection, and resource efficiency.

6. **Validation of Findings**

To ensure the reliability and validity of the findings, the review was cross-verified with meta-analyses and key industry reports on vehicular security. The synthesis was structured to align with best practices in systematic reviews, including transparency and reproducibility of the methodology.

7. **Proposed Framework for Future Research**

Based on the review, a framework for advancing IDS for CAN is proposed, emphasizing:

- Incorporating federated learning to improve scalability and adaptability.
- Developing lightweight yet robust detection mechanisms for resource-constrained environments.

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- Exploring interdisciplinary approaches that integrate cryptography, machine learning, and blockchain technologies.

CONCLUSION

The Controller Area Network (CAN) is a vital communication protocol in vehicular systems, remains highly vulnerable to a variety of cyberattacks due to its lack of inherent security features. Intrusion Detection Systems (IDS) have emerged as a critical defense mechanism, enabling the detection and mitigation of malicious activities within the CAN. Its provides a comprehensive analysis of the state-of-the-art IDS approaches for CAN, categorizing them into signature- based, anomaly-based, hybrid, and machine learning- driven methodologies. While each approach offers unique advantages, challenges such as false positives, computational overhead, and limited adaptability persist, especially in resource-constrained vehicular environments. Emerging trends, including lightweight cryptographic techniques, block chain-enhanced logging, and federated learning, show promise in addressing these challenges and advancing IDS design.

REFERENCES

[1] *Vishal R. Deshmukh , Prof. Dr. Indrabhan S. Borse , "Enhancing Security in Vehicular Networks: A Study of Controller Area Network Intrusion Detection Systems", Vol. 9, No. 2, 2024, PP. 82-85, International Journal of Innovations in Engineering and Science, www.ijies.net*

[2] *Checkoway, Stephen, et al. "Comprehensive experimental analyses of automotive attack surfaces." In Proceedings of the USENIX Security Symposium, vol. 12, pp. 6-8. 2011.*

[3] *Miller, C., & Valasek, C. (2013). Adventures in automotive networks and control units. DEF CON.*

[4] *Muter, M., & Asaj, N. (2014). Entropy-based anomaly detection for in-vehicle networks. IEEE Intelligent Vehicles Symposium (IV), 1110–1115.*

[5] *Cho, K.-T., & Shin, K. G. (2016). Fingerprinting electronic control units for vehicle intrusion detection.* USENIX Security Symposium.

[6] *Marchetti, M., & Stabili, D. (2017). Anomaly detection of CAN bus messages through analysis of ID sequences.* IEEE Transactions on Intelligent Transportation Systems, *18(5), 1238–1248.*

[7] *Gmiden, M., Boudriga, N., & Bouaziz, T. (2019). A CAN bus intrusion detection architecture for connected vehicles.* IEEE Vehicular Technology Conference (VTC).

[8] *Taylor, A., Leblanc, S., & Japkowicz, N. (2020). Anomaly detection in automotive CAN bus data with deep learning.* IEEE Vehicular Networking Conference (VNC).

[9] *Kang, M., Kim, S., & Cho, J. (2021). Hybrid intrusion detection system for CAN bus security in connected*

cars. IEEE Transactions on Vehicular Technology, *70(3), 2346–2356.*

[10] *Humayed, A., & Luo, B. (2022). Lightweight cryptographic-based intrusion detection system for in-vehicle networks.* ACM Transactions on Cyber-Physical Systems.

[11] *Zhou, H., Wang, C., & Zhang, Y. (2023). Blockchain-enhanced intrusion detection for connected vehicles: A decentralized approach.* IEEE Internet of Things Journal.

[12] *Haichun Zhang, XuMeng, XiongZhangandZhenglin Liu, "CANsec: APractical in-Vehicle Controller Area Network Security Evaluation Tool", Sensors 2020, 20, 4900; doi:10.3390/s20174900 www.mdpi.com/journal/sensors*

[13] *Koscher, Karl, et al. "Experimental security analysis of a modern automobile." In Security and Privacy (SP), 2010 IEEE Symposium on, pp. 447-462. IEEE, 2010.*

[14] *Zhao, Lichao, et al. "In-vehicle network security: Vulnerabilities, challenges, and research directions." IEEE Transactions on Intelligent Transportation Systems 17.12 (2016): 3436-3452.*

[15] *Abomhara, Mohamed, and Asif Irshad Khan Køien. "Security of the internet of things: Vulnerabilities, attacks, and countermeasures." IEEE Access 5 (2017): 115-124.*

[16] *Zimba, Johannes, et al. "Anomaly detection for in-vehicle networks using machine learning." 2019 IEEE 16th Annual Consumer Communications & Networking Conference (CCNC), 2019, pp. 1-6.*

[17] *Park, Soo-Hyung, et al. "Deep learning-based intrusion detection system in in-vehicle network." Electronics 9.10 (2020): 1622.*

[18] *Rössler, Johannes, et al. "Towards an intrusion detection system for in-vehicle networks based on ECU communication behavior." 2018 9th IFIP International Conference on New Technologies, Mobility and Security (NTMS), 2018, pp. 1-5.*

[19] *Liu, Zhipeng, et al. "A survey on security aspects for vehicular ad hoc networks." IEEE Transactions on Intelligent Transportation Systems 22.1 (2021): 95-108.*

[20] *Wang, Xingyu, et al. "A hybrid intrusion detection system for in- vehicle network security." 2022 IEEE 24th International Conference on Intelligent Transportation Systems (ITSC), 2022, pp. 1-6.*

[21] *Gupta, Anjali, et al. "Federated learning-based intrusion detection for connected vehicles." IEEE Transactions on Vehicular Technology 72.4 (2023): 3565-3577.*

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

ANALYSIS OF RISK IN E-BANKING AT NATIONAL AND INTERNATIONAL LEVELS

Zehra Fatima
Research Scholar
Dept. of Commerce,
P.K. University, Shivpuri, M.P.
Dr. Aiman Fatma
Associate Professor
Dept. of Commerce,
P.K. University**,** Shivpuri, M.P.

Abstract:

E-banking has revolutionized the financial services industry by providing greater accessibility, convenience, and efficiency in conducting banking transactions. However, its rapid growth has introduced new risks, both at the national and international levels, posing challenges to financial institutions, regulators, and customers. This paper explores the various types of risks associated with e-banking, including cyber threats, data breaches, financial fraud, and system failures, which can undermine the security and reliability of online banking platforms. It also examines the regulatory frameworks in place to mitigate these risks, focusing on the differences in national regulations across various countries and the need for international collaboration to address global threats. Through a comparative analysis, this study highlights the vulnerabilities that arise from cross-border e-banking transactions, such as money laundering, identity theft, and digital currency fraud. Furthermore, the paper suggests strategies for improving risk management in e-banking, such as advanced cybersecurity measures, stricter regulatory standards, and enhanced consumer awareness. The findings underscore the importance of adopting a unified approach to e-banking risk management, emphasizing both national and international efforts to safeguard the future of digital banking.

Keywords:

E-banking risks, cybersecurity threats, operational disruptions, data breaches, identity theft, financial crime, money laundering, international banking, e-banking governance, risk mitigation strategies, disaster recovery plans, international cooperation, digital transformation in banking,

Introduction:

The rise of electronic banking (e-banking) has revolutionized the financial industry, providing consumers with convenient, accessible, and cost-effective means to perform transactions. However, as the adoption of e-banking increases globally, so do the risks associated with it. These risks span a wide range of areas,

ISBN Number: 978-93-95305-78-5

from technological vulnerabilities to regulatory challenges, and can affect both financial institutions and their customers.

At the **national level**, e-banking introduces challenges related to security, privacy, regulatory compliance, and the stability of financial systems. Governments and regulatory bodies in individual countries face the complex task of creating frameworks that protect consumers while fostering innovation. Common risks include cyberattacks, data breaches, fraud, and system failures, which can significantly damage the reputation of banks and undermine public trust in e-banking services.

On the **international level**, e-banking risks become even more intricate due to the interconnectedness of global financial markets, cross-border regulations, and the diversity of legal and regulatory frameworks. Issues such as money laundering, cross-border fraud, and discrepancies in data protection laws pose significant challenges for international financial institutions. Moreover, as cybercriminals operate on a global scale, banks must contend with ever-evolving threats that transcend national boundaries.

This analysis explores the key risks inherent in e-banking both at the national and international levels, identifying the critical areas of concern for financial institutions, regulators, and consumers. Furthermore, it discusses potential strategies to mitigate these risks, ensuring the continued growth and trust in e-banking services worldwide.

Review of Literature:

Susan M.H.M. and S.A. Finn (2018) discuss key principles for managing cyber risks in financial institutions. Their work highlights the dynamic nature of cyber threats and the necessity for real-time monitoring and response mechanisms.

Christopher L. Culp (2010) explores the operational risks faced by financial institutions, particularly in the context of system failures, human errors, and inadequate infrastructure. His work underscores the need for rigorous operational risk management frameworks.

FATF Guidelines stress the importance of combating money laundering and terrorism financing in the context of e-banking. The focus on compliance with anti-money laundering (AML) and know-your-customer (KYC) regulations is critical for mitigating these risks.

IMF (2017) reports on global trends in e-banking, emphasizing challenges such as currency exchange risks, cross-border fraud, and discrepancies in data privacy laws.

McKinsey & Company (2013) provide insights into reputational risks associated with e-banking, particularly in cases of fraud, data breaches, or system failures. The report suggests proactive communication and transparency to rebuild customer trust.

ISBN Number: 978-93-95305-78-5

David G. Mayes (2008) discusses frameworks for e-banking regulation and supervision, offering practical strategies for mitigating operational and compliance risks.

Types of risks in E-banking:

E-banking, or electronic banking, involves the use of digital platforms and technologies to conduct financial transactions. While it offers numerous advantages, such as convenience and accessibility, it also introduces various risks. Below are the main types of risks in e-banking:

1. Security Risks

- **Cybersecurity Threats**: These include hacking, malware, phishing, and other attacks that target e-banking systems to steal sensitive data or financial resources.
- **Data Breaches**: The unauthorized access or exposure of personal, financial, or account information.
- **Identity Theft**: Fraudsters can impersonate legitimate customers to gain access to their banking accounts.
- **Phishing and Social Engineering**: Fraudsters trick customers into revealing personal details like login credentials or banking information via deceptive emails or phone calls.

2. Operational Risks

- **System Failures**: Technical issues such as server outages, software bugs, or hardware malfunctions can disrupt e-banking services, causing financial losses or service downtime.
- **Inadequate Infrastructure**: Poorly designed systems or lack of maintenance can result in inefficiencies and service disruptions.
- **Human Error**: Mistakes made by staff during software configuration, transaction processing, or data entry can lead to financial losses or other issues.

3. Fraud Risks

- **Account Takeover**: Cybercriminals using stolen credentials to access accounts and transfer funds without the owner's consent.
- **Money Laundering**: Criminals using e-banking systems to launder money by moving illicit funds through accounts or conducting complex transactions.
- **Transaction Fraud**: Fake transactions that appear legitimate but are designed to steal money or misappropriate funds.

4. Compliance and Legal Risks

- **Regulatory Non-compliance**: E-banking platforms must adhere to local and international regulations, such as data protection laws, anti-money laundering (AML), and know-your-customer (KYC) requirements.

ISBN Number: 978-93-95305-78-5

- **Data Privacy Issues**: Failure to safeguard personal and financial data could result in breaches of privacy laws, leading to fines and loss of customer trust.
- **Legal Disputes**: Conflicts arising from issues such as fraud, improper transactions, or breaches of terms and conditions.

5. Financial Risks

- **Market Risk**: Exposure to fluctuating financial markets that can impact e-banking operations, such as changes in interest rates, currency exchange rates, or stock prices.
- **Credit Risk**: The risk that a borrower may default on a loan, which can affect the bank's e-lending or e-financing operations.
- **Liquidity Risk**: E-banking systems can face difficulties in ensuring sufficient cash flow, especially during peak demand or market shocks.

6. Reputation Risks

- **Customer Trust Erosion**: If e-banking services suffer from security breaches, fraud, or operational failures, it can result in a loss of customer confidence and harm the bank's reputation.
- **Negative Public Perception**: Scandals, fraud, or delays in service can create negative press and lead to customers switching to competitors.

7. Technological Risks

- **Obsolescence of Technology**: Rapid technological advancements can lead to outdated systems that are more vulnerable to security breaches or inefficiencies.
- **Integration Risks**: When e-banking systems integrate with third-party services or legacy systems, compatibility issues or security vulnerabilities can arise.

8. Strategic Risks

- **Business Model Risk**: As customer preferences and technology change, e-banking providers may face risks if their business models become obsolete or fail to adapt.
- **Competitive Pressure**: The constant emergence of new players in the digital banking space can put pressure on traditional banks to innovate and meet consumer expectations.

9. Environmental Risks

- **Natural Disasters**: Physical infrastructure like data centers may be vulnerable to natural disasters (earthquakes, floods, etc.), potentially disrupting e-banking operations.
- **Power Failures**: A loss of power in critical systems or data centers can cause interruptions in service or loss of data.

ISBN Number: 978-93-95305-78-5

Risk in E-banking at national and international level

E-banking, while offering convenience and efficiency, introduces various risks at both national and international levels. Here's an analysis:

Risks at National Level:

- **Operational Risks:** These arise from internal deficiencies in systems, processes, or human error. Examples include:
  - **System failures:** Disruptions in the bank's IT infrastructure can prevent customers from accessing services.
  - **Fraudulent activities:** Employees or external parties may exploit vulnerabilities to misappropriate funds.
  - **Data breaches:** Sensitive customer information can be compromised due to cyberattacks or inadequate security measures.
- **Security Risks:** These involve threats to the confidentiality, integrity, and availability of data. Examples include:
  - **Phishing and malware attacks:** Customers may fall victim to scams that steal their login credentials.
  - **Hacking and denial-of-service attacks:** Cybercriminals may target bank systems to disrupt operations or steal data.
- **Legal and Regulatory Risks:** These relate to non-compliance with laws and regulations governing e-banking activities. Examples include:
  - **Data privacy violations:** Banks may fail to adequately protect customer data, leading to legal action.
  - **Money laundering and terrorist financing:** E-banking channels may be exploited for illicit activities.

Risks at International Level:

- **Cross-border Risks:** These arise from the complexities of operating across different legal and regulatory jurisdictions. Examples include:
  - **Varying legal frameworks:** Banks must comply with different laws and regulations in each country they operate in.
  - **Enforcement challenges:** It can be difficult to pursue legal action against cybercriminals operating in other countries.
- **Currency and Exchange Rate Risks:** These relate to fluctuations in exchange rates that can affect the value of transactions.
- **Political and Economic Risks:** These involve instability in foreign countries that can disrupt e-banking operations.

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Comparison of Types of Risks in E-Banking at National and International levels:

1. Operational Risk

Operational risks arise from failures in internal processes, systems, or external events.

- **National Level:** These risks often stem from insufficient IT infrastructure, human errors, or service outages. For example, a system failure in a domestic bank can disrupt services for customers, impacting their trust.
- **International Level:** Cross-border operations face challenges like time zone differences, integration of systems, and lack of standardized procedures. Disruptions in international transactions can severely impact global trade and commerce.

2. Security Risk

Cybersecurity remains a critical concern in e-banking.

- **National Level:** Cyberattacks like phishing, malware, and Distributed Denial of Service (DDoS) can target local banks and customers, leading to financial losses and data breaches.
- **International Level:** Global financial institutions face sophisticated threats such as Advanced Persistent Threats (APTs) and cross-border money laundering schemes. The interconnectedness of global banking systems amplifies the impact of these threats.

3. Compliance and Regulatory Risk

E-banking must adhere to national and international regulations to maintain legal and operational integrity.

- **National Level:** Banks face challenges in complying with data protection laws, consumer rights, and anti-money laundering (AML) regulations specific to their country.
- **International Level:** Varying regulatory frameworks across countries make compliance complex. Financial institutions must navigate conflicting regulations, such as those related to GDPR in Europe and similar laws in other jurisdictions.

4. Reputational Risk

A single incident can significantly damage a bank's reputation.

- **National Level:** Negative publicity from data breaches or service disruptions can erode trust in local banks, leading to customer attrition.
- **International Level:** Global banks risk losing customer confidence worldwide, potentially impacting their market position and valuation.

Mitigation Strategies

ISBN Number: 978-93-95305-78-5

Mitigating these risks requires strong cybersecurity measures, proper regulatory adherence, effective operational management, and continuous monitoring of evolving threats in the digital landscape.

1. Strengthening Cybersecurity: Banks must invest in robust cybersecurity measures, including firewalls, encryption, and intrusion detection systems. Regular audits and penetration testing can help identify and address vulnerabilities.

2. Regulatory Compliance and Training: Financial institutions must stay updated with evolving regulations and provide training to employees on compliance requirements. Collaboration with regulatory bodies ensures smoother adaptation to new laws.

3. Disaster Recovery and Business Continuity Planning: Developing and testing disaster recovery plans can minimize the impact of operational failures. Banks should also have business continuity plans to ensure service availability during crises.

4. International Collaboration: Banks should collaborate with international organizations such as the Financial Action Task Force (FATF) to address global risks. Sharing intelligence on cyber threats and adopting standardized protocols can enhance security and efficiency.

- **Strong authentication:** Using multi-factor authentication to verify customer identities.
- **Encryption:** Protecting data in transit and at rest using encryption technologies.
- **Intrusion detection and prevention systems:** Monitoring systems for suspicious activity and blocking potential attacks.
- **Regular security audits and vulnerability assessments:** Identifying and addressing potential weaknesses in systems.
- **Employee training and awareness programs:** Educating employees about security best practices.
- **Compliance with relevant laws and regulations:** Adhering to data privacy and security standards.

International Cooperation:

Addressing international e-banking risks requires cooperation between countries to:

- **Harmonize legal and regulatory frameworks:** Establishing common standards for e-banking security and data privacy.
- **Share information on cyber threats:** Collaborating to identify and track cybercriminals.
- **Enhance law enforcement cooperation:** Working together to investigate and prosecute cybercrime.

By taking these steps, banks and governments can help to ensure the safety and security of e-banking at both national and international levels.

ISBN Number: 978-93-95305-78-5

Conclusion

E-banking has transformed the global financial landscape but comes with significant risks that require a multi-faceted approach to mitigate. By understanding these risks through the above references, banks and regulators can develop stronger frameworks to safeguard e-banking's integrity. By addressing operational, security, compliance, and reputational risks, financial institutions can build a more secure and resilient e-banking ecosystem. Collaboration among stakeholders, including governments, regulators, and financial institutions, is essential to tackle risks at both national and international levels effectively.

References:

- Basel Committee on Banking Supervision (BCBS) reports on e-banking risk management.
- Financial Action Task Force (FATF) guidelines on combating money laundering in e-banking.
- Case studies of cybersecurity breaches in e-banking (e.g., 2020 SolarWinds cyberattack).
- "Operational Risk Management in Financial Institutions" by Christopher L. Culp (2010).
- "Cybersecurity and Cyberrisk Management: Key Principles for the Financial Services Industry" by Susan M. H. M. and S. A. Finn (2018).
- “E-Banking and Cybersecurity” by Peter W. Clarke (2007).
- “Regulation of E-Banking and Payment Systems in the European Union: A Comparative Approach” by Oren Bar-Gill (2007).
- “Electronic Banking: A Guide to E-Banking Regulation and Supervision” by David G. Mayes (2008).
- "Financial Stability and E-Banking: A Global Perspective" by McKinsey & Company (2013).
- "The Legal Aspects of E-Banking" by M. A. Clarke and R. H. McLean (2010).
- “Legal Risks in Electronic Banking” by K. G. O’Doherty (2009).
- "Strategic Risk Management in Banks: A Global Perspective" by R. V. Ramnath and A. N. Jha (2012).
- "Global Trends in E-Banking and Online Payments: Challenges and Opportunities" by the International Monetary Fund (IMF, 2017).
- "Risk Management in Online Banking: Lessons from Asia and Europe" (2016) by the Asian Development Bank.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

Clinical application Protease from *Acinetobacteria* Species

Salunke.S M, Dr. Jadhav B. N, Dr. Satpute. R. A.

Department of Biotechnology, Vinayakrao Patil Mahavidyalaya, Art's Commerce and Science College Vaijapur. Chhatrapati Sambhajinagar-423701, Maharashtra, India.
Department of Zoology, Vinayakrao Patil Mahavidyalaya, Art's Commerce and Science College Vaijapur. Chhatrapati Sambhajinagar-423701, Maharashtra, India.
Government Institute of Science, Department of Botany Chhatrapati Sambhajinagar-423701, Maharashtra, India.
Corresponding Email ID:- sweetysalunke25@gmail.com.

Abstract:- Extracellular protease from *Acinetobacteria* species isolated from fish gut. The protease was produced and purified by ammonium persulphate, dialysis, Sephadex G column chromatography and Ion Exchange Chromatography and HPLC. Characterization was done by using BAPNA substrate and MALDI-TOF. Purified protease was studied for anti-inflammatory and anti-cancerous activity. The 50 percent inhibitory concentration was as followed for IL-6 0.348 mg/ml and LNCAP cell line 30.11µg/ml.

Keywords:- Protease, *Acinetobacteria* species, anti-inflammatory and anti-cancerous activity.

Introduction:- Protease are the important class of enzymes can be extracted by microbial source for large scale production. *Acinetobacteria* species are gram negative bacteria belong to class gammaproteobacteria and family Moraxellaceae [2]. It has ability to produce extracellular protease like serine protease S1A trypsin [5]. The extracellular protease can be easily recovered by downstream process during batch fermentation [8]. The trypsin plays important in inflammation and cancerous activity. It makes the macrophages and monocytes active and move at the site of infection [10,11]. Trypsin role in gelatin degradation at the time of fertilization, it helps the sperm to swim [3]. It has diverse role in different industry like dehairing of hair in leather industry, destaining in detergent, eye lenes cleaning, silver recovery from X-ray film [1,4,6,7,9].

In the present study the extracellular protease was purified and studied for clinical application against IL-6 by ELISA and LNCAP cell line of prostate gland by MTT assay.

Material and Methods:-

Pure culture of *Acinetobacteria* bacteria

Inoculum Preparation

A loopful suspension *Acinetobacteria* bacteria was inoculated in 20ml Nutrient broth.

ISBN Number: 978-93-95305-78-5

Production Media

The Batch culture media was prepared by adding in 250 ml of Yeast extract 3gm, Maltose 3gm, $MgSO_4$ 0.5, K_2HPO_4, 0.5, $CaCl_2$, 0.2, KCl 0.2, $NaCO_3$ 0.5% was autoclave at 121ºC for 15-20min. After media cool down was transferred to laminar air flow and 5ml overnight grown culture was inoculated.

Enzyme purification

Precipitation by 40-60% w/w Ammonium persulphate, dialysis membrane preparation by 2% sodium bicarbonate and EDTA and boil for 15-20 min, pack the one end of dialysis with thread add precipitated protease then again seal the other end, suspend the dialysis bag in the Tris buffer HCl 20mM overnight, Tris Buffer gel Chromatography glass column chromatography 2×50ml, stationary phase Sephadex-G 25 mobile phase 25mM Tris Tris buffer. Ion exchange Chromatography anion exchanger Resin DEAE cellulose and elution buffer 0.1- 1.0mM. HPLC, Characterization by BAPNA substrate and MALDI-TOF. The anti-inflammatory and anti-cancerous activity was performed by Progenome Life Science.

Protein content was estimated by Lowry *et al* method using bovine serum albumin (BSA) as the standard at 660nm.

Protease activity by Anson method, the activity was measured against the release of tyrosineµg/min at 660nm using 0.5% of casein as substrate in 50mM glycine NaOH of pH 9. The reaction was terminated by adding 10% of TCA trichloroacetic acid of 0.5 ml.

Trypsin activity amidase activity was measured by using BAPNA (Na-benzoyl-DL-arginine-p-nitroanilide hydrochloride) as substrate. BAPNA was prepared by adding 43.5 mg of BAPNA in 1 ml DMSO solution and adjusting volume 50mM Tris-HCl containing 10mM $CaCl_2$ pH-8. The 0.5ml protease was used by adding 0.5 ml of BAPNA substrate incubate for 20 min. Then followed by reading at 410nm. The one unit of enzymes release 1µmol of nitroaniline from BAPNA/ml/min.

Results:-

The overnight grown culture 5ml was inoculated in 250ml of production media and incubated in orbital shaker at 120-150rpm at 30-40ºC. After 24 -48 hours the extracellular protease by collecting filtrated the filtrate was used as crude protease the protein and protease activity was measured by Lowry's and Anson method. Purification starts from subjecting the filtrate to generate cell free medium by centrifugation at 5000 rpm at 5ºC and the supernatant was collected. The collected samples were further for precipitation by salt ammonium per sulphate, then molecular size separation by gel filtration and depending upon charge Ion-Exchange chromatography, after each step protein and protease activity was measured, HPLC shows two peak of trypsin as compared with standard trypsin and then SDS- PAGE to determine molecular

ISBN Number: 978-93-95305-78-5

weight was in between 23-25 KD Characterization was done by using BAPNA trypsin activity was 10U. HPLC collected fraction used for MALDI-TOF it shows 51% percentage score of matching HPLC fraction was further used to check the anti-inflammatory and anti- cancerous activity. The clinical application of purified protease anti-inflammatory activity against IL-6 was 0.348mg/ml and anti-cancerous activity against LNCAP prostate gland cell line was 30.11µg/ml.

Table No:1 Protease Activity Assay By *Acinetobacteria*

Sr.No	Purification steps	Total Protein in mg/ml	Total Protease U/ml	Specific Activity U/mg
1	Crude Enzyme	58	170	2.9
2	Ammonium Per Sulphate	20	98	4.9
3	Dialysis	12	75	6.2
4	Sephadex G-25	8	54	6.7
5	Ion Exchange Chromatography	2	17	8.5

Fig No:1 Acinetobacter bacteria on Skim Milk Agar

ISBN Number: 978-93-95305-78-5

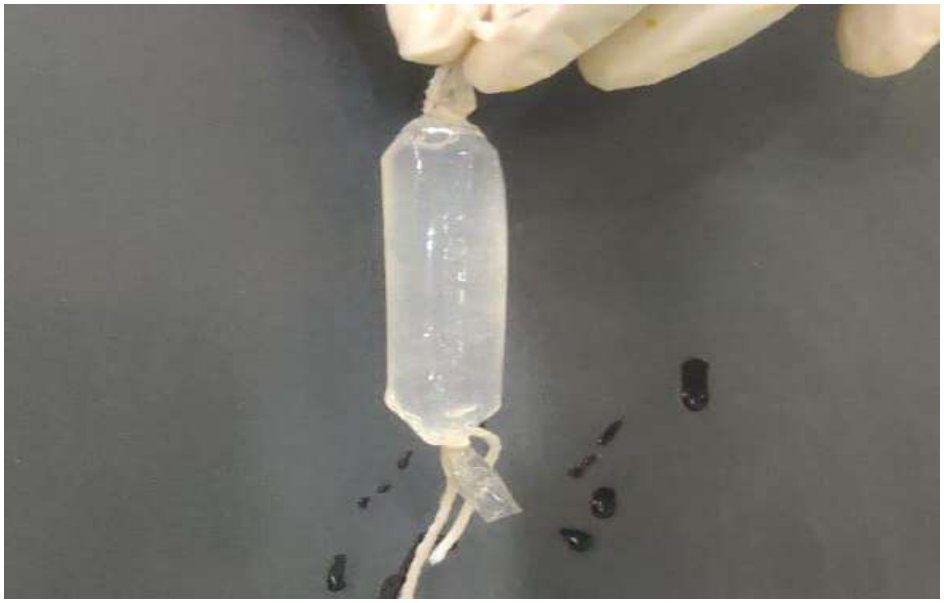

Fig No: 2 Dialysis of Protease.

Fig No 3: Sephadex Gel Column Chromatography.

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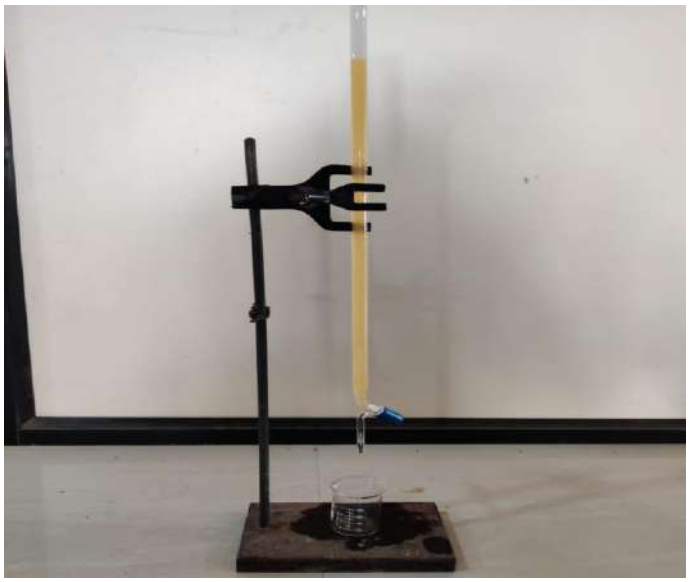

Fig No:4 Ion exchange Chromatography.

Acknowledgement:-

Author is thankful to Dr. Pardeshi A.B Professor and Head of Department of Zoology of Deogiri College Chhatrapati Sambhajinagar, Maharashtra for giving his guidance.

References:-

1. A.M Wolff, M.S. Showell, M.G Venegas, B.L. Barnett, and W.C. Wertz, "Laundudry performance of subtilisin proteases," in *Substilisin Enzymes: Practical Protein Engineering*, R.Bolt and C. Betzel, Eds., pp. 113-120, Plenum Press, New York, NY, USA, 1993.
2. Aoife Howard, Michael O Donoghue, Audrey and Roy. Sleator, "*Acinetobacter baumannii* An emerging opportunistic pathogen"Virulence3:3, 243-250, 2012.
3. Chiemi Miura, Takashi Ohta, Yuichi Ozaki, Hideki Tanaka and Takeshi Miura, Trypsin is a multifunctional factor in spermatogenesis, www.pnas.org/cgi/doi/10.1073/pnas.090761106, 2009.
4. H.Outtrup, C. Dambmann, M.D. Christiansen, and A. Aaslyng, "Bacillus sp. JP 395, method of making and detergent composition," US patent no5461366, 1988.
5. J. Singh, N. Batra, and R.C. Sobti, "Serine alkaline protease from a newly isolated *Bacillus sp.* SSR1," Process Biochemistry vol.36, no. 8-9 pp.781-785,2001.

ISBN Number: 978-93-95305-78-5

6. Kumaran E, Mahalakshmipriya A, Rajan S, “Effect of fish waste based Bacillus protease in silver recovery from waste X-ray films.” Int J Curr Microb App Sci 2(3): 49-56, 2013.
7. N. Fujiwara, K. Yamamoto, and A. Masui, “ Utilization of a thermostable alkaline protease from an alkalophilic thermophile for the recovery of silver from used X-ray Film,” Journal of Fermentation and Bioengineering, vol.72,no.4 pp.306-308,1991
8. Ramakrishna DPN, Reddy GN, Rajagopal SV, “Purification and properties of an extracellular Alkaline produced by Bacillus Subtilis (MTTC NO-10110)”. Int J Biochem Biotechnol 6(4): 493-504, 2010.
9. S.J. Ainsworth, “Soaps and Detergents,” Chemical and Engineering News, vol.72, no.4,pp. 34-59, 1994.
10. Tawari, M., “The role of Serratiopeptidase in the resolution of inflammation”, Asian Journal of Pharmaceutical Sciences 12. 209-215, 2017.
11. Wang, X., Yu, H., Xing, R. and Pengcheng Li., “Characterization, Preparation and Purification of Marine Bioactive Peptides”, BioMed Research International Vol-2, Article ID 9746720, 16 pages, 2017.

Synergy 2025: A Multidisciplinary Forum for Collaborative Research and Innovation
January 2025
ISBN Number: 978-93-95305-78-5

FEMINIST CONSCIOUSNESS IN THE WORKS OF SUDHA MURTHY: A LITERARY AND SOCIO-CULTURAL ANALYSIS

Ms. Sarika Sanjay Mohite
Research Scholar
English Literature
University of Technology, Jaipur

Abstract

This research critically analyzes the feminist consciousness in the works of celebrated Indian writer and social activist Sudha Murthy. Murthy's fiction, which addresses intersectionality, economic independence, gender equality, and challenging patriarchal conventions, is a significant work of feminist scholarship in contemporary India. Borrowing from feminist theory in the guise of Chandra Talpade Mohanty's critique of Western feminism, Judith Butler's gender performativity, and Simone de Beauvoir's "the Other," this work analyzes how Murthy's work challenges patriarchal gender norms and foregrounds women's agency against oppression. An examination of Murthy's major work, Dollar Bahu, Mahashweta, and The Day I Stopped Drinking Milk, illustrates the way she attributes human qualities to women's autonomy, self-sufficiency, and power under patriarchal setups. Murthy's interdisciplinarity in her gender, class, and caste analysis, which gives a profound knowledge of the multifaceted reality of women, further consolidates her feminist authorship. The research also considers the eco-feminist side of Murthy's work and how she marries gender and ecological concerns in her representation of women as ecostewards. Besides the work, Murthy's work as a philanthropist with the Infosys Foundation, driving economic empowerment, health, and girls' education among women, consolidates further her advocacy of gender equality. This discussion concludes with the recognition of Sudha Murthy as a social and literary visionary whose writing has remained inspiring and empowering for women and makes her a significant voice within India's feminist movement.

Keywords: *Sudha Murthy, Feminist Consciousness, Gender Equality, Economic Independence, Eco-Feminism.*

1. INTRODUCTION

Feminist literature has long advanced gender correspondence and challenged patriarchy. Over the globe, ladies’ scholars talked out on marginalized issues. Through their writings, they made a discourse almost the women's organization, resistance, and personality and challenged conventional sexual orientation parts

ISBN Number: 978-93-95305-78-5

of men and ladies whereas toppling them. In women's activist composing, harsh structures are called into address and a world where ladies are specialists and pioneers is envisioned. This scholarly development has influenced women's activist beliefs around the world, changed lives, and challenged sex generalizations all through history. In Indian writing, women's activist journalists have tended to things of financial reliance, residential drudgery, sex segregation, and social imbalance. These works venture the particular issues Indian ladies experience, being formed by societal standards, social standards, and auxiliary abberations. Effective writer, donor, and social dissident Sudha Murthy has made an incredible effect on feminist.

Women's versatility in complex sociocultural settings is portrayed over Murthy's work. Her exposition is basic, but the subjects are profound, uncovering the complexities of control that saturate women's presence within the residential circle and in society. Murthy's female characters reflect women's independence, resistance to patriarchal standards, and nuanced sexual orientation parts. Her ladies are the normal Indian lady of nowadays, who battle between their needs and societal desires. By displaying these irregularities, Murthy's words weaken conventional developments of womanliness and make strengthening both real and typical. Instead of staying on women's subordination, she celebrates their perseverance, quality, and capacity to self-define. Her work challenges gender roles and captures a picture of the day when ladies will be at freedom to function as operators and in their places in society.

1.1. Objectives of the Study

- To analyze feminist themes of agency, autonomy, and resistance in Sudha Murthy’s works.
- To explore the intersectionality of gender, class, and caste in her narratives.
- To examine the connection between Murthy’s literary themes and her real-world feminist activism.

2. LITERATURE REVIEW

Rameshwar, B. D. (2022) analyzed Murthy's books, articles, and brief stories to get it her women's activist viewpoint on sexual orientation, personality, and strengthening. Murthy reliably highlighted female heroes who hooked with society and sex standards. Amid their ventures, Murthy stood up to women's flexibility, sexual orientation imbalance, and patriarchy. In show disdain toward of these challenges, Murthy's heroes were clever, imaginative, and decided to claim their independence. Murthy's work shed light on how caste, lesson, religion, and sexual orientation met to build the lives of Indian ladies. By voicing marginalized

ISBN Number: 978-93-95305-78-5

ladies and disturbing prevailing talks, Murthy's work pushed women's liberation and social change forward. Sudha Murthy was lauded in this audit for her commitment to sexual orientation balance and women's strengthening in Indian women's activist composing, as well as her touchy representation of women's life. Murthy's fabulous composition and relatable characters shed light on sexual orientation relations in today's India.

Zankar, R. D. (2023) analyzed the sociocultural concerns postured by well-known Indian essayist Sudha Murthy's works, more so her fiction, like "Dollar Bahu" and "Astute and Something else." Indian writing put parcel of center on the sociocultural concerns since they advertised a see into the nation's social and social hones. The different complexity of Indian society was displayed in Sudha Murthy's composing, which managed with issues like caste-based separation, sex imbalance, communal agreement, societal bad form, and women's strengthening. In addition, Sudha Murthy's writing touched upon sex imbalance, the office of ladies in Indian society, and women's strengthening. This theoretical highlighted Sudha Murthy's part in shedding light and rousing discourse on the complex viewpoints of Indian culture, personality, and social life through the examination of distinctive socio-cultural issues in her work.

Supriya and Jayakanth (2024) investigated the psychological consequences of viciousness within The Mother I Never Knew and Dollar Bahu by Sudha Murty. Through investigating how viciousness got to be genuine and settled injury inside Murty's characters, the consider investigated how sex, control, and culture molded person and collective characters. Murty's fiction delineated the enduring caused by residential disloyalty, social disengagement, passionate disregard, and physical mishandle. This inquire about outlined Murty's characters' strength and strengthening in reaction to harsh social teach. Literary theory, sociology, and psychology accounted for the impact of Murty's violence on the self and position in society of characters and how Murty's writing reinforced patriarchal relations. Murty's fiction illustrated how marginalized individuals and women challenged traditional norms through portrayals of the psychosocial implications of violence. This research advanced the trauma, gender, and literature discussion by demonstrating how literary analysis shed light on the otherwise marginalized emotional and psychological tolls of violence.

Abraham, A. A., & Prabhak, A. A. (2021) dwelt upon how traditional Indian marriage roles created inner challenges. Sudha Murthy was among India's leading English-language women writers, writing on women's challenges in globalization and traditional Indian society. Sudha Murthy's House Cards was a multifaceted novel on women's challenges. The novel examined several concepts that struggled to work

ISBN Number: 978-93-95305-78-5

in traditional Indian society and troubled contemporary Indian women. Women had long endured in silence under patriarchy. Gradually, they claimed their rights and preserved their dignity on the dating scene. This story proved that new women could preserve their peace, high-quality home atmosphere without losing their self-dignity. Her female protagonists illustrated how Indian society construed women's sentiments and attitudes. These women were real people who appreciated their relationships with their environment, society, men, children, homes, mental health, and themselves. They were real women who inspired us through their connection with their environment, society, men, children, homes, minds, and selves.

3. SUDHA MURTHY: A LITERARY AND SOCIAL VISIONARY

Sudha Murthy's writing life is intricately connected to her social activism, and thus, she is an exceptional voice among modern Indian writing. She is the chairperson of Infosys Foundation, which has engaged considerably in the area of women empowerment, education, and healthcare and has emphasized uplifting marginalized communities. Her concern for social well-being is not only in her philanthropic deeds; it shines brightly through the pages of her literature; whose narratives focus upon the true difficulties of women and the issues surrounding societal norms vs. individual hopes. Murthy's own works are recognized to be uncomplicated yet profoundly evocative and are thereby a broad-reading public. In her narratives, she delineates a practical picture of Indian society, where ladies are likely to confront dug in patriarchal frameworks but too learn how to form their character and autonomy.

Figure 1: Sudha Murthy

Themes of monetary freedom, neighborhood abuse, and survival are fundamental to Murthy's compositions, such as Dollar Bahu, Mahashweta, and The Day I Stopped Drinking Milk, which portray the life of ladies with unpretentious undercurrents. For case, the hero Anupama in Mahashweta is left by

ISBN Number: 978-93-95305-78-5

her spouse after she is analyzed with leukoderma. She overcomes the societal unthinkable of the malady and overhauls her life on her possess terms instead of being pushed towards franticness. Dollar Bahu focuses to the truth that financial thriving requires not essentially infer sexual orientation uniformity through a comparison between the situation of ladies in India and somewhere else. Vinuta, the central hero, is segregated against in spite of her unwavering commitment to her family, symbolizing the imbued biases that take priority over morals in favor of fabric well-being. Likewise, The Day I Stopped Drinking Milk recounts the histories of women who opt for autonomy and self-respect over social and economic disadvantage.

Murthy disproves the female stereotype of passive victimhood through her depiction of female protagonists who are strong and independent individuals. Her characters are less likely to be agents of suffering, rather more resilient, stronger, and capable of violating social norms. Murthy not only challenges patriarchal values but also inspires the reader by telling the stories of ordinary women embarking on magnificent journeys of discovery. Her works add much to feminist theory by reminding us that self-reliance and the power to direct one's own destiny, not the approval of others, are the ultimate sources of empowerment.

4. FEMINIST CONSCIOUSNESS: THEORETICAL FRAMEWORK

The term "feminist consciousness" can be defined as the perception of the gender inequality and the common struggle to destroy patriarchal systems in literature, activism, and argumentation. History, politics, and cultural demands all affect the construction of feminist consciousness, which is not the same everywhere. By giving women a voice in words, resisting gender norms, and introducing probable other futures for women's autonomous lives, literature has actively developed feminist sensibility.

Key Feminist Theories and Their Relevance

The foundation for gender representation in literature research has been established by various feminist scholars. The feminist consciousness in Sudha Murthy's work is analyzed critically in this research based on their work.

- **Simone de Beauvoir's work published in 1949**, The Second Sex, challenges the classical status of women as "the Other" in patriarchal societies. Her assertion that "one is not born, but rather becomes, a woman" illustrates how gender is constructed socially, which is relevant to Murthy's presentation of rebellious women.

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- **Judith Butler: Gender Issues (1990)** Gender, as per Butler's theory of performativity, is a socially constructed performance. This helps readers comprehend how Murthy's female protagonists reconstruct themselves by negotiating and subverting gendered roles.
- Western feminism is faulted by **Chandra Talpade Mohanty (1988)** for universalizing women across borders. Mohanty's intersectionality, which believes that women of various backgrounds are oppressed due to their caste, class, and money, aligns with Murthy's work. To understand Murthy's works in the sociocultural Indian context, Indian feminist theory is crucial. The encounters of Indian ladies with settlements, household savagery, instruction, and monetary independence have all been investigated by Kumkum Sangari and Uma Chakravarti. Murthy includes to this talk by investigating these concerns in straightforward, locks in fiction.

Sudha Murthy and Third-Wave Feminism

The principles of Third-Wave Feminism, which came to conspicuousness within the 1990s and prioritize social equity, differing qualities, and intersectionality, are seen in Murthy's works. Third-wave women's liberation recognizes the differing qualities of women's lives and deconstructs the solid understanding of woman's rights, not at all like prior women's activist developments centered on political and legitimate rights.

Figure 2: Third-Wave Feminism

Murthy's fiction encapsulates this intersectional creative ability through the portrayal of ladies of diverse foundations and their battles being verbalized in a way that rises above victimhood. Her stories are not fundamentally approximately progressive resistance; or maybe, they highlight unpretentious acts of resistance and resilience—women working out organization within the terms of family, custom, and society. For illustration, in Dollar Bahu, female hero Savitri hooks with Indian and Western social

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financial disparities and gendered chains of command, foregrounding how budgetary freedom impacts the organization of ladies. Additionally, Mahashweta addresses the stigmatization of impaired ladies within the story of Chandri, who stands up to social preferences and rethinks herself on her possess terms. These stories illustrate how Murthy's women's activist awareness is in line with third-wave feminism's accentuation on office, choice, and person strengthening.

Feminist Themes in Murthy's Fiction

A few of the major subjects which repeat in Murthy's fiction are adjusted with women's activist plans:

- **Women's Financial Office and Freedom:** The majority of her works emphasize the significance of financial freedom as strengthening. Women in her works generally seek education and financial independence as a way of re-establishing their agency.
- **Marriage and Patriarchy:** Murthy troubles the traditional marriage institution by tracing how it generally reinforces gender oppressions. Her narratives explore ways in which women negotiate household responsibilities and, on occasion, reverse coercive marriage orders.
- **Intersectionality of Gender, Class, and Caste:** Murthy's tales express the multi-dimensionality of oppression, recognizing that the experiences of women are determined not only by gender but also class and caste.
- **Redefining Female Identity and Motherhood:** The representation of mothers within her works refutes the idealized sacrificial mother, and her portrayal of maternal figures is more complex.
- **Subversion of Social Norms:** Murthy's female protagonists often subvert social norms by taking unconventional routes, be it career, relationships, or beliefs.

Beyond Fiction: Murthy's Feminist Activism

Murthy's feminist work goes beyond literature. She advocates for girls' education, economic empowerment, and healthcare through her philanthropy. Her narratives and non-fiction confirm her backing for sexual orientation uniformity. Her work with the Infosys Establishment has given grants to underprivileged young ladies, professional preparing to ladies, and rustic healthcare upgrades. These exercises certify Murthy's confidence in orderly and long-term societal alter. This ponder illustrates how Murthy's activism improves her scholarly work, actualizing her women's activist vision in writing and life through her compositions, addresses, and charitable exercises. Sudha Murthy may be a social and scholarly visionary who motivates and engages eras of ladies through her consistent integration of composing and social activism.

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5. FEMINIST THEMES IN SUDHA MURTHY'S FICTION

1) Women's Agency and Autonomy

Female organization is one of the most topics in Murthy's works. Anupama, the courageous woman of Mahashweta, opposes the ailment on her skin by fashioning her claim one of a kind way and battling against society's partiality toward ladies with incapacities. Comparable to this, Vinuta in Dollar Bahu speaks to implicit quality through familial dominance. Murthy's depiction of women on their way to money related autonomy and self-worth studies patriarchal values in that strengthening isn't found in others' endorsement but in self-sufficiency. Through such stories, Murthy instructs her peruses the significance of self-respect and determination, outlining ladies who break through societal confinements and fashion their claim ways.

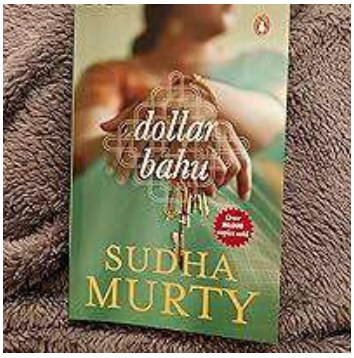

Figure 3: Dollar Bahu

2) Resistance Against Patriarchal Norms

Murthy's narratives demolish solid talks of female subordination, instep proposing elective courses through which ladies declare their rights. Within " The Day I Stopped Drinking Milk ", stories title ladies who overcome harsh social traditions by choosing to be self-reliant than to comply to society's desires. By appearing ladies who challenge onerous relational unions, prohibitive traditions, and economic dependences, Murthy builds a women's activist talk that's accessible yet transformative. Her works emphasize the flexibility of ladies who, within the confront of misfortune, rethink their position in society through acts of insubordination and self-determination.

3) Gender, Class, and Caste Intersections

Murthy's feminist activist awareness rises above sexual orientation to look for convergences of lesson and caste. The presence of Shrimati within "The Old Man and His God" outlines how lower-caste ladies are

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prey to expanded separation. Essentially, "The Magic Drum and Other Favourite Stories" gives stories that uncover the multi-dimensional lives of abused ladies.

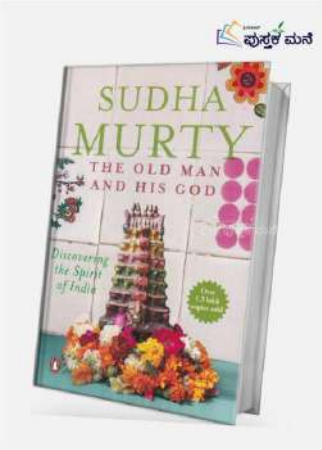

Figure 4: The Old Man and His God

Through such conjunctions, Murthy's story gets to be a chunk of the enormous picture of dialog with respect to intersectional woman's rights, encouraging an all-round approach to gender equity. Murthy's composing subverts the way social progressions trample ladies and presents a level-headed picture of multi-layered battles of ladies at the borders.

4) Eco-Criticism in Murthy's Feminist Vision

The crossing point of women's liberation and environment in Murthy's work is less well-known but similarly noteworthy. In her work, women are depicted as shields of the normal world, connecting natural corruption to abuse of ladies. This kind of ecofeminist position is reliable with present day eco-criticism, which looks at the crossing points between gender and natural issues. A progressed mindfulness of eco-feminist issues can be seen in Murthy's portrayal of rustic nature, eco-friendly living, and gender parts in connection to protecting natural adjust. She envisions a world where nature and ladies are regarded and protected from mishandle by tying sexual orientation equity and natural information together.

6. CONCLUSION

The writings by Sudha Murthy speak to the women's activist topics luxuriously and with complexity by appearing the qualities, office, and versatility of ladies as they go up against the strengths of society's desires and suppression. Her work frequently centers around ladies who battle against such confinements and imperatives and triumph over antagonistic challenges such as sex dissimilarity, social desires, and the

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traditions of lesson and caste. Murthy's stories illustrate her profound social equity bowed, appearing characters who deny cliché parts and battle for independence and nobility. Not as it were does she center on women's individual battles in her composing but too encourage peruses to reexamine the broader social teach that provide rise to imbalance. Her stories put significance on sexual orientation balance, strengthening of the person, and the redemptive control of instruction. Finally, the composing of Sudha Murthy contributes a awesome bargain to women's activist talk through an express and recognizable story almost women's presence, and as such she may be a solid figure in writing and activism.

REFERENCES

1. *Abraham, A. A., & Prabhak, A. A. (2021). Female Conscientious in The Indian Context: Re-examination Identities in Sudha Murthy's House of Cards. Indian Review of World Literature in English, 17(1).*
2. *Agrawal, K., & Dwivedi, R. (2022). Domestic violence in Sudha Murthy's novel Mahasweta.*
3. *Agrawal, K., & Dwivedi, R. (2024). Mythology and Modernity: Sudha Murty's Contribution to Contemporary Indian Literature. Research Journal of Humanities and Social Sciences, 15(3), 255-259.*
4. *Alyahya, R. S. (2019). THE SOCIAL AND ETHICAL VALUES IN THE SELECT NOVELS OF SUDHA MURTHY. Humanities & Social Sciences Reviews, 7(5), 667-673.*
5. *Baburaj, J. (2022). A Liberal Feminist Reading of Sudha Murty's Mahashweta and Gently Falls the Bakula.*
6. *CJ, A. (2023). A FEMINIST READING OF SUDHA MURTHY'S NOVEL MAHASHWETA (Doctoral dissertation, St Teresa's College (Autonomous), Ernakulam).*
7. *Hima, S. (2022). Analysing the Feminine Self: A Postfeminist study of Women's Quest for Identity in the select novels of Jaishree Misra and Anita Nair (Doctoral dissertation, Research & Post Graduate Department of English St. Thomas' College (Autonomous), Thrissur).*
8. *Jyothi, P., & Vijayanand, A. (2023). FAMILY DYNAMICS AND ITS IMPACT ON PRESENT GENERATION–A SPECIAL REFERENCE TO NOVELS OF SUDHA MURTHY. Journal of Pharmaceutical Negative Results, 236-240.*

ISBN Number: 978-93-95305-78-5

9. *Jyothi, P., & Vijayanand, A. (2023). Indian Women struggle against the Obstructions of a Closed Society with special reference to Sudha Murthy Novels. The journal of contemporary issues in business and government, 29(2), 317-325.*

10. *Rameshwar, B. D. (2022). Review of Feminist Consciousness in the Works of Sudha Murthy. African Diaspora Journal of Mathematics, 25(5).*

11. *Shanthi, M. Locating Eco-Feminist Dialogues in Sudha Murthy's Gently Falls the Bakula and Pundalik Naik's The Upheaval.* Middle Flight, *1*.

12. *SUBHASHINI, K. (2023). POST FEMINIST ANALYSIS OF SUDHA MURTY'S THE MOTHER I NEVER KNEW.*

13. *Supriya, R., & Jayakanth, R. (2024). Psychological Impact of Violence: A Trauma-Based Analysis of Gender and Power in Sudha Murty's Fiction.*

14. *Vaswani, N. (2021). Sudha Murthy: An Eminent Contributor to Literature. International Journal of English Literature and Social Sciences, 6(1), 109-112.*

15. *Zankar, R. D. (2023). A Role of Socio-cultural Issues in Indian Fiction with Special Reference to Sudha Murthy's Fiction.*

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