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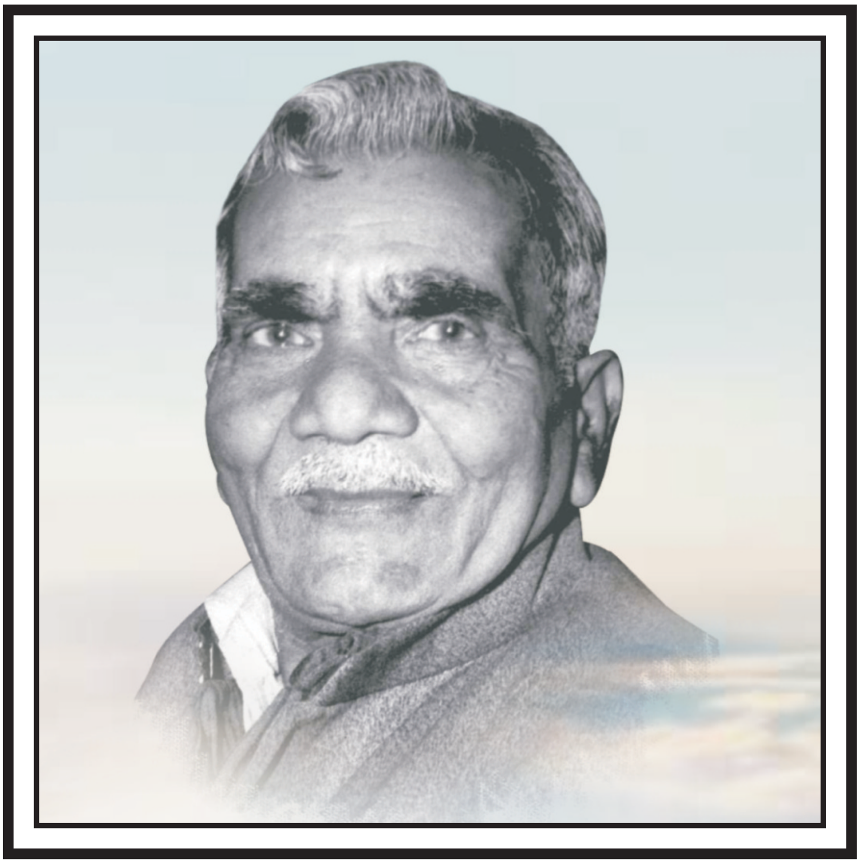
Inspiring Soul



The actual fact of life is,
"To achieve Golden path to success;
one must strive hard from dawn to dusk."
The crux behind this is,
"The hard work that you put in,
will be recognized as an appreciatioin by honor of success."

- Mukut Behari Lal

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Editors - in - Chief Message

Dear All,

It's our immense pleasure to introduce you the Volume-4 of Journal of Indian Institute for Engineering, Management and Science (JIIEMS). We would like to extend a very warm welcome to all the readers of JIEMS. In this issue, focus is given to publish original research work that contributes significantly to strengthen the scientific knowledge in area of Engineering, Management, Science & Technology. The key focus would however be the emerging sectors and research which discusses application and usability in societal or consumer context whether individual or industrial. Through this journal, we provide a platform for academicians, research scholars and professionals throughout the world to present latest advancements in different areas. Our goal is to take the journal in a direction where it reflects the multidisciplinary nature and becomes the premier journal that covers all aspects of engineering, management, science & Technology.

The success of any journal is built primarily on four groups of people: the contributors, the reviewers, the associate editors, and the publications staff. For this journal, the contributions have come in not only from the academic community but also from the corporate world. We would like to thank all the contributing authors for providing outstanding research articles on a broad range of topics and we hope that the research featured here sets up many new milestones. We appreciate the efforts put by all the editorial team members, reviewers who have helped us in making this journal a possibility. We have had an overwhelming response from some very eminent editors and researchers globally to support as editorial Team. We look forward to make this endeavor very meaningful. We also thank all the publishing staff members and express my sincere appreciation for the support they have given to JIIEMS.

JIIEMS is currently accepting manuscripts for upcoming issues based on original qualitative or quantitative research, an innovative conceptual framework, or a substantial literature review that opens new areas of inquiry and investigation. Case studies and works of literary analysis are also welcome. It would be definitely a privilege to publish a high quality research article which satisfactorily passes the editorial and peer review protocol. On behalf of the advisory board, we welcome your comments, views and suggestions. I hope to be able to bring about gradual changes in the near future for a successful indexation in the prestigious databases and more importantly for the improvement of the journal.

Please direct any manuscripts, questions or comments to: jiiemsr@gmail.com

Editors-in-chief
JIIEMS

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Editors Message

Dear Authors and Readers,

Welcome to the latest edition of Volume - 4, Journal of Indian Institute for Engineering and Management Sciences (JIIEMS). As we navigate through the ever-evolving landscape of industrial engineering and management sciences, our commitment to fostering insightful research and facilitating scholarly dialogue remains unwavering. In this issue, we are proud to present a diverse array of articles covering a broad spectrum of topics within our field. From innovative approaches to supply chain optimization to cutting-edge advancements in operations management, each contribution represents a unique perspective and a valuable addition to the collective knowledge base of our discipline.

As editors, we are immensely grateful to the authors whose dedication and expertise have enriched the pages of this journal. Their rigorous research and intellectual curiosity continue to inspire and inform our community, driving progress and innovation in industrial engineering and management sciences. We also extend our heartfelt appreciation to our diligent reviewers, whose constructive feedback and insightful critiques ensure the quality and rigor of the articles we publish. Their commitment to excellence is essential in maintaining the standards of scholarly integrity and advancing the frontiers of knowledge in our field. Finally, we would like to express our gratitude to our readership, whose engagement and support are instrumental in the success of JIIEMS. Your enthusiasm for scholarly inquiry and your commitment to advancing the boundaries of industrial engineering and management sciences are the driving forces behind our continued growth and success. We hope that you find this issue of JIIEMS both informative and inspiring, and we encourage you to join us in our mission to promote excellence in research and scholarship in industrial engineering and management sciences.

Please direct any manuscripts, questions or comments to: jiiemsr@gmail.com

With warm regards,
Sanjeev Kumar Arya
Editor
JIIEMS

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Board Diversity and Sustainability Reporting In Nigerian Listed Consumer Goods Companies

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ABSTRACT

Corporate complexities, technological innovations, and economic diversification are on the increase and posing serious concerns to business. These global issues are of great concern in driving a modern corporate economy to attain its desired goals Thus, the need for sustainability reporting through corporate responsibility and accountability. This study's primary goal is to assess how corporate board diversity affects sustainability reporting in publicly traded consumer products companies in Nigeria.To analyse the data gathered, the study used robust least square regression along with descriptive and inferential statistics. The results of the study showed that the three aspects of sustainability reporting-economic, social, and environmental-have a favourable and significant link with board diversity. Analysis of the relationship between the board's diversity attributes revealed that board nationality and female board directors had a negative significant relationship with economic sustainability reporting and a negative insignificant relationship with social and environmental sustainability reporting. Non-executive directors have no meaningful connection to sustainability reporting, although board size significantly improves sustainability reporting.The study concluded that board diversity has effect on sustainability reporting of listed Nigerian consumer goods companies. It was therefore, recommended that for a responsive and sustainable business, effort should be made by corporate actors and policy makers to maintain a large and unitary board not falling below standard of Security Exchange Commission and the independence of the board should not be compromised, hence, the non-executive directors' number should be maintained.

Keywords: Board diversity, Board nationality, Board size, Sustainability reportin

1. INTRODUCTION

An organization's long-term viability and success are vital to its continued existence and survival. As a result, a well-balanced board is essential to good corporate governance and helps a company remain viable. Board diversity entails the combination of people with different factors that distinguishes them or binds them together. The heterogeneity among board members brings about hypercritical decisions when compared to homogenous board. Corporate governance and sustainability reporting (SR) is a multifaceted and critical research area especially in terms of economic significance in a diverse country like Nigeria; with a growing, dynamic cultures, and regulatory frameworks.

There is need for an effective corporate governance system that cater for local characteristics while aligning with global sustainability goals in Nigeria as its practices play a very important role in ensuring that businesses are well-managed, transparent, accounTable, contributing to economic stability and growth. Sustainability reporting (SR) which encompasses economic, social and environmental issues is an important part of investment decision-making process especially when investing in companies' sustainability (Tilt et al. 2020; Caporale et al. 2022). The need to evaluate how strong corporate governance and sustainability reporting impact capital flows into businesses is very crucial as any lack of clarity on sustainability reporting practices could lead to information gap thereby affecting investment decisions negatively (Rabaya& Saleh, 2021).

In recent decades, the idea of Sustainability Reporting (SR) by businesses has gained significant traction. Research on sustainability and accounting has gained popularity recently, particularly when it comes to non-financial data that businesses produce and display (Rahman &Alsayegh, 2021). The attention and demands from stakeholders, including shareholders, customers, employees, suppliers, investors, the government, creditors, and social and environmental activist groups, have led to an increase in non-financial information (Maama & Appiah, 2019). These stakeholders expect businesses to make positive contributions to the well-being of society and the environment.

The traditional financial reporting focuses primarily on financial performance overlooking non-financial aspects such as environmental and social impacts. However, this conventional financial reporting tends to prioritize short-term financial gains and shareholder value over those of other stakeholders, such as employees, customers, communities and the environment which may not align with long term sustainability goals. All stakeholders are important and complement the other, and none to be overlooked. Recent research on corporate governance and business financial success conducted in Ghana, South Africa, and Nigeria revealed a strong positive correlation (Coleman &Wu, 2020; Karaye & Buyukkara 2021; Agbata et al; Mensah & Bein, 2023). Scholarly literature on corporate governance and sustainability reporting predominantly carried out in South Africa and Nigeria are emerging (Anazonwu et al, 2018; Musa et al, 2020; Olayinka, 2021; Modozie&Amahalu, 2021; Osemene et al, 2021; Yahaya et al, 2022; Chouaibi et al, 2022; Bosun-Fakunle et al, 2023; Ledi&Ameza-Xemalordzo, 2023 among others), both countries are among the largest developing economies in sub-Sahara Africa. The need that all firms listed on the Johannesburg Stock Exchange (JSE) use the King I, II, III, and IV principles when reporting on sustainability may help to explain this.In Nigeria, the Petroleum Industry Act (PIA) and the Nigerian Sustainability Banking Principles (NSBPs) are two sector-specific laws that have been essential to sustainability reporting. Research on corporate governance structures and sustainability reporting is still lacking, but (Tilt et al, 2020).

Furthermore, previous studies have explained relationship between sustainability reporting and corporate governance mechanisms with the suggestion that board attributes such as board size, gender, non-executive directors' independence, board committees, CEO duality and compensation increase sustainability reporting (Karama et al., 2020; Jamil et al., 2020; Rajakulanajagam 2020; Erin et al, 2021; Osemene et al., 2021; Olayinka, 2021; So et al., 2021; Tasim& Khan 2022;

Ikpor et al, 2022; Oyekale et al., 2022; Claudya &Raharja, 2023; Helfaya et al., 2023; Uwaifo& Okoh, 2024 among others). Others have shown that board size, independence, institutional pressure have insignificant influence on sustainability reporting (Osemene&Adinnu, 2021; Yahaya et al., 2022; Tasim& Khan, 2022; Agbata et al., 2022; Bosun-Fakunle et al, 2023; Abdulrasaq, 2023). This suggests that problem with sustainability reporting and corporate governance still persists especially with regards to measurement parameters. For instance, in the study conducted by Uwaifo& Okoh, (2024), the sustainability reporting variable is based on assigning binary score of one or zero to indicate disclosure or no disclosure reporting respectively. Measurement of sustainability reporting is more than assigning score of zero or one to determine the disclosure index, it involves taking aggregate of the scores to establish the disclosure or reporting index. The goal of this study is to determine sustainability disclosures by using a composite score of the criteria and aggregating them. This study aims to close the measurement gap by using the Global Reporting Initiative (GRI) score index.

The following research questions were posed in light of the research problem:

- How do female board members affect sustainability reporting in consumer goods businesses that are listed in Nigeria?
- How does the nationality of the board affect sustainability reporting in publicly traded consumer goods companies in Nigeria?
- How do non-executive directors affect sustainability reporting in consumer products businesses that are listed in Nigeria?
- How does board size affect sustainability reporting in consumer products businesses that are listed in Nigeria?

This study aims to evaluate the effect of board diversity on sustainability reporting in listed Nigerian consumer goods companies. The specific objectives of the study are to:

- Examine the effect of female board directors on sustainability reporting in listed Nigerian consumer goods companies;
- Evaluate the effect of board nationality on sustainability reporting in listed Nigerian consumer goods companies;
- Determine the effect of non-executive directors on sustainability reporting in listed Nigerian consumer goods companies.
- Determine the effect of board size on sustainability reporting in listed Nigerian consumer goods companies.

To the best of our knowledge, this is a more recent study on the relationship between board diversity and sustainability reporting in Nigerian listed consumer goods companies, incorporating gender, board nationality, non-executive directors, and board size as components of the independent variable. This study addresses a variable gap in the measurement of sustainability reporting and is motivated to contribute to the body of literature on sustainability reporting.

1.1. Sustainability Reporting

Since they gain a sustained competitive edge, boost employee motivation, boost profitability, legitimacy, and cut costs, it has long been known that sustainability reporting by businesses in both developed and developing nations fosters accountability and transparency (Nwobu, 2017; Kwakye et al., 2018). Companies publish social and environmental reports, sometimes referred to as sustainability reporting, to meet the informational demands of all stakeholders in addition to financial statements that are prepared in accordance with legal financial obligations.

The idea of sustainability reporting, which combined the company's economic, social, and environmental facets, first appeared in the middle of the 1990s. The three Ps—people, planet, and profit—are also referred to as the Triple Bottom Line (TBL). According to Elkington (2018), the Triple Bottom Line (TBL) was founded on social justice, environmental quality, and quantified economic growth. Sustainability reporting, according to Uwuigbe et al. (2018), is "a story told by a company about the environmental, social, and societal efforts brought about by its ordinary exercises." Therefore, describing an organization's financial and non-financial activities is part of sustainability reporting.

In a similar vein, Mion and Adaui (2020) described sustainability reporting as satisfying the information demands of stakeholders regarding the economic, environmental, and social (EES) effects of businesses' operations. The study by Merve and Kuzey (2020) supports this definition, stating that sustainability reporting (SR) is a voluntary activity with two main goals: to inform stakeholders about an organization's sustainability progress and efforts, and to evaluate the current state of an organization's economic, environmental, and social dimensions. Sustainability reporting is always an all-inclusive and comprehensive reporting activity that is carried out in conjunction with the organization's regular operations.

According to the Global Reporting Initiative (GRI) (2022), sustainability reporting, disclosure, or performance is the method through which businesses disclose the social, environmental, and economic effects of their routine operations. For the purposes of this study, sustainability reporting is the process of assessing, reporting, and holding all internal and external stakeholders accounTable for an organization's performance on economic, social, and environmental issues in order to achieve sustainable development. Giving stakeholders a more thorough report on the company's financial and sustainability performance requires disclosing both its financial and non-financial operations.

1.2. Board Diversity

The concept of board diversity means having a combination of people with different factors that distinguishes them or binds them together. It encompasses an infinite number of dimensions ranging from age to nationality, gender preferences to political preferences, relational skills to task skills, functional background to religious background. A well composed board with different age, class, nationality, educational background, technological knowledge etc. will impact positively on the sustainability of a firm and these matters to good corporate governance practice. Some articles about gender diversity touch on women's involvement in decision-making. Since women are more inclined to engage in social activities and take care of the environment, having them on the board will improve an organization's economic, social, and environmental performance (Osemene&Adinnu, 2021). In addition, Garcia-Sanchez et al. (2019) opined that female board commissioners exhibit greater ethical behaviour and commitment in providing higher quality voluntary disclosures making companies with many female board memberships to disclose sustainability information that is more balanced, clear, concise and reliable. Similarly, female gender is less likely to display unethical behaviour for the sake of the organisation thereby helping the board make better and more ethical decisions (Ruiz-Palomino et al., 2021).

Several studies have been carried out on the positive role of women participation in decision making especially on social and environmental sustainability reporting (Pucheta-Martinez et al., 2019; Buallay et al., 2020; Osemene et al., 2021; Modozie&Amahalu 2021; Olayinka 2021, Helfaya et al., 2023 and Bosun- Fakunle et al., 2023). Nationality and sustainability reporting had a strong positive link, while gender diversity and sustainability reporting had a positive but negligible relationship, according to a recent study by Uwaifo& Okoh (2024). There is no effect of female board members on sustainability reporting, according to a few research (Razaq et al., 2023; Orumwense& Osa-Izeko, 2023). Even if there are academic studies on how gender diversity affects sustainability reporting, more research on other aspects of board diversity is vital to the conversation about corporate governance and sustainability reporting. Thus, the essence of this study.

Anazonwu et al. (2018) used panel data regression to determine how corporate board diversity affected sustainability reporting for a sample of publicly traded industrial companies in Nigeria. Nationality of board members was found to have no discernible positive impact; nevertheless, there was a strong correlation for women directors, the percentage of non-executive directors, and multiple directorships. In their study, Orumwense& Osa-Izeko (2023) found that while board size had a strong negative link with environmental sustainability, board independence had a positive but negligible relationship. Additionally, there was a negligible negative correlation between environmental sustainability and board nationality and gender diversity.In contrast, Salvation et al. (2022) found no significant relationship between board diversity and environmental reporting in their study on the moderating influence of audit committees on the environmental reporting of listed industrial businesses in Nigeria. The study employed directors' share ownership, board size, and board independence as a composite index to represent board diversity. Therefore, more research on the topic is required.

1.3. Theoretical Review

The agency and stakeholders' theories propounded by Jensen and Meckling (1976) and Johnson (1971) respectively serve as a foundation for this study.

Agency Theory: Proponents proposed a theory that explains how conflicts of interest between managers (agents) and shareholders (principals) form the basis of a company's governance. It looks at and describes how ownership and management are separated within the company, as well as how the principals and agents relate to one another. Agency theory helps to reduce information asymmetry between principals and agents thereby ensuring business owners and investors have a better investments and long-term sustainability of their resources. As opined in the study of Manita et al, (2018), corporate entities that disclose sustainability information represents a tool capable of reducing information asymmetry and mitigating environmental risk, litigation costs and bad reputation. Furthermore, Rasaq et al., (2023) study aligns with agency theory as large board improves sustainability reporting. However, one of the major criticism of agency theory is that it focuses more on shareholders' monetary values and financial outcomes, with less consideration for other potential users of non-financial (economic, environmental, and social) information (Elaigwu et al., 2024). Furthermore, the approach favours immediate profits above long-term sustainability objectives, which leads to choices that are detrimental to the organization's sustainability reporting. In order to close this gap, this study incorporates stakeholders' theory.

Stakeholders' Theory: It is predicated on the idea that a socially conscious business is one that strikes a balance between a variety of interests in addition to those of the owners; that is, in addition to aiming to maximise the wealth of the shareholders, who supply the company with capital, the business should also take into account the interests of its employees, suppliers, customers, investors, local communities, and society at large. According to Johnson (1971), agents who manage businesses have a moral obligation to take into account the interests of all stakeholders and to balance them appropriately.The fundamental idea behind the stakeholders' theory is that the company's management makes decisions from time to time and employs strategies to carry them out in a way that satisfies the needs of the greatest number of stakeholders in terms of ethical monitoring and non-monitoring considerations. Therefore, from the standpoint of the stakeholders, the board of directors' integration of economic, social, and environmental issues through sustainability reporting is an implementation of appropriate corporate reporting. Stakeholder theory should serve as the foundation for sustainability reporting, according to a number of studies that have been produced on the subject (Pucheta-Martinez et al., 2019; Buallay et al., 2020; Hamad et al., 2020 and Agbata et al., 2022). According to these researches, companies that implement sound corporate governance by meeting the needs of stakeholders, including shareholders, and the general public enjoy a positive reputation and achieve success. According to the stakeholders' theory of corporate governance, a company's board of directors has an obligation to its primary stakeholders; as a result, it has a moral obligation to take all stakeholders' interests into account when conducting business.

1.4. Empirical Review

Several studies have been carried on sustainability reporting, financial performance and corporate governance in both developing and developing economies. Research from emerging economies, including Kumo et al. (2024), examined how board attributes, specifically board size, board independence, board gender diversity, and board CSR committee, affected corporate sustainability reporting practices (CSRP). They found that while board independence has a negative impact on CSRP, board features like board size, board overall gender diversity, and board CSR committee boast the disclosure of CSRP. In another study carried out by Pucheta-Martinez et al., (2019) to explore whether board gender diversity specifically women directors representing institutional ownership improves the sustainability development of listed firms by affecting CSR policies. The study showed that women directors representing institutional ownership positively affect CSR policies. In a related study, Buallay et al. (2020) investigate the connection between sustainability reporting and gender diversity on boards. According to the report, banks with substantial assets and little financial leverage typically have more diverse boards.

Erin et al., (2021) examined the association between corporate governance and sustainability reporting quality of listed firms in Nigeria. It was found that board governance variables (board size, board gender diversity, board expertise and audit committee) are significantly associated with sustainability reporting quality. In the same way, Bosun-Fakunle et al. (2023) looked into how corporate governance affected Zimbabwe's environmental efficiency. Board independence and institutional ownership have good but negligible effects on environmental performance, but board size, gender diversity, and management ownership have positive and significant effects. With the exception of the discrepancy in Razaq et al.'s (2023) findings, which review the impact of corporate governance mechanisms on sustainability reporting of listed non-financial firms in Nigeria and find that board size and financial expertise have a positive and significant effect on sustainability reporting while board gender diversity has no significant effect on sustainability reporting of listed non-financial firms in Nigeria, these studies demonstrated that female participation in board decision making has a positive impact on sustainability reporting. This is as a result of different climes of study and methods of unit of analysis.

Osemene et al. (2021) in a comparative study of corporate governance mechanisms and Environmental Accounting Reporting (EAR) in selected African quoted companies, revealed that board committee had a significant influence on EAR in the African countries, board diversity in Kenya and Nigeria, board size in South Africa and Nigeria, board independence in Egypt and Kenya, and institutional ownership in Nigeria, Egypt and South Africa were found to have significant influence on EAR. Musa et al., (2020) investigated the influence of a diverse board on the extent of sustainability reporting in listed industrial goods firms on the Nigeria Stock Exchange. The study revealed that age diversity negatively and significantly affects the extent of sustainability reporting and no evidence was found on the nexus between national diversity, education diversity and sustainability reporting.
Furthermore, Modozie and Amahalu (2021) investigated how board structure affected the sustainability reporting of Nigerian listed industrial commodities. According to the study, environmental sustainability reporting is significantly impacted by board member shareholding in a negative way, by board independence in a positive way, and by female board representation and board meetings in a significant way.In contrast, Yahaya et al.'s (2022) study on the impact of corporate governance on environmental disclosure by publicly traded Nigerian consumer goods companies found that while board size and independence have no discernible effect on the firms' Environmental Disclosure Index, the presence of an environmental sustainability committee and board of directors meetings significantly increases the amount of environmental information disclosure. Additionally, a recent study by Yahaya et al. (2023) using random effect regression on 49 firms examined the effects of information technology governance and stakeholder pressure on the transparency of sustainability reporting of listed Nigerian financial services firms. The findings showed that both factors positively affect the transparency of sustainability reporting of listed Nigerian financial services firms.

From the foregoing reviews, Nigeria and other African countriesstudies revealed that there is a positive significant relationship between sustainability reporting and board gender diversity, having few studies on board nationality that showed no relationship with sustainability reporting. Thus, giving rise to variable measurement gap, hence, this study measures board diversity by the composite index of female directors, nationality, board size and non-executive directors.

2. METHODOLOGY

2.1. Theoretical Framework

This study is supported by stakeholders' theory, which tries to explain why and how specific occurrences occur by offering a more comprehensive view of the connections between board diversity and sustainability reporting.

2.2. Model Specification

The model was specified to examine the effect of board diversity on sustainability reporting of listed Nigerian consumer goods companies. This study adapted the model of Salvation et al, (2022) which is as follows:
$ER_{it} = \alpha_0 + \beta_1 DOB_{it} + \beta_2 FS_{it} + \beta_3 FA_{it} + \beta_4 ROA_{it} + e_{it}$ 3.1
Where: ER= Environmental reporting; DoB = Diversity-of-Board; FS = Firm size; FA = Firm age
ROA= Return on Assets; t = time period 2002-2019; α_0 = Constant term; e_{it} = Error term,;β1 - β4 = Coefficient of the variables.
The model adapted was econometrically stated as follows:
$SR_{it} = \alpha_0 + \beta_1 DOB_{it} + \beta_2 PROF_{it} + \beta_3 FS_{it} + e_{it}$ ....***Model One***
$ECD_{it} = \alpha_0 + \beta_1 DOB_{it} + \beta_2 PROF_{it} + \beta_3 FS_{it\ t} + e_{it}$ ......***Model Two***
$SOD_{it} = \alpha_0 + \beta_1 DOB_{it} + \beta_2 PROF_{it} + \beta_3 FS_{it} + e_{it}$.........***Model Three***
$EVND_{it} = \alpha_0 + \beta_1 DOB_{it} + \beta_2 PROF_{it} + \beta_3 FS_{it} + e_{it}$ ...***Model Four***
$SR_{it} = \alpha_0 + \beta_1 FEMD_{it} + \beta_2 BNAT_{it} + \beta_3 BS_{it} + \beta_4 NED_{it} + \beta_5 PROF_{it} + \beta_6 FS_{it} + e_{it}$ ....***Model Five***
$ECD_{it} = \alpha_0 + \beta_1 FEMD_{it} + \beta_2 BNAT_{it} + \beta_3 BS_{it} + \beta_4 NED_{it} + \beta_5 PROF_{it} + \beta_6 FS_{it} + e_{it}$...***Model Six***
$SOD_{it} = \alpha_0 + \beta_1 FEMD_{it} + \beta_2 BNAT_{it} + \beta_3 BS_{it} + \beta_4 NED_{it} + \beta_5 PROF_{it} + \beta_6 FS_{it} + e_{it}$..***Model Seven***
$EVND_{it} = \alpha_0 + \beta_1 FEMD_{it} + \beta_2 BNAT_{it} + \beta_3 BS_{it} + \beta_4 NED_{it} + \beta_5 PROF_{it} + \beta_6 FS_{it} + e_{it}$...***Model Eight***
Where:
SR= Sustainability Reporting; ECD=Economic Dimension; SOD= Social Dimension; EVND= Environmental Dimension; DOB = Diversity-of-Board; FEMD=Female Directors; BNAT=Board Nationality; BS=Board Size; NED=Non-Executive Directors; PROF=Profitability ratio; FIRMSIZE = Firm size; t = time period 2018-2023; α_0 = Constant term;εit = Error term; β1 – β6 = Coefficient of the variables.

2.3. Research Design

The ex-post facto research strategy was used in this study because it allowed the researcher to examine independent factors in retrospect for potential relationships with the dependent variable. The study's main goal was to investigate the connection between board diversity and sustainability reporting in Nigerian consumer goods businesses that were listed between 2018 and 2023. The time periods were selected based on the availability and currency of the data required for the research. The sustainability reporting index and its several components represent the dependent variable, whilst the board diversity indicators reflect the independent factors.

2.4. Population of the Study

Twenty-one (21) consumer products companies that were listed on the Nigerian Exchange Group (NGX) as of November 30, 2024, make up the study's population. The consumer goods sector was chosen because of its visibility and large market share in addition to its sensitive nature to the environment. This study used data downloaded from each firm’s reports (sustainability reports, annual reports, and websites). To be eligible for the study's sample, a company must have either a standalone sustainability report of any kind (such as sustainability reports, corporate social responsibility reports, corporate social responsibility progress reports, integrated reports, and corporate environmental reports) or published annual reports or accounts during the study period that significantly support sustainability performance indicators. Thirteen (13) companies met this consideration thus the sample size.

2.5. Nature and Data Source

The data employed for this study were secondary in nature as they are readily available in the companies' annual reports, websites and publications. Sustainability reporting index represents the dependent variable and was accessed from the annual and sustainability reports of each firm. The three pillars of sustainability reporting are economic, social, and environmental, according to earlier research. The degree of sustainability reporting in corporate annual reports was measured using content analysis. The Global Reporting Initiative (GRI) framework's primary sustainability performance metrics were applied. A disclosure index was employed by earlier scholars to examine and evaluate environmental, corporate social responsibility, and sustainability reporting. This index is used in accordance with GRI criteria, where KPIs are crucial. When using content analysis to convert qualitative data into quantitative measurements, these markers are essential. Previous researchers have employed content analysis, a research technique that uses methodical procedures to analyse written material and translate it into quantitative measures, in their study of sustainability reporting (Dissanayake, 2020; Hamad et al. 2020; Agbata et al. 2022). The KPIs utilised in Dissanayake's (2020) study were applied to this one. The GRI G4 guidelines were introduced in 2013 and are required to be followed by the sustainability reports published after December 2015, in 2018, GRI standards superseded the GRI G4. The GRI - Standards has 88 performance indicators; 13 economic indicators (EC) and 30 environmental indicators (EN) and the social indicator is further divided into four categories; 21 indicators for labour practices and decent work (LA), 11 for human rights (HR), 6 for society (SO) and 7 for product responsibility (PR). (Loprevite et al., 2020).
A Disclosure Index (DI) is used in this study to determine the sustainability reporting level of the sampled firms. The FIND option is used to track for the sustainability data in every report. To determine the SRS (dependent variable) value for each sampled company, the ratio of the company's maximum points to the total projected number of items to be disclosed by the firm is calculated.

The independent variables of this study are board diversity indicators. Based on research from Anazonwu et al., (2018) and Salvation et al., (2022), board diversity is measured by the composite index to proxy nationality, board size, women directors and non-executive board members. Aside the independent variables, two other control variables are used. They are profitability ratio and firm size. These variables have been used by prior researchers as determinants of voluntary disclosures and aid control variables in this study.

2.6. Method of Data Analysis

The descriptive and inferential statistics estimation techniques were used. For data analyses, the technique utilized to analyse the data was panel least square regression.

2.7. Variables Measurement and Definition

The study's hypotheses were tested using the dependent (explained), independent (explanatory), and control variables, which are listed in Table 1.

Table.1.Measurement and Description of Dependent and Independent Variables

Symbols	Variable	Measurement	Variable Type	Literature
SR	Sustainability Reporting	Measured by the ratio of the Economic, Social and Environmental indicators scores obtained using the 2020 Global Reporting Initiatives (GRI) standards	Dependent	Claudya &Raharja (2023)
ECD	Economic dimension	Measured by the ratio of economic indicators scores using the 2020 Global Reporting Initiatives (GRI) Standards	Dependent	Claudya &Raharja (2023
SOD	Social dimension	Measured by the ratio of social indicators scores using the 2020 Global Reporting Initiatives (GRI) Standards	Dependent	Claudya &Raharja (2023
ENVD	Environmental dimension	Measured by the ratio of environmental indicators scores using the 2020 Global Reporting Initiatives (GRI) Standards	Dependent	Claudya &Raharja (2023
DOB	Diversity of Board	Measured by the composite index to proxy nationality, board size, women directors and non-executive board members	Independent	Anazonwu et al., 2018; Salvation et al., 2022
FEMD	Female Directors	The proportion of female directors on the	Independent	Oseme ne et al.,

		board		(2021)
BNAT	Board Nationality	This the proportion of foreign directors to total number of directors	Independent	Salvation et al., 2022
BS	Board Size	Total number of directors both executive and non-executive members on the board.	Independent	Oseme ne et al., (2021)
NED	Non-Executive Directors	Proportion of non-executive directors to total directors on the board.	Independent	Oseme ne et al., (2021)
PROF	Profitability	Measured as a ratio of net income before tax to shareholder's equity	Control	Oseme neet al., (2021)
FRMSIZE	Firm size	Measured by natural log of Total assets	Control	Oseme ne et al., (2021)

Source: Authors' compilation, (2024).

3. RESULTS AND DISCUSSION

The characteristic of the data used for this study is presented

Table.2.Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
SR	78	0.587	0.127	0.340	0.740
ECD	78	0.569	0.183	0.290	0.880
SOD	78	0.427	0.120	0.180	0.600
ENVD	78	0.808	0.165	0.520	1.000
DOB	78	5.224	1.194	2.500	8.250
FEMD	78	2.231	1.194	0.000	5.000
BNAT	78	0.769	0.424	0.000	1.000
BS	78	10.141	2.173	6.000	15.000
NED	78	7.756	2.408	3.000	14.000
PROF	78	0.289	0.781	-2.295	4.323
LFRMSIZE	78	10.943	0.537	9.596	12.040

Author's computation (2024) (Stata 14)

The descriptive Table gives a summary of the test statistics. Sustainability reporting score stood at 0.587, representing 59% of the average score for companies in the consumer goods sector with a minimum score of 34% and maximum score of 74%. The environmental indicator on the average showed 80%, economic indicator 60% and the social indicator 40%. This implies that the consumer goods companies are environmentally friendly and fairly balanced socially. The composite index of diversity of board shows a mean value of 5.22 with a standard deviation of 1.19 that is relatively small compared to the average. The mean score of female directors and board nationality stood at 2.23 and 0.77 respectively with a minimum of 0 and maximum of 5 female directors on the board. Foreign nationals make up around 77% of the board's diversified membership. With both executive and non-executive board members, the average board size is ten, with a minimum of six and a maximum of fifteen members. This implies that consumer goods companies in Nigeria are within the threshold of board size as stipulated by Securities and Exchange Commission (SEC) (2011) corporate governance code which stated that public company's board size should not be less than five directors and not above twenty. The non-executive directors have a mean score of 7.76 with a minimum of 3 non-executive directors and a maximum of 14 non-executive directors on the board. This implies that with this average number of 7 non-executive directors, the wealth of their knowledge, expertise and independent judgment will be seen on issues of strategy and performance on the board decisions among which is sustainability reporting.

Clearly, the results from the control variables employed in the analysis shows for profitability an average of 29% profiTable firms in the sector with a minimum of ₦2,294,700,000 loss and a maximum of ₦4,322,700,000 profit. With a minimum value of 9.596 and a high value of 12.04, the business size as determined by the log of total assets had a mean value of 10.943.

3.1. Regression Results

Diagnostic tests are carried out in other to validate regression model. There are certain tests that should be carried out to aid drawing conclusion based on the regression analyses, test of hypotheses and the coefficient estimation accurately. Similarly, certain assumptions must be met to use ordinary least square, among which are test to check for the presence of multicollinearity and heteroscedasticity problem. This study employed the Breusch-Pagan/Cook Weisberg test for heteroscedasticity and the Variance Inflation Factor (VIF) to check for multicollinearity.

Table.3.Results of Regression Model, Test for Multicollinearity and Heteroscedasticity

	MODEL 5			MODEL 6			MODEL 7			MODEL 8		
Variable	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)
Con	0.814	2.850	0.006	0.959	2.980	0.004	-0.216	-0.720	0.472	2.082	5.650	0.000
DOB												
FEMD	-0.011	-0.910	0.365	-0.024	-1.760	0.083	0.002	0.210	0.836	-0.022	-1.450	0.152
BNAT	-0.154	-4.150	0.000**	-0.339	-8.110	0.000**	-0.077	-1.980	0.051**	-0.150	-3.140	0.003***
BS	-0.035	3.100	0.003**	0.033	2.640	0.01**	0.013	1.130	0.264	0.061	4.260	0.000***
NED	0.000	0.020	0.981	0.011	1.040	0.304	0.010	1.020	0.310	-0.016	-1.350	0.182
PROF	0.061	0.650	0.520	0.006	0.060	0.952	0.088	0.900	0.372	0.049	0.400	0.688
LFRMSIZE	-0.041	-1.320	0.192	-0.047	-1.340	0.183	0.447	1.370	0.176	-0.149	-3.710	0.000***
R-SQUARED			0.454			0.664			0.327			0.459
VIF			2.390			2.390			2.390			2.390
Breusch-Pagan			0.001			0.846			0.008			0.003
NO.=obs			78			78			78			78

	MODEL 5			MODEL 6			MODEL 7			MODEL 8		
Variable	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)
Con	0.814	2.850	0.006	0.959	2.980	0.004	-0.216	-0.720	0.472	2.082	5.650	0.000
DOB												
FEMD	-0.011	-0.910	0.365	-0.024	-1.760	0.083	0.002	0.210	0.836	-0.022	-1.450	0.152
BNAT	-0.154	-4.150	0.000**	-0.339	-8.110	0.000**	-0.077	-1.980	0.051**	-0.150	-3.140	0.003***
BS	-0.035	3.100	0.003**	0.033	2.640	0.01**	0.013	1.130	0.264	0.061	4.260	0.000***
NED	0.000	0.020	0.981	0.011	1.040	0.304	0.010	1.020	0.310	-0.016	-1.350	0.182
PROF	0.061	0.650	0.520	0.006	0.060	0.952	0.088	0.900	0.372	0.049	0.400	0.688
LFRMSIZE	-0.041	-1.320	0.192	-0.047	-1.340	0.183	0.447	1.370	0.176	-0.149	-3.710	0.000***
R-SQUARED			0.454			0.664			0.327			0.459
VIF			2.390			2.390			2.390			2.390
Breusch-Pagan			0.001			0.846			0.008			0.003
NO.=obs			78			78			78			78

In checking for presence of multicollinearity problem, 5 or greater bivariate correlation between the predictors indicates multicollinearity presence. From Table 3, the VIF results from the models ranges between 1.3 and 2.3, suggesting that multicollinearity is not a problem. Additionally, the Breusch-Pagan/Cook Weisberg test for heteroscedasticity was performed in order to ascertain a uniform variance and the assumption that the errors were constant. The null hypothesis is rejected since the p-values for models 1, 3, 4, 5, 7, and 8 are less than 0.05, suggesting that there is no uniform variance and that the estimates are skewed. Thus, the OLS is not appropriate. To correct this problem, the robust regression is applied. Robust regression is a form of weighted and reweighted least square regression used in any situation where some outliers are found.

Table 4. Robust Regression

	MODEL 1			MODEL 2			MODEL 3			MODEL 4		
Variable	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)
Con	1.271	4.060	0.000	1.945	4.290	0.000	-0.020	-0.080	0.937	2.511	5.920	0.000
DOB	0.057	3.940	0.000**	0.086	4.070	0.000**	0.039	3.340	0.001***	0.067	3.430	0.001***
FEMD												
BNAT												
BS												
NED												
PROF	0.139	1.430	0.158	0.327	2.320	0.023**	0.132	1.690	0.095*	0.078	0.590	0.560
LFRMSIZE	-0.090	-2.770	0.007**	-0.171	-3.630	0.001**	0.025	0.960	0.341	-0.190	-4.310	0.000***
PROB.>F			0.002			0.000			0.000			0.001
NO.=obs			78			78			78			78
	MODEL 5			MODEL 6			MODEL 7			MODEL 8		
Variable	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)	coef.	t.stat	p>(t)
Con	0.800	2.650	0.010	0.910	2.650	0.010	-0.176	-1.310	0.196	2.083	5.110	0.000
DOB												
FEMD	-0.014	-1.070	0.287	-0.026	-1.780	0.08*	-0.008	-1.360	0.178	-0.027	-1.580	0.119
BNAT	-0.148	-3.760	0.000**	-0.342	-7.650	0.000**	-0.049	-2.780	0.007***	-0.153	-2.900	0.005***
BS	0.029	2.490	0.015**	0.031	2.310	0.024**	-0.049	-5.010	0.000***	0.060	3.760	0.000***
NED	0.004	0.390	0.701	0.009	0.840	0.406	0.036	8.330	0.000***	-0.014	-1.100	0.274
PROF	0.048	0.480	0.629	0.023	0.200	0.839	-0.023	-0.510	0.609	0.043	0.320	0.750
LFRMSIZE	-0.037	-1.120	0.269	-0.040	-1.060	0.292	0.063	4.270	0.000***	-0.148	-3.320	0.001***
PROB.>F			0.000			0.000			0.000			0.000
NO.=obs			78			78			78			78

Author's computation 2024 (Stata 14)

Note: the asterisks ***, ** and * indicate significance at the level of 1%, 5% and 10% respectively.

Table 4 illustrates the connection between sustainability reporting and board diversity for consumer products companies in Nigeria that are listed. Additionally, the outcome demonstrates the relationship between the three sustainability reporting dimensions—economic, social, and environmental—as well as the composite board diversity index and its individual characteristics. Likewise, the connection between the dependent and control variables is also disclosed. Given that the F statistics revealed a p-value of 0.0000, the models are well-fitting. With p-values of 0.000, 0.000, 0.001, and 0.001 at the 0.05 significant level, respectively, the composite index of board diversity has a positive and significant relationship with sustainability reporting, economic dimension, social dimension, and environmental dimension, according to an analysis of the robust least squares models 1, 2, 3, and 4. With the exception of the economic dimension, sustainability reporting, the social dimension, and the environmental dimension are negatively and negligibly correlated with the individual characteristics of board diversity, such as the presence of female board directors.The economic dimension of sustainability reporting has a negative significant link with the female board directors, as indicated by the p-value of 0.08 at the 0.1 significant level. A significant negative correlation between sustainability reporting and the different components was found by the board nationality. Board size shown a negative significant link with the social dimension (p-value of 0.000), but a positive significant relationship with sustainability reporting, economic dimension, and environmental dimension (p-values of 0.015, 0.024, and 0.000, respectively). With a p-value of 0.000 < 0.05, the results of the study on non-executive directors revealed a positive significant link with the social dimension but no significant relationship with sustainability reporting, economic dimension, or environmental dimension.

Control variables are utilised to increase the predictability of the independent variables in elucidating the relationship with the dependent variable. In addition to the profitability and company size ratios, COVID-19 was included in this analysis because of the effects this time period had on business. Profitability and economic dimension have a substantial positive relationship, as indicated by the p-value of 0.023 at 0.05 degrees of freedom. The p-values of 0.158, 0.095, 0.560, 0.629, 0.839, -0.609, and 0.750 indicate that sustainability reporting, social dimension, and environmental dimension do not significantly correlate with profitability. According to the log of total assets, business size and sustainability reporting, the economic and environmental dimensions, but not the social dimension, are significantly correlated negatively.Model 7 demonstrated that the social component and business size have a significant positive association. There was no correlation between sustainability reporting and the different dimensions and the COVID-19 control variable.

3.2. Discussion of Findings

In aligning with agency theory, Rasaq et al. (2023) posits that large board improves sustainability reporting. Similarly, several scholars have opined in their studies that diverse board influence long term decisions of the organisation (Salvation et al. 2022; Orumwense& Osa-Izeko 2023; Rasaq et al. 2023 and Uwaifo& Okoh 2024) among others. A unit increase in board diversity will lead to a 5.7, 8.6, 3.9, and 6.7 unit increase in sustainability reporting, economic, social, and environmental dimensions, respectively, according to the robust regression's result regarding the positive significant relationship between the three dimensions and diversity of the board. This finding is consistent with Anazonwu et al. (2018)'s study but not with Salvation et al. (2022).

A further analysis revealed that three dimensions with the individual attributes of diversity of board revealed that female board directors has a negative insignificant relationship with a sustainability reporting, social dimension and environmental dimension except for economic dimension. This contradicts the findings of Modozie&Amahalu (2021), which suggest that female board directors have a major impact on environmental sustainability reporting. The economic dimension of sustainability reporting has a negative significant link with the female board directors, as indicated by the p-value of 0.08 at the 0.1 significant level. This suggests that for every unit increase in the number of female board members, sustainability reporting, the social dimension, and the environmental dimension will fall by 1.4, 0.8, and 2.7 units, respectively, and vice versa. This contrasts with Olayinka's (2021) research, which found that having more female directors on the board significantly improves economic sustainability reporting.In contrast, the economic component decreases by 2.6 units for every unit rise in female directors, and vice versa.

According to the analysis, there is a 14.8, 32.2, 4.9, and 15.3 unit drop in sustainability reporting and the economic, social, and environmental aspects of sustainability reporting for every unit rise in board nationality, and vice versa. This is consistent with research by Anazonwu et al. (2018) and Musa et al. (2020), which did not find any evidence linking sustainability reporting to national diversity. With the exception of the social component, board size significantly positively correlates with sustainability reporting, economic, and environmental aspects. The findings suggested that the sustainability reporting, economic, and environmental components increased by 2.9, 3.1, and 6 for every unit increase in board size. The result is in tandem with the study of Rajakulanajagam (2020); Erin et al, (2021); Olayinka (2022); Claudya &Raharja (2023); Bosun-Fakunle et al, (2023). Board size also showed negative significant relationship with social dimension of sustainability. That for every unit increase in board size, leads to a 4.9% decrease in social dimension and vice versa. This is in consonance with the study of Osemene&Adinnu, (2021); Kumo et al, (2024) but at variance with Yahaya et al, (2022).

Non-executive directors' presence at the board influence strategic decisions. Sustainability reporting, the economic dimension, and the environmental dimension do not significantly correlate with non-executive directors; however, the social dimension does, with a p-value of 0.000 < 0.05. This suggests that the social dimension of sustainability reporting increases by 3.6 units for every unit rise in non-executive directors, and vice versa. This is at variance with the result of Rajakulanajagam (2020); Modozie&Amahalu (2021) that revealed board in independence has significant positive effect on environmental sustainability reporting.
The implication of the result of profitability ratio that shows a positive significant relationship exist with economic sustainability reporting is that a unit increase in the returns on capital employed will lead to 2.3 unit increase in economic sustainability reporting. Also, the implication of no significant relationship between profitability ratio and sustainability reporting, social and environmental dimension shows that an increase or decrease in the returns on capital employed does not affect sustainability reporting. The same is true for company size, which, with the exception of the social dimension, which did not exhibit any significant link, exhibited a negative significant relationship with sustainability reporting, economic, and environmental aspects. Therefore, business size has no bearing on sustainability reporting. This contrasts with the research conducted by Adekanmi (2022); Yahaya et al. (2022).

4. CONCLUSION

The study identified the characteristics of sustainability reporting in consumer goods businesses quoted in Nigeria and the relationship between sustainability reporting and board diversity. The aforementioned analysis demonstrated a considerable positive correlation between board diversity and sustainability reporting. Additionally, there is a negative significant association between female board directors and economic sustainability reporting, and a negative insignificant relationship with sustainability, social sustainability, and environmental sustainability reporting. Likewise, there is a significant negative correlation between board nationality and sustainability reporting, including economic, social, and environmental sustainability reporting. As a result, board size has a strong positive correlation with sustainability reporting, whereas social sustainability reporting has no significant correlation with either economic or environmental sustainability reporting.Non-executive directors showed a positive significant link with the social dimension but no significant relationship with sustainability reporting, economic sustainability reporting, or environmental sustainability reporting.

The stakeholders' and agency theories are upheld for this study as the diversity of board especially as regard board size have effect on the sustainability decisions. Based on the findings of this study, it was recommended that board size stipulated by Securities and Exchange Commission should be upheld and adhered to by companies. That female director should be increased on the board as some companies do not have their presence on the board, same for board nationality that has negative relationship too. Also the independence of the board should not be compromised, hence, the non-executive directors' number should be maintained in other to foster objective input in sustainability reporting.
Finally, there is need to expand this study to include more sectors in the Nigerian economy as this study is limited to quoted consumer goods companies. Also, further study could be extended to small and medium scale industries.

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Digital Generation: The Quranic Generation an Opportunity And Challenge To Build An Integrated Future

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ABSTRACT

International Takhfidz Al Husna Islamic Boarding Schoolin Mayong, Jepara, Indonesia, is an educational institution that integrates the teaching of the Qur'an with general education to form students who are not only intellectually intelligent, but also have a Quranic character. It offers an intensive Qur'an takhfidz programme as well as studies on tafsir, hadith, fiqh, and Islamic character education. The main focus of this boarding school is the formation of Quranic character through the values contained in the Qur'an, such as honesty, patience, and responsibility. Amidst the challenges of the times and technology, Al Husna Islamic Boarding School tries to maintain a balance between tradition and innovation by utilising technology in the learning process. Technology plays an important role in supporting Quranic character education, by providing more personalised and adaptive learning. Through traditional and modern approaches, as well as the utilisation of technology, the boarding school is committed to producing a young generation that not only has a deep understanding of religion, but can also face global challenges with solid moral principles. This Quranic character building aims to produce individuals who have noble character and can have a positive impact on society, both nationally and internationally.

***Keywords:* character building, Quranic morals, technology, curriculum integration, Digital generation, Quranic Generation**

1. INTRODUCTION

The rapid development of technology in the 21st century has had a significant impact on social, cultural and educational life around the world. The Alpha and Beta generations, growing up in the midst of the digital revolution, face unique challenges in the character building process. In this context, it is important to ensure that the education they receive includes not only intellectual development, but also the formation of a strong and virtuous character. Character education, especially those based on Qur'anic values, plays a very important role in preparing young people to face complex moral and social challenges.

One approach that is gaining attention is the use of technology (digitalisation) in character cultivation. This technology offers various innovative solutions in supporting character education, including in instilling Quranic values that can form noble individuals. Such is the case at International Takhfidz Al Husna Islamic Boarding School, which is specifically engaged in instilling Quran-based education in early childhood starting from kindergarten level, elementary school level, junior high school level and senior high school level. With its ability to provide personalised and adaptive learning, and efficient technology has the potential to help accelerate the process of internalising Islamic values, such as honesty and integrity.

This article aims to explore various strategies of Quranic character building for the younger generation through the application of technology in education. By understanding the role of technology in supporting Quranic character education, we can explore how this technology can serve as an effective tool to shape a generation that is not only intelligent, but also has solid morals, based on the teachings of the Qur'an. This discussion will also touch on the challenges and opportunities that arise in integrating technology with Quranic values in character education in this digital era.

2. RESEARCH METHODS

This research aims to explore and analyse the strategy of Quranic character building in the Alpha and Beta Generations through the use of digital media at Al Husna International Islamic Boarding School in Jepara, Indonesia. To achieve these objectives, this research uses a qualitative approach with a case study design. The approach used in this research is descriptive qualitative. This approach was chosen because this research aims to describe in depth and thoroughly the application of digital media in the formation of Quranic character for the Alpha and Beta Generations. By using a qualitative approach, this research will collect data through interviews, observations, and document analysis to understand the phenomenon contextually at International Takhfidz Al Husna Islamic Boarding School which has integrated technology in learning Quranic character.

3. DISCUSSION

3.1. International Takhfidz Al Husna Islamic Boarding School Jepara Indonesia

International Takhfidz Al Husna Islamic Boarding School MayongJepara, located in Jepara Regency, Central Java, Indonesia, is an educational institution that has a main focus on teaching and memorising the Qur'an (Takhfidz) for students from various backgrounds. Although it does not abandon formal education other than the Qur'an from the early childhood education level, elementary school level, junior high school level and senior high school level. This institution offers an educational approach oriented towards strengthening Islamic character, a deep understanding of the teachings of the Qur'an, and personal development based on universal Islamic values implemented in an integrative curriculum that includes two main components: general education and memorisation of the Qur'an (takhfidz) as its flagship programme. This learning not only includes memorisation of the Qur'an, but also the study of Quranic tafsir, hadith, fiqh, as well as character and moral development based on the values contained in the Qur'an. As an institution that prioritises memorisation of the Qur'an, this boarding school has an intensive programme for students who want to memorise the entire contents of the Qur'an in a relatively short time. In addition, the teaching is complemented by deepening the meaning and interpretation of the Qur'anic verses, which aims to make the students not only memories the Qur'an by heart, but also to develop their character and morals based on the values of the Qur'an.

As an object of research, International Takhfidz Al Husna Islamic Boarding School can be used as an interesting example to explore various aspects of education related to the formation of Quranic character, the integration of religious values in the modern education system, and the application of innovative methods in teaching the Qur'an in the digital era. One aspect that is highly emphasised in International Takhfidz Al Husna Islamic Boarding School is character building based on the teachings of the Qur'an. This Quranic character education serves to form individuals who not only master religious knowledge but also have noble morals and can practice Islamic teachings in everyday life. The characters taught in this boarding school include honesty, responsibility, patience, humility, respect for parents, prioritising congregational prayers and promoting morals in studying and other values contained in the teachings of the Qur'an and hadith. In addition to science, it also teaches the development of students' interests and talents as a means of channelling their potential. With education based on Quranic values, students are expected to become individuals who are beneficial to society, have a broad understanding of religion, and are able to face the challenges of the times with solid moral principles. International Takhfidz Al Husna Islamic Boarding School is also active in social activities and community service. Santri are expected not only to be good individuals in the Islamic Boarding School environment, but also to have a positive impact on the surrounding community. Social activities carried out include religious teaching to the general public, community empowerment through skills training, and chariTable activities to help others.[1]

The main challenge faced by the international Takhfidz Al Husna Islamic Boarding School is to maintain a balance between tradition and innovation. In the face of increasingly sophisticated times, this boarding school needs to ensure that the use of technology does not reduce the essence of religious education based on the teachings of the Qur'an. In addition, another challenge is how to ensure that the quality of education remains consistent despite the increasing number of students and the evolving teaching process. However, with the opportunity to integrate technology in teaching and learning, International Takhfidz Al Husna Islamic Boarding School has great potential to reach more students and optimise the Quranic character education process through digitalisation collaboration. This opportunity can expand the positive impact of this boarding school both nationally and internationally.

3.2. The importance of character education for children

According to Fakri Gafar, character education is a process of transforming life values to grow and develop in a person's personality so that it becomes one in the person's life behaviour. This definition implies that character education at least includes the transformation of policy values which are then developed in a person and will eventually become a personality, character and habits in behaviour.[2]Scerenko continued, that character education can be understood or interpreted as an earnest effort by means of exemplary characteristics, study (history, and biographies of great sages and thinkers), and emulsion practice (maximum effort to realise the wisdom of what is observed and learned).[3] Whereas in Islam, personality, character, character is known as morals, there are *mahmudah* (praiseworthy) morals and *madzmumah* (despicable) morals. These Islamic morals are all sourced from the great Prophet Muhammad who has been crowned by Allah as *uswatunhasanah* (a good example)[4], and the character of the Prophet is the Qur'an.[5] So the character of a Muslim is a character that comes from the Qur'an and reflects the teachings contained in it. And so also as said by Rosulullah about the essence of the sending of the Rosul, namely to perfect good character.[6]

From some of the opinions of these experts, it can be concluded that character education is education that teaches about character, personality, attitudes and morals so that an individual is formed as expected.[7] This means that an educational institution must prioritise the cultivation and development of character values in students in the learning process which can then be applied in everyday life during their lifetime.

Thus, character education is not merely education that is logical (scientific) knowledge, which is only enough to be known and memorised as knowledge, but must be able to be practised and impregnated with the meaning of the substance of the behaviour. So that someone can do something until it enters the area of deep awareness and becomes a character or character itself. Even in Islamic teachings, the movements of the heart have been calculated to be a character, such as envy, spite, *su'udzon, husnudzon* and so on.

Childhood is a golden period, so called because childhood is the beginning of the formation of habits, character and character of a person in the future. It is in this childhood that at least parents can still supervise and accompany the development and growth of children in every process of their time. So that parents can maximise education in the smallest environment, namely the home. Parents can also then choose a representative residence and school environment with carrying capacity according to the child's development. Because at home and at school is the child's longest social time, then this must be maximised as best as possible.

Children's growth and development is not only limited to intellectual development (cognition).

Children's growth and development is not only limited to intellectual development (cognitive), but must be aligned with the development of movement (psychomotor) and a sense of caring (affective) in Bloom's taxonomy, in line with the 2003 National Education System Law also mandates education in Indonesia to shape the personality of students to become intellectually, emotionally and spiritually mature human beings.[8] So that International Takhfidz Al Husna Islamic Boarding School combines national education and quranic education by forming an integral curriculum, which is expected to instil and shape the morals of students to grow and develop into intellectual individuals and also have quranic morals.

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[1] Interview, 1-2 Februari 2025
[2] Muhammad Fadhillah, dkk, *Pendidikan Karakter Pada Anak Usia Dini,* (Yogyakarta, Ar-Ruzz Media, 2013), hlm. 22

[3]Muchlas Samani, dkk, Konsep dan Model Pendidikan Karakter, (Banadung, PT. RemajaRosdakarya, 2011), hlm. 45
[4] Al quran, Al Ahzab: 21
[5]Hadits yang diriwayatkan ‘‘Aisyah ketika ditanya bagaimana akhlak Rosul: yaitu Al quran
[6]Innama bu'itstu liutamima makarimal akhlak.
[7]Sudaryanti, Pentingnya Pendidikan Karakterbagi Anak Usia Dini, Pendidikan Anak, Vol. 1, edisi 1 2012
[8]Undang-UndangSistem Pendidikan Nasional Tahun 2003

3.3. Grounding Quranic Manners

As a Muslim, we should not be unfamiliar with religious teachings. The main teaching of Islam is the Qur'an. In Al quran, there are religious teachings that are commands, prohibitions of mandatory (*mahdhoh*) and non-obligatory (*ghoirumahdhoh*) sharia guidance, history / stories, moral guidance and so on. Some quranic moral values include:

Table 1: Verses that Explain Morals

Personal Behaviour	Letter/Satter
Honest	QS: 83/1, 2/10, 22/30, 5/63
Patience	QS: 41/35, 2/153, 16/96, 28/54, 28/80, 3/142
Fair	QS: 5/8, 57/25, 7/29, 4/135
Ikhlas	QS: 4/125, 4/146. 10/105
Trustworthy and Promise Keeping	QS: 23/8, 17/34, 70/32-35
Keeping Speech	QS: 2/263, 4/148
Frugal	QS: 17/26, 17/29, 25/67
Simple	QS: 102/1-3
Grateful	QS: 14/7, 14/34
Social Behaviour	
Self-control	QS: 3/133
Avoid prejudice and backbiting	QS: 49/12
Be gentle	QS: 20/44, 25/63
Doing good	QS: 2/177, 16/90, 103/1-3
Establishing silaturohim	QS: 41/34
Caring for others	QS: 2/271. 107/1-3
Not being arrogant	QS: 31/18, 40/76

In its development, Muslims began to experience moral degradation. Many have left the teachings and guidance of Islam. This is evidenced by research from George Washington University which tested several noble Islamic values such as honesty, trustworthiness, fairness, punctuality, empathy, tolerance and so on based on the Qur'an and the moral sunnah of Rosulullah. The researchers compiled an indicator related to the noble values of Islam which is hereinafter called the Islamicity Index. They conducted research on 108 countries to measure how Islamic these countries are. It turns out that the results show that the most Islamic country is New Zealand, while the country that runs the most Islamic economy is Ireland. Indonesia ranks 140th for Islamicity index and 104th for Islamic economy.[9]

So that from this situation it is very important to grow and instil quranic morals again massively, especially educational institutions that are involved in teaching the Qur'an. Seeing this situation, Al Husna Islamic Boarding School is committed to always aggressively preach, spread and ground quranic morals throughout Indonesia, moreover it can reach the whole world by graduating students who are intellectually and spiritually qualified.

[9]Ridwan Abdullah, pendidikan Karakter: Mengembangkan Karakter Anak yang Islami, (Jakarta: Bumi Aksara, 2016), hlm. ix

3.4. *i_Generation*: and its Characteristics

The generation of the last 25 years, which started with generation Z (millennial generation), continued by the Alpha generation and earlier this year continued by the beta generation, they are the generation that from birth has been welcomed by the development of technology and the internet. As the periodisation of birth is detailed as below:

Table 2: Birth of a Generation[10]

No	TahunKelahiran	Nama Generasi
1.	1925 - 1946	Veteran generastion
2.	1946 - 1960	Baby Boom Generation
3.	1960 - 1980	X Generation
4.	1980 - 1995	Y Generation
5.	1995 - 2010	Z Generation
6.	2010 - 2025	Alfa Generation
7.	2025 +	Beta Generation

The last three generations are often referred to as the i_generation (internet generation). They have the following characteristics:

(1). Multi-Tasking, this generation can do a job simultaneously in using technology, (2). Technology based, this generation is very dependent on technology, especially internet-based. (3). Audio-Visual, this generation prefers audio and visual over text and writing, (4). Open, they are a generation that is open to new things, easily curious about new things and try them, (5). Critical, with the technology they hold, they can access information quickly and accurately, so they have complete information and make them critical of information that is not appropriate, (6). Creative, the amount of knowledge gained from their gadgets makes them creative, (7). Innovative, because they are always dissatisfied with today's situation, they try to come up with innovations that can make their lives easier, which is supported by technology, (8). Collaboration, they like their fellow generation to solve problems faced rather than having to compete.

By seeing the characteristics of this generation, we can then map out how to integrate with learning to instil quranic morals.

The Quranic Character Building Strategy at Takhfidz Al Husna International Boarding School

Al Husna International Islamic Boarding School is an educational institution that teaches general education and religious education with an integrative curriculum, with a takhfidz Al quran approach for kindergarten, elementary school, junior high school and high school levels.

The strategies and approaches used are a combination of traditional and modern methods, *bayani*, *burhani* and *irfani* approaches. Some of the strategies applied here include: (1). Traditional: *halaqoh*, this *halaqoh* method is carried out when conducting lessons for speed reading, increasing memorisation or level up tests per *juz*, classical, classical methods are used when conducting yellow books learning (*fiqih, tafisr, lughot*, etc.), *At Ta'lim* method *At ta'lim* is carried out when parenting (between caregivers with student guardians and students), in this activity filled with problem solving obstacles experienced by students to find solutions. Tarhibwatarghib, which is a

[10]Hadion, dkk, *Generasi Z dan Revolusi Industri 4.0,* (Purwokerta, Pena Persada, 2020), hlm. 2

reward and punishment method for students who get the slightest achievement to get appreciation, from the most memorization, the best memorization and reading, the highest score, the smoothest memorization and so on, as well as students who violate will get punishment, such as being late, not praying in congregation and so on with educational punishment, namely memorizing 1 juz, reading *asmaulhusna*, *nadhomalfiah* and so on (2). Modern: multimedia, starting the covid-19 pandemic case, A transformation of learning with the help of multimedia is needed, this method is used when students‘ guardians visit or when students go home to always monitor students’ memorisation to the teachers. Administrative digitalisation, the institution has implemented digitalisation of all school administration, from payments, correspondence, permits and so on,

While the approach taken is through (1). *Bayani*: which is used through learning the yellow book of *tafsir*, *lughoh* (*alfiah*), namely understanding the Qur'an normatively textual. With this students will know the meaning and meaning of Al quran per word and the meaning of the word. (2). *Burhani*, which is used by understanding the verses of *kauniyah*. Students are invited to the surrounding environment to understand and learn the meaning of nature around. (3). *Irfani*, which is used through the recitation of the *dhikr* of *Surah alWaqiah* after the Isha prayer, fasting on sunnah Islamic holidays that are recommended to fast, and through *tahajud*, *hajat* and *dhuha* prayers.

4. CONCLUSION

Technology has enormous potential in supporting character education, especially in shaping quranic character for the Alpha and Beta generations. Through this technology, education can become more personalised, adaptive, and relevant to the challenges of the times. Qurani character building through technology integration can not only help the younger generation in understanding and practising Islamic values, but also equip them with moral and social skills that are essential in this increasingly complex world. Integrating technology in quranic character education can be a step forward in creating individuals who are not only intellectually smart, but also strong in morals and ethics.

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Folk Traditions As Tool For Overcoming The Challenges Of Artificial Intelligence In Education

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ABSTRACT

Modern education is undergoing a transformation under the influence of artificial intelligence (AI), which opens up new opportunities, but also creates a number of challenges, such as alienation from traditional values, a decline in critical thinking, and the loss of personal interaction. This article examines the role of folk traditions as a tool for overcoming these challenges. The study is based on the analysis of educational practices in which traditional teaching methods - oral traditions, rituals, mentoring, and collective forms of knowledge - contribute to the formation of moral guidelines, the development of communication skills, and the strengthening of intergenerational ties. Folk traditions are considered as a mechanism for adapting to technological changes, ensuring a balance between innovation and the preservation of cultural identity. Particular attention is paid to how the integration of folk pedagogy into the modern educational system can compensate for the deficit of emotional intelligence in AI-based learning. Examples from different cultures show that traditional practices develop empathy, responsibility, and awareness of collective identity, which is especially important in the context of digitalization. Thus, folk traditions act not only as a cultural heritage, but also as a relevant tool for harmonizing the educational process, allowing to effectively combine the achievements of AI with the deep values of society. The article emphasizes the need to synthesize technologies and traditions to form a sustainable educational environment of the future. In addition, the article considers the prospects for introducing traditional teaching methods into the digital educational environment, emphasizing the importance of a humanistic approach in the formation of personality. A conclusion is made about the need to synthesize technologies and folk pedagogy, which will create a sustainable educational system based on respect for the cultural heritage and intellectual development of a person. The methods of integrating folk tales, crafts, folklore and rituals into the educational process in order to preserve cultural identity and value education are analyzed. It is concluded that folk traditions can contribute to the harmonious development of the individual, combining the achievements of the past and the technological capabilities of the future.

Key words: folk traditions, artificial intelligence, education, critical thinking, cultural identity, digital addiction, emotional intelligence, folklore, value education, traditional crafts.

1. INTRODUCTION

The modern education system is rapidly changing under the influence of artificial intelligence (AI). Automation of learning processes, personalized learning, and virtual platforms open up new perspectives, but at the same time create a number of serious problems for society. These include a decline in the level of lively communication, loss of emotional engagement, weakening of critical thinking, and a deviation from traditional values. In the context of digitalization, the issue of preserving the humanitarian dimension of education is becoming particularly acute, which makes the search for tools that can harmonize technological progress and cultural traditions relevant. Folk customs and traditions accumulated over centuries are not only part of cultural heritage, but also a powerful source of knowledge. They include oral traditions, collective forms of knowledge, ritual systems, and mentoring that help shape moral orientations, develop communication skills, and strengthen intergenerational bonds. Unlike algorithmic digital technologies, traditional educational practices focus on developing emotional intelligence, collective thinking, and a sense of personal responsibility. In the context of digitalization, studying the role of folk traditions in education is of particular importance, as they can be an important tool to eliminate the negative consequences of the introduction of AI. This work is dedicated to analyzing folk pedagogy as a mechanism for adapting the education system to new realities, as well as finding ways to integrate it into modern digital educational platforms.

2. RELEVANCE OF THE TOPIC

The introduction of artificial intelligence (AI) into the field of education will lead to fundamental changes in teaching methods, the interaction between students and teachers, as well as in the process of personality formation. On the one hand, AI provides access to unlimited educational resources, automates knowledge assessment, and personalizes learning. On the other hand, the digitalization of the educational process is creating serious problems: a decline in the role of live communication, a weakening of emotional intelligence, a loss of critical thinking, and a retreat from traditional values. In such conditions, folk traditions serve as an effective tool for maintaining spiritual and moral orientations and harmonizing the educational process. They represent a system of time-tested pedagogical practices aimed at developing personal responsibility, collective interaction, and the transmission of cultural experience between generations. The introduction of folk pedagogy into the digital education environment allows for a balance between technological innovations and cultural values, preventing the mechanization of learning and student disengagement. The relevance of the topic is driven by the need to find new ways to integrate AI into the educational environment without losing the human dimension of learning. Researching of this issue will help not only identify the risks of excessive technologicalization of education, but also suggest strategies for minimizing them through the use of folk traditions. Thus, researching of this topic contributes to the development of a sustainable education model that combines advanced technologies with fundamental cultural and ethical principles.

3. LITERATURE REVIEW

The works of N.V.Karpov (2015) and Kuleshova (2018) in the field of ethnopedagogy, which reflect folk traditions and their educational potential, prove the great role of folk traditions in shaping a child's personality. Folktales, proverbs, songs, and rituals contribute to the development of values, critical thinking, and emotional intelligence.

For example, Krylova (2020) argues that oral traditions help children understand information and develop analytical skills. Studies investigating the impact of digitalization on education, such as Ivanov (2021) and Smirnov (2022), express the view that the active use of digital technologies reduces children's concentration levels, weakens their skills in lively communication and critical perception of information. Turgeneva's (2019) study highlights the dangers of gadget addiction, confirming the need to introduce alternative teaching methods, including folk traditions. The work of Gardner (1983) and Goulman (1995) on the theory of multiple intelligences and emotional intelligence on critical thinking and emotional intelligence in the AI era emphasizes the importance of emotional stability and the ability to analyze information. Sidorova (2020) proves that folk traditions, including collective forms of learning (games, holidays, rituals), help develop skills and increase the ability to adapt to change. According to research by Zaitsev (2017) and Belkina (2019), incorporating folk traditions into education contributes to the development of creativity and social competence. Practical examples of the introduction of ethnopedagogy into school education are provided by Sokolova (2021) in her study, which shows the positive influence of traditional culture on the formation of resistance to digital addiction. Incorporating elements of traditional culture into the educational process helps children develop critical thinking, social responsibility, and emotional intelligence, as well as adapt to the digital age.

4. RESEARCH METHODS

The following research methods were used to fully reflect and analyze the topic:

Theoretical methods: Analysis and synthesis - study of scientific literature on ethnopedagogy, artificial intelligence, and digitalization of education, identification of key patterns and connections. Comparative analysis comparing traditional teaching methods and modern digital technologies, identifying their strengths and weaknesses. Historical-cultural analysis studying folk traditions in educational contexts of different historical periods.

Empirical methods: Questionnaires and surveys – to collect data from teachers, parents, and students on the adoption of folk traditions in the educational process and their impact on children. Observation – recording children's behavior in an educational setting using folk traditions and digital technologies. Pedagogical experiment - introducing folk traditions into the educational program and analyzing their impact on the development of children's critical thinking, emotional intelligence, and social adaptation.

Qualitative methods: Case studies (analysis of specific cases) - examining successful examples of integrating folk traditions into the educational process. Content analysis of educational programs – studying the degree to which folk traditions are incorporated into educational standards and school courses.

Statistical methods: Quantitative analysis methods are the processing of data obtained from questionnaires, surveys, and experiments using statistical techniques. Correlation analysis to determine the relationship between the use of folk traditions and the level of children's adaptation to the digital environment.

Using a comprehensive approach that includes theoretical, empirical, qualitative and statistical methods will allow for a deeper understanding of the role of folk traditions in overcoming the challenges associated with artificial intelligence in education.

Main section. The modern education system is actively introducing artificial intelligence (AI) technologies that are transforming the learning and teaching processes. Positive aspects include personalization of the learning process, accessibility of knowledge, and automation of daily tasks. However, along with these advantages, there are also significant challenges that require a comprehensive understanding. For example, automating interactions between teachers and students leads to a reduction in personal connections, which can impair social skills and the ability to empathize. One of the main problems associated with the introduction of artificial intelligence (AI) into the learning process is the decrease in live communication between students and teachers. Traditional forms of learning involve active interaction, exchange of ideas, teamwork, and emotional connection, which contribute not only to knowledge but also to the development of social skills. However, with the current shift to digital platforms and automated learning systems, a number of negative trends have been observed. AI technologies are increasingly replacing teachers in the processes of testing knowledge, explaining material, and organizing the learning process. Online courses, virtual classrooms, and educational bots are reducing the need for face-to-face interaction, leading to students' disengagement from teamwork and a decline in their communication skills. Lively communication helps to develop empathy, listening skills, and the ability to express oneself. As the communication through text chats, forums, and video lectures has become increasingly prevalent, these skills have been weakened in the digital learning environment, and students have become accustomed to receiving information in a one-sided manner. This is causing difficulties in their relationships in life. Traditional pedagogy is based on personal interaction, where the teacher not only provides knowledge, but also emotional support to students.

Artificial intelligence is not capable of completely replacing a live teacher in terms of motivation, encouragement, and building trusting relationships. The reduction in live learning factors is reducing student engagement and leading to being tired. Group work, discussions, debates, and team projects develop students' ability to collaborate, consider the opinions of others, and find compromises. In the context of online learning and relationships based on individual intelligence, such forms of interaction are gradually losing relevance, which is reducing students' ability to solve problems collaboratively. Elements of folk traditions can be used to support lively communication and strengthen social interaction in the learning process, for example: mentoring and teaching from elders to younger ones - this helps to strengthen intergenerational ties and learn through personal experience. Joint ritual and cultural activities help to build community spirit, responsibility, and a sense of belonging to the community. Oral traditions (fairy tales, proverbs, legends) develop communication skills and active listening skills. Play and work group experiences promote learning through interaction and collaborative activities. .Integrating folk traditions into the educational process help minimize the negative effects of digitalization by maintaining vibrant communication as an important element of learning and upbringing.

AI-based learning focuses on data analysis and algorithms, which help students, memorize information without thinking deeply. One of the major challenges of using artificial intelligence (AI) in the learning process is the formalization of knowledge. This process is due to the fact that teaching based on algorithms and digital technologies emphasizes standardized assimilation of information, which leads to a superficial understanding of the material, a decrease in creative thinking, and a decrease in the role of practical experience. AI is focused on processing and analyzing large amounts of data, which has led to educational programs increasingly being built on the "question-answer" principle. Students remember information in a clearly structured form, but they are not always able to deeply understand and apply the knowledge they have gained in practice. AI-based technological educational platforms offer ready-made solutions and standard response algorithms. This reduces the motivation to seek alternative perspectives, hindering the development of independent analysis and critical thinking. As a result, students may develop knowledge that is formal in nature but does not help them understand the subject in depth. Traditional learning always involves applying knowledge to real-life situations through practice, discussion, mentoring, and group activities. In the context of digitalization, education is becoming more theoretical, with real-world experiences being replaced by virtual simulations that do not always capture all the nuances of the real world. AI programs are based on global educational standards, which can lead to the equalization of national, ethnocultural, and individual characteristics of education. In this case, education becomes ABSTRACT and disconnected from the traditional experience of the society in which the student is studying. To avoid the negative consequences of formalizing knowledge, it is necessary to turn to folk traditions that ensure deep, vivid, and practical assimilation of information. For example, oral transmission of knowledge (fairy tales, legends, proverbs, sayings). These forms of teaching promote associative and figurative perception of information, making it understandable and adapTable to everyday life. The second type is teaching through mentoring and experience. This form of transferring knowledge from elders to younger people, which helps develop skills based on personal interaction, enhances their practical application. As a third type, we offer elements of folk crafts and collective labor. Learning through practice, including traditional crafts, agricultural skills, or folk games, develops not only theoretical understanding, but also the ability to apply knowledge in real-life situations.In addition, children learn more by doing something once than by hearing it a thousand times. In addition, children can also experience feelings such as the animal world, love for nature, and the culture of farming.

Another recommended form of teaching is the development of critical thinking through oral and group discussions. Folk pedagogy includes elements of collaborative analysis of stories, proverbs, and myths, which contributes to the development of logic and thinking skills. Integrating these elements into the educational process helps minimize the effects of formalization of knowledge and ensures the development of critical thinking, creativity, and practical experience, which is especially important in the era of active implementation of digitalization and AI.

Technological education often ignores national characteristics and traditional forms of education, which leads to cultural alienation. One of the serious problems associated with digitalization and the introduction of artificial intelligence (AI) into the educational process is the weakening of cultural and moral values.Modern technologies are aimed at providing information in a unified, algorithmic format, which is leading to the loss of spiritual orientations, a decrease in the role of traditional pedagogical practices, and a weakening of students' cultural identity. The traditional education system, based on the teacher's personal example, lively communication, and mentoring, not only imparts knowledge but also shapes moral values. Artificial intelligence lacks the ability to convey emotional and moral experience, empathy, compassion, and respect for tradition. Automated learning platforms neglect the educational function and focus on rational acquisition of knowledge. AI programs based on global standards have universal educational models, which leads to a decrease in the role of national traditions and values. It is causing students to distance themselves from their own national traditions, language and customs, and to lose touch with their historical heritage. In many cultures, education traditionally involves participation in rituals, ceremonies and family traditions, which help to form a sense of belonging to society. The digitalization of education and distance learning technologies are reducing the participation of children and young people in these processes, contributing to the gradual loss of cultural values.

Modern technology provides students with a huge amount of information, but it does not always help them distinguish between right and wrong, truth and falsehood. In traditional education, the teacher plays an important role in shaping ethical principles, while AI cannot provide personal experience, empathy, and moral conviction. In order to prevent the deterioration of cultural and ethical values, it is necessary to actively introduce folk traditions into the educational process. As effective solutions, we propose the revival of oral folk pedagogy, the introduction of national traditions and cultural elements into educational programs, the use of mentoring and family traditions, and the joint holding of traditional rituals and holidays in educational institutions.
-Integrating folk traditions into the educational process helps maintain the spiritual and moral foundations of education by ensuring a balance between technological innovations and cultural values. We believe that this is the formation of socially responsible citizens who are not only highly educated, but also morally sTable, respectful of their cultural heritage and traditions.

The use of AI in education encourages students to rely on algorithms instead of developing their own thinking and decision-making. In such conditions, folk traditions can act as a tool to ensure the balance of the educational process, which helps to maintain a vibrant connection between generations and strengthen cultural values. The introduction of artificial intelligence (AI) and digital technologies into the educational process has led to increased convenience, personalization and accessibility of learning. However, on the other hand, another serious problem is created, technological dependence, which negatively affects the cognitive abilities, social adaptation and independence of students.

Modern educational platforms powered by AI offer ready-made solutions, test knowledge, and select individual learning programs. However, excessive use of such technologies reduces students' ability to independently analyze information, build arguments, and critically evaluate their acquired knowledge. Instead of thinking and searching for solutions, students begin to rely on automatic AI suggestions. As students become accustomed to interactive and playful educational platforms, traditional forms of learning (reading books, working with texts, participating in discussions) seem boring to them. This leads to a loss of interest in learning in an environment without digital support. In addition, reliance on algorithms limits students' creativity and initiative. Studies have shown that excessive use of digital technology reduces the ability to pay attention and remember information. Students who are accustomed to search engines and quick responses are less likely to remember the material because they know that they can always find it online. This leads to superficial assimilation of knowledge and reduces long-term memory.

The transition to distance and online learning formats has reduced the amount of live communication between students and teachers. As a result, schoolchildren and students have difficulty communicating in real life, losing empathy and teamwork skills. In addition, excessive exposure to the digital environment leads to gadget addiction, decreased physical activity, and deterioration of psycho-emotional well-being.

To reduce the negative consequences of technological dependence, we believe it is important to introduce the above-mentioned folk traditions into the educational process, which develop independent thinking, strengthen social ties, and preserve cultural identity. For example, telling young children fairy tales and involving them in discussions, memorizing proverbs and riddles trains memory, concentration, and speech skills, and reduces dependence on Internet resources. Meanwhile, folk games, dance groups, and joint folk rituals and holidays that involve performing physically lively movements strengthen interpersonal communication, develop communication skills, and reduce the influence of the virtual world.

Teaching traditional crafts, farming, cooking, and other practical skills helps students to move away from gadgets and develop patience, concentration, and coordination. The use of folk traditions in the learning process creates a balance between technology and lively interaction, helping students develop independent thinking, critical analysis, and social skills. As a result, education becomes not only high-tech, but also a harmonious, high-quality activity aimed at developing a person in the conditions of a digital society.

5. CONCLUSION

The development of artificial intelligence technologies in education is ineviTable, but when using them, traditional teaching practices should be taken into account. Folk traditions, as carriers of moral values and cultural experience, can be an important tool for overcoming the challenges associated with the digitalization of education. Their integration into modern educational programs will help maintain a person-centered approach, strengthen social ties, and ensure the harmonious development of students in the face of technological progress. The synthesis of tradition and innovation can create an effective educational environment, where the achievements of AI are complemented by deep values that ensure the comprehensive development of the individual and cultural continuity.Developing educational programs that take into account ethno cultural characteristics is an important and necessary step in creating an inclusive, just, and sustainable educational environment. In the context of globalization and cultural diversity, it is important not only to preserve and respect ethnic traditions, but also to integrate them into the educational process, which will contribute to the development of respect, tolerance, and mutual understanding among students.

The use of cultural elements in educational materials, teaching in native languages, organizing thematic courses and additional programs, as well as creating educational platforms that promote the preservation and dissemination of cultural heritage - all this teaches students to better understand their own culture and respect the cultures of other peoples. The successful implementation of such programs requires not only the availability of quality educational materials and resources, but also the training of teachers who are ready to work with the diversity of students, take into account their ethno cultural characteristics, and create an atmosphere of mutual understanding. It is also important to overcome stereotypes and biases in order to promote the integration and success of all students, regardless of their nationality. Thus, the inclusion of ethnocultural characteristics in educational programs is not only a way to preserve the rich heritage of peoples, but also a key factor in the formation of a harmonious, tolerant and diverse society.

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Sexual Orientation, Gender Identity & Expression and Sex Characteristics: Legal and Social Perspectives

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ABSTRACT

Sexual orientation, gender identity and expression, and sex characteristics (SOGIESC) form a critical aspect of human rights discourse in contemporary society. The recognition and protection of SOGIESC rights have evolved globally, with legal frameworks and judicial precedents playing a crucial role in ensuring equality and non-discrimination. Despite significant progress, challenges such as social stigma, legal hurdles, and institutional discrimination persist, impacting the lives of LGBTQ+ individuals. This paper explores the legal, social, and human rights aspects of SOGIESC, analyzing the historical developments, landmark case laws, and challenges faced by individuals belonging to the LGBTQ+ community. The research also examines international human rights instruments and domestic laws that shape the discourse on gender and sexual diversity. Additionally, this paper highlights the need for comprehensive legal reforms, increased public awareness, and inclusive policies to ensure equal rights for all individuals, regardless of their gender identity or sexual orientation. The paper concludes with recommendations for enhancing legal protections and promoting social acceptance for individuals with diverse sexual orientations and gender identities.

Keywords: Sexual Orientation, Gender Identity, Gender Expression, Sex Characteristics, LGBTQ+ Rights, Human Rights, Legal Recognition, Anti-Discrimination, Equality, Social Inclusion.

1. INTRODUCTION

The discourse on SOGIESC has gained significant attention due to increasing advocacy for the rights of LGBTQ+ individuals. These terms encompass various identities and expressions, challenging traditional notions of gender and sex. While some countries have embraced progressive legal measures, others continue to criminalize or marginalize non-conforming individuals. This paper examines the legal recognition and challenges surrounding SOGIESC rights, focusing on international legal frameworks, national jurisprudence, and the broader social implications.

2. LEGAL FRAMEWORK AND INTERNATIONAL HUMAN RIGHTS INSTITUTIONS

Universal Declaration Of Human Rights (Udhr) The UDHR (1948) lays the foundation for human rights, emphasizing equality and non-discrimination. Although it does not explicitly mention sexual orientation or gender identity, Articles 1 and 2 have been interpreted to include SOGIESC rights.

Yogyakarta Principles Adopted in 2006, the Yogyakarta Principles outline states' obligations to uphold SOGIESC rights under international law. These principles provide a framework for non-discrimination, legal recognition, and access to justice for LGBTQ+ individuals. The principles emphasize the need for legal gender recognition, protection against violence, and equal rights in areas such as employment, healthcare, and education.

3. OTHER INTERNATIONAL TREATIES

International Covenant on Civil and Political Rights (ICCPR) – The Human Rights Committee has ruled that discrimination based on sexual orientation violates ICCPR provisions.
Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) – Expands gender protections to include diverse gender identities.
European Convention on Human Rights (ECHR) – The European Court of Human Rights (ECtHR) has delivered landmark rulings upholding SOGIESC rights.
International Covenant on Economic, Social and Cultural Rights (ICESCR) – Recognizes the right to work, education, and healthcare without discrimination, including based on gender identity and sexual orientation.
Convention on the Rights of the Child (CRC) – Calls for the protection of all children from discrimination, including based on gender identity and expression.

4. CASE LAWS ON SOGIESC RIGHTS

4.1. India

Navtej Singh Johar v. Union of INDIA (2018)
The INDIAn Supreme Court decriminalized consensual same-sex relations by striking down Section 377 of the INDIAn Penal Code, recognizing LGBTQ+ rights as fundamental under Articles 14, 15, and 21 of the Constitution. This judgment was a landmark decision in affirming the dignity and equal rights of LGBTQ+ individuals.
National Legal Services Authority (NALSA) v. Union of INDIA (2014)
This case affirmed the rights of transgender persons, granting legal recognition to self-identified gender and mandating affirmative action. The ruling acknowledged the historical discrimination faced by transgender individuals and emphasized the necessity of social and economic inclusion.

4.2. United States

Obergefell v. Hodges (2015)
The U.S. Supreme Court ruled that same-sex marriage is a constitutional right, reinforcing the principle of equality under the Fourteenth Amendment. This decision was pivotal in securing marriage equality and dismantling barriers faced by LGBTQ+ couples in legal and social settings.
Bostock v. Clayton County (2020)
The Court held that discrimination based on sexual orientation and gender identity is prohibited under Title VII of the Civil Rights Act of 1964. This decision extended employment

protections to LGBTQ+ individuals, ensuring equal treatment in the workplace.

4.3. United Kingdom

Goodwin v. United Kingdom (2002)
The European Court of Human Rights held that the UK violated the rights of transgender individuals by refusing to recognize their gender identity. This case contributed to the legal recognition of gender identity and emphasized the importance of respecting self-identification.

5. CHALLENGES AND DISCRIMINATION

Despite legal progress, individuals face widespread discrimination in employment, healthcare, and public life. Issues include:

Conversion Therapy – Many countries lack bans on practices aimed at changing sexual orientation, which continue to cause significant harm to LGBTQ+ individuals.
Legal Gender Recognition – Transgender persons struggle with bureaucratic hurdles in obtaining identity documents that reflect their gender identity, which impacts their access to services and rights.
Violence and Hate Crimes – LGBTQ+ individuals are disproportionately affected by violence and targeted attacks, with many legal systems failing to provide adequate protections and redress.
Healthcare Discrimination – Many transgender and non-binary individuals face barriers to accessing gender-affirming care due to restrictive laws and lack of awareness among medical professionals.
Social Stigma and Marginalization – Persistent societal prejudices continue to exclude LGBTQ+ individuals from various aspects of public and private life, reinforcing inequality.

6. RECOMMENDATIONSAND CONCLUSION

To ensure greater protection and equality for SOGIESC individuals, legal and policy measures should include:

- Enacting comprehensive anti-discrimination laws to protect individuals from bias in employment, housing, education, and healthcare.
- Ensuring legal recognition of gender identity without unnecessary medical or bureaucratic requirements, making the process more accessible and dignified.
- Strengthening protections against hate crimes through enhanced legal frameworks, law enforcement training, and support services for victims.
- Enhancing public awareness and education on gender diversity to combat stereotypes and foster a more inclusive society.
- Implementing mental health and social support systems to assist LGBTQ+ individuals in overcoming systemic barriers and social stigma.

The recognition of SOGIESC rights is crucial for a just and inclusive society. By advancing legal frameworks and promoting social acceptance, states can fulfill their human rights obligations and create a world where everyone can live with dignity and freedom. Continuous advocacy, policy reforms, and judicial interventions are essential in addressing existing gaps and ensuring equal rights for all individuals, regardless of their gender identity or sexual orientation.

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Effects of Electric Vehicle Integration on the Indian Distribution Network

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ABSTRACT

In recent years, electric vehicles have become a significant trend in the global market. The integration of electric automobiles is one of the major changes that will take time to become sustainable and to meet customer expectations, especially when taking into account the scale of the INDIAn automotive sector. The main purpose of this essay is to analyse how electric vehicles (EVs) would affect the automobile business in INDIA. People who are thinking about buying an electric vehicle are worried about how far they can go since there is not a dependable charging network. The most significant issue is that the distance an electric car can go is restricted by the amount of time its battery lasts. In order to reduce range anxiety, it is essential to develop quicker battery-swapping technologies, establish a worldwide network of infrastructure investment, and create bigger batteries that are more inexpensive. The availability of public charging stations is an important factor that might greatly influence the adoption of electric automobiles. Building large public infrastructure may have certain benefits. As a consequence, thestudy will focus on research questions, objectives, and targets that will optimise the desired outcome of the study after a thorough evaluation of the many themes included in the article.

Keywords:* *Electric Vehicles (EVs), Environment, Technology, INDIAn Market, Infrastructure, Public, Battery, Automobile Industry.

1. INTRODUCTION

The widespread adoption of electric cars is needed as a way to address a variety of environmental issues, including climate change. About 23% of the world's Green House Gas (GHG) emissions from energy originate from the transportation sector. In order to keep global warming below 2°C, the transport sector must make a considerable effort to meet the ambitious objective of lowering greenhouse gas emissions.[1,2] if the electricity used to charge electric vehicles (EVs) is generated by power plants that burn fossil fuels rather than renewable sources, just moving from internal combustion engine (ICE) vehicles to EVs will not be sufficient to reduce greenhouse gas emissions. There will be a little decrease in the amount of greenhouse gases emitted throughout the world since it will only result in a shift in the use of fossil fuels from transportation to power.

Connecting a few hundred electric cars to the distribution grid will not have any impact on it. On the other hand, if there is a moderate to high penetration of electric vehicles into the distribution grid, grid operation and management will definitely encounter certain challenges.[3] The published pilot EV studies are examined in order to undertake the simulation study. The research assesses how varying rates of electric vehicle adoption affect low voltage distribution networks. This article talks about a Monte Carlo method that may be used to evaluate the impact of electric vehicles on distribution networks. This article examines the impact of electric vehicle (EV) charging on power quality due to the harmonics that are generated by the power electronic converters that are utilised in EV charging stations. [4, 5] Single-phase chargers are the home charging equipment for electric automobiles. This page explains the methods for charging these vehicles on a distribution grid, which rely on voltage. We assess the many challenges that hinder the incorporation of electric vehicles into the distribution network. The growth of electric vehicles (EVs) has been made possible by a variety of legislation in countries that have established EVs, all while ensuring a high level of grid security.[6]

This research investigates how the growing use of electric automobiles would affect the distribution network. When simulating electric car charging infrastructure, it is important to take into account the development of charging station scenarios that comprise a combination of slow, medium, quick, and high-power chargers. Furthermore, in every instance, it is necessary for us to create network models that include solar rooftop and storage. We take into consideration the energy consumption and losses of electric vehicles (EVs) in order to determine the long-term implications of EV load on the present feeder load.[7] The number of electric vehicles that are expected to be in the sample feeders in 2030 is estimated based on the following factors: current vehicle registration data, daily average distance travelled by vehicle segments, battery capacities, and electric vehicle policies from the INDIAn government, the NCT Delhi government, the Ministry of Power, Niti Ayog reports, and FAME schemes. We discuss the estimated number of electric cars that will be under the selected feeders for the fiscal year 2030. The presentation examines how the electric car charging infrastructure is affected by the charging pattern and the number of charges in the selected feeder. [8]

1.1. Charging Infrastructure

In order for electric automobiles to be successful, they need to be able to charge quickly. Charging infrastructures that use either alternating current (AC) or direct current (DC) are both

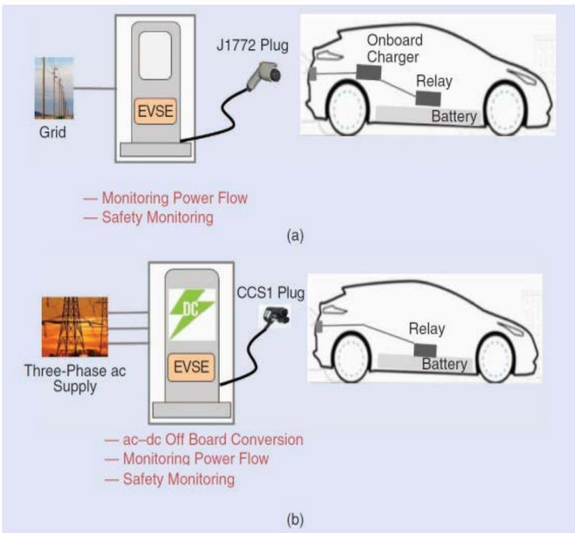

Figure.1.The various charging technologies (a) AC charging stations employ EV onboard chargers. (b) DC charging stations immediately charge EV batteries.

feasible. When utilising an onboard charger, which converts AC to DC, the battery energy storage system (BES) of the electric car is charged further. On the other hand, direct current charging sends power directly into the battery management system of the battery energy storage (BES), which is located within the electric vehicle (EV). You won't need any additional equipment on board if you wish to charge rapidly utilising DC power. The only method to charge quickly is to use direct current (DC). The charging infrastructure for both AC and DC charging is shown in the image below (Fig 1)

2. OBJECTIVES

This study's main objective is to investigate how electric vehicles (EVs) impact INDIA's distribution system. This includes looking at the increase in load demands, the need of upgrading infrastructure, and the integration of smart grid technologies. We will look at problems with charging infrastructure and power quality, and we will also explore the possibility of boosting grid stability via the use of Vehicle-to-Grid (V2G) technology. Furthermore, the study will assess the possible impacts on the government and the environmental benefits of adopting electric vehicles (EVs).

2.1. Impact of charging of EVS on distribution system

Switching to electric cars has various advantages, including a decrease in dependency on fossil fuels, an increase in the efficiency of the transportation system, a reduction in air pollution, and a decrease in global warming. Even with the many benefits of

Electric cars, the operations of charging and discharging do have an impact on distribution. The main impacts of charging are shown in Figure 2, and they are explained in detail below.[9]

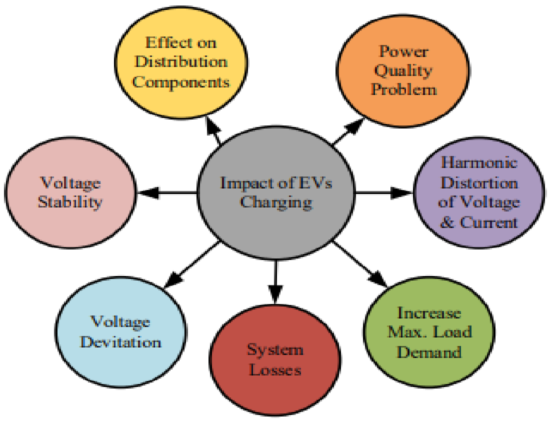

Figure.2.Impacts of EVs Charging on the Distribution System [9]

2.2. Voltage stability

Voltage stability is the ability of a system to maintain the steady-state voltage across all system buses, beginning at a predetermined point, in the presence of disturbances. An increase in the load has a major impact on voltage stability.[10,11] This article uses system simulation to find the bus with the weakest link in a 13-bus system. The goal is to establish the best locations for charging stations for electric vehicles across the distribution network. [12] Looks into how sTable the voltage is while electric vehicles are charging. Find out which node in a 33-bus radial distribution system is the most at risk of a voltage collapse by using the voltage stability index. The voltage sensitivity index is used to offer an optimal placement strategy for charging stations, which shows how their numbers change when there is demand for electric cars. I examined the impact of 43 various bus systems on the margin of static voltage stability that was created by charging electric automobiles. Looked at how the charging of electric cars on a fourteen-bus system impacted the stability of the power.[13,14]

2.3. Voltage deviation

This study concludes from its examination of voltage deviation that, in contrast to the main distribution system,[16] voltage variation on the secondary system typically occurs when the load from electric vehicles (EVs) grows. The difference between the voltage that is predicted and the voltage that is actually measured is called "voltage deviation." The answer is given by the formula.[17]

VD = Vn–Va
V_n = nominal voltage
V_a = actual voltage.
Varying nations have varying restrictions on the amount of voltage variation that is allowed. According to national standards, the standard limit of voltage variation in the United States is ±5% of the nominal voltage. The article demonstrates that the charging is uncoordinated and delayed, and it also shows that the voltage on the feeder is inconsistent.[18]

2.4. Increasing maximum load demand

Charging load is rising in tandem with the adoption of electric cars. [19] The grid is under increased strain during maximum load duration, reducing the reserve margin. examine how charging affects the distribution grid in various scenarios, such as unregulated home charging and charging during off-peak hours.[20] Review the effects of disorganised car charging and proposed tariff-based charge. [21]

Use daily, monthly, and year data to analyse the effect of charging EVs on the load curve when the penetration level of cars is varied. [22] Determines the effect of rapid charging on the distribution system and the effect of varying highway penetration levels on the maximum load demand at charging stations.[23,24] Have a look at the good and bad effects of charging on the grid. This paper's author utilised real-time driving data and user behaviour patterns to analyse the grid loading caused by electric vehicle charging. Examined how the distribution system might be affected by home charges. [25]

2.5. Poor power quality

Power quality has one meaning for utility companies and a completely other one for customers.[26] Utilities place a high value on power quality in terms of reliability, and customers depend on these utilities to provide them with the energy they need to operate their equipment correctly. When the IEEE language refers to power quality, it is talking about making sure that sensitive equipment is powered and grounded in a manner that is sufficient for it to work properly. [27] The quality of power is determined by three factors: voltage, frequency, and waveform. Power quality problems occur in the system because the charging load of electric cars is not a linear number. Problems with power quality include issues such as voltage sag and harmonics. [28]

2.6. Harmonic distortion of voltage and current

When the frequency of the signal is an integral multiple of the reference signal, we refer to it as harmonic. Harmonic distortion is caused by nonlinear loads and devices in the power system, as seen in Figure 3. Even when a perfect sinusoidal voltage is supplied across the nonlinear resistance, the current that flows through the load does not take the shape of a sine wave.[29]

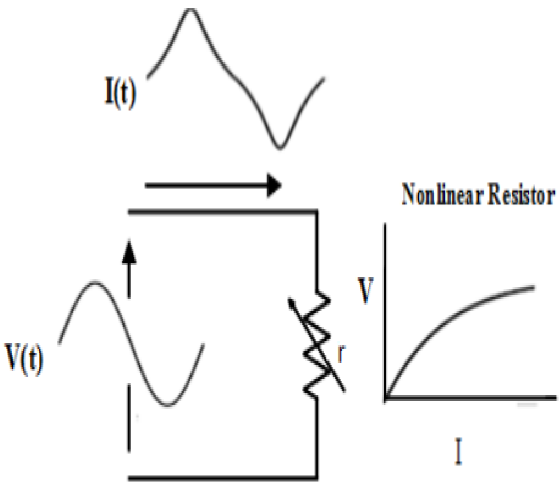

Figure.3.Current distortion caused by nonlinear resistance [29]

Harmonic distortion occurs while discussing current and voltage. There are two indices that may be used to measure harmonic distortion: total demand distortion and total harmonic distortion. Find out how much harmonic distortion is created by the charging load of electric cars and examine how harmonics affect the assets of the distribution system.[30,31] This research investigates the impact of harmonics on an IEEE 34-node system and finds that electric cars with a higher state-of-charge (SOC) have fewer power quality difficulties in distribution. Look at how charging electric vehicles at home affects distribution. [32] They discovered that home-based charging had a less impact on the distribution system by applying a stochastic method for their investigation. Employ a Monte Carlo simulation technique to find out how a charging plug-in hybrid electric vehicle (PHEVs) affects the distribution system. A remedy to this problem was presented, along with a proposal for how electric vehicle charging impacts the functioning of the distribution system.[33,34] I created a multi-stage zip model to account for electric car load and compared it to the constant power model. According to their findings, the load model must be accurate in order to demonstrate the actual impact on the distribution system in terms of voltage profile, system losses, and system load demand.[35] Examined the impact of harmonic distortion on the distribution system when charging at home and discovered that both the current flowing through the load and the voltage distortion in the substation bus bar are significantly influenced.[36] Looked at how different degrees of electric car charging impacted distribution in regard to voltage profile and harmonic distortion. Examine how different pricing strategies affect the distribution system. Investigate how charging electric cars affects the real distribution system in terms of the quality of the power supply. [37,38] Examined the impact that the levy would have on the distribution system.[39,40] A method was introduced that makes use of charging stations linked to renewable energy sources in order to improve the voltage profile of the distribution system and decrease the frequency of harmonic distortion. Proposes a random model for electric vehicles (EVs)[41,42] and electric buses and examines the impact on the distribution network. Investigate the impact of quick charging on the distribution system where the penetration of electric cars is capped at 50% and the penetration of wind output is capped at 30%. Examine the voltage profile, feeder overload,[43] and distribution system assets to determine how charging electric cars impacts the distribution system with very low voltage.[44,45]

2.7. Effect on distribution system devices

The typical process for generating and distributing electrical power includes a generating station,[46] a transmission system, and a distribution system. Electric cars need a significant amount of energy to operate. Due to a rise in the distribution of loads, some elements of the system are experiencing overloaded. Charging electric cars has an impact on the devices in the distribution system.[47] Find out more about how level 1 charging affects the distribution system and how uncontrolled level 1 charging may impair the lifetime of transformers. When there are a significant number of electric vehicles in the distribution system, uncontrolled charging may seriously damage transformers and other equipment.[48,49] The distribution transformer might quickly become overloaded by level 2, level 3, and fast chargers, depending on how many electric vehicles (EVs) are on the road. When the local distribution transformer is overloaded, it may lead to a number of issues, including voltage dips, harmonic distortion, losses in the transformer, and higher maximum demand. For this, a transformer with a bigger capacity, a larger cable, and an overhead line are all required. When charge loads are applied, the temperature of the transformer increases. [51, 52] This shortens the lifespan of the transformer and causes the feeder to become overloaded, which leads to a poor voltage profile in the distribution system. This study's authors have developed a model that may be used to forecast how distribution transformers and cables will respond when the penetration level of automobiles increases.[53] They also recommend a demand response strategy in order to reduce the burden on the distribution system that is created by charging electric vehicles. The controlled charging system may be used to extend the lifespan of the distribution transformer. The article shows how delayed charging may be used to fill in the troughs of the load profile. [54] To control charging, it proposes a charge management system and explains how it would affect the grid. The research investigates a low voltage distribution system in Greece that depends significantly on solar photovoltaic installations and has a large number of electric cars. The author proposes an energy storage system to keep the voltage within a certain range. This is necessary since the distribution system experiences both under and over voltage circumstances throughout the day due to the increased use of electric vehicles and solar energy. [55]

2.8. System losses

The demand for load will increase if electric vehicle charging is added to the grid. When the load is larger, the loss in the system is also higher because more current travels through the feeder. The research demonstrates that system losses, which are quantified for both unregulated and delayed charging, increase as the number of electric cars on the road increases. Provide an explanation of the investment in the distribution system and the system loss that was caused by the penetration of electric vehicles (EVs). Over 15% of the distribution system's cost is due to investments in network development, and system losses might reach 40% at a penetration level of 60%.[56]

2.9. EV Interaction with the Distribution Network

V2G is a technology that allows electric cars to send energy back and forth between themselves and the grid. This is made possible by the combination of the electric car charging infrastructure and information and communication technologies. The modeling research of electric vehicle interaction with the distribution network has advanced from its original stage of unidirectional mode to its current stage of bidirectional mode.[57]

3. RECOMMENDATIONS FOR FUTURE RESEARCH

The following recommendations for more research are based on these shortcomings:

Realistic EV Load Model and Profiles: Researchers in the future should leverage the increasing quantity of data on customers' electric vehicle (EV) use and charging patterns to develop more precise EV load models and profiles. These models must take into account factors like as energy use, driving behaviour, and the way consumers respond to different retail incentives. As a result, it is important to use the electric vehicle (EV) and load profiles, as well as the models that have been created using data from actual EV fleets. This includes the types of EVs and the types and usage of chargers. Commercial charging stations and commercial electric vehicles, especially big trucks, are expected to have a major effect on distribution networks. Previous study has not adequately addressed this element, and it should be investigated in more detail.

Detailed Impact Quantification: The present metrics that are used to assess network impact and hosting capacity are generally based on the classic worst-case strategy, which is often used in electrical system design. This technique might be misleading since you cannot use a bottleneck in one portion of the network to calculate the total hosting capacity of the whole network. Future studies should employ a rigorous quantification method to better understand the impact on individual assets, such as particular feeders or transformers. Probabilistic and statistical indications that might be incorporated include overload or voltage violation percentages, occurrence frequencies, and durations, among others. To find the optimal solution, it is important to measure the impact in detail so that we can understand the state of the network and how much it can really host.

Dynamic Hosting Capacity Assessment: It is important to conduct an accurate and complete review, but the hosting capacity of networks is also influenced by the level of penetration and operating states of distributed generators (DGs), storage systems, electric vehicles (EVs), and the network, including their modes of operation. As a result, it is essential to assess the network's capacity to host dynamic content. More study is needed in order to completely understand how different scenarios of electric vehicle adoption and operation affect network dynamic rating and capacity, as well as the inverse connection.

Techno-economic Analysis of Solutions: Despite the fact that regulated or controlled charging has been shown to be successful, there is a lack of research that investigates the regulatory and financial consequences of this system for many groups, including market players, network operators, and owners of electric cars or charging stations. Future study should examine a variety of solutions from a techno-economic standpoint in order to meet practical challenges, such as regulatory constraints.[58]

Role of Distribution Generation and Storage: Multiple studies have shown that regulated or controlled electric vehicle (EV) charging is not the best way to manage EV charging and its impacts. Rather, distributed generation and storage are more desirable options. In order to manage the specific demand for electric vehicle charging, it is necessary to ascertain the penetration level of distributed generators and power storage systems, as well as their operating regime; more research is needed in this area. In addition, it is important to do a thorough economic study of the additional distributed generation (DG) sources, such as solar photovoltaic (PV) systems, and storage systems that will be required to manage the demand for electric cars.

Holistic and Hybrid Approach: This is due to the fact that a number of factors, such as load demand, charging behaviour, network design, and regulations, influence the impact of electric vehicles (EVs) and the hosting capacity of distribution networks. In addition to affecting various objectives for solution development, such as network performance and the economics of EV mitigation solutions, many of these factors are unknown and subject to change. A more holistic and hybrid approach that incorporates two or more methodologies may be more effective in capturing the complexity and diversity of the situation and generating solutions. As previously said, using a number of objective criteria while developing solutions may result in strong and universal effects. In addition, there has not been a lot of study on how different mitigation measures impact various aspects of network design and functioning.

4. CONCLUSION

Integrating electric vehicles (EVs) into INDIA's electrical system has both benefits and drawbacks. Even while grid modernisation, smart charging solutions, and strategic planning may help reduce the strain that increased electric vehicle adoption might have on infrastructure, which can contribute to voltage instability and peak load variations, these issues can still be addressed. The distribution network's stability and sustainability rely on efficient demand-side management, the integration of renewable energy sources, and the collaboration of policymakers. Our study indicates that in order to optimise the interaction between electric cars and the grid, we need to invest in charging stations, improve load management systems, and implement laws and regulations. With proper planning, the adoption of electric vehicles (EVs) might increase the efficiency of the grid and assist INDIA in transitioning to sustainable energy.

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AI-Driven Educational Systems and Human Rights in INDIA: Ethical Considerations and Policy Implications

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ABSTRACT

The integration of Artificial Intelligence (AI) in education has transformed learning environments, offering personalized instruction, adaptive assessments, and data-driven insights. However, as AI-driven educational systems expand in INDIA, concerns regarding human rights, digital equity, and ethical governance emerge. This paper explores the intersection of AI in education and human rights, analyzing challenges related to data privacy, algorithmic bias, accessibility, and the digital divide. While AI has the potential to enhance educational opportunities, marginalized communities may face disproportionate disadvantages due to lack of digital infrastructure and biases in AI-driven decision-making. The study examines regulatory frameworks, including INDIA's National Education Policy (NEP) 2020 and global human rights standards, to propose policy interventions ensuring AI deployment in education aligns with principles of fairness, inclusivity, and transparency. Ethical AI governance, stakeholder collaboration, and responsible AI design are essential to prevent discrimination and uphold the right to education for all. By fostering an AI ecosystem grounded in human rights, INDIA can achieve an equiTable and sustainable digital education landscape. The findings contribute to the discourse on AI ethics, digital inclusivity, and policy frameworks for human rights-centric educational innovation.

Keywords: AI in Education, Human Rights, Digital Equity, Ethical AI, NEP 2020, Algorithmic Bias, Data Privacy, Educational Technology, INDIA, Digital Divide

1. INTRODUCTION

Artificial Intelligence (AI) has emerged as a transformative force in various sectors, including education. AI-driven educational systems offer promising advancements such as personalized learning, adaptive assessments, and predictive analytics that enhance student engagement and outcomes. In INDIA, the National Education Policy (NEP) 2020 underscores the importance of leveraging AI and technology to bridge educational gaps and improve access to quality education. However, the rapid integration of AI in education brings forth significant ethical and human rights concerns. These concerns revolve around issues such as data privacy, algorithmic bias, digital accessibility, and the potential exacerbation of socio-economic disparities. Addressing these challenges is crucial to ensuring that AI in education aligns with principles of equity, inclusivity, and fairness.

1.1 Background

The global education landscape is witnessing a paradigm shift with the integration of AI. In INDIA, AI-powered learning tools are being increasingly deployed in schools and higher education institutions to tailor learning experiences, automate administrative tasks, and enhance student performance. AI applications, such as intelligent tutoring systems and predictive analytics, enable educators to identify learning gaps and customize interventions accordingly. The NEP 2020 advocates for the adoption of AI to support adaptive learning and provide quality education to all students, irrespective of their socio-economic backgrounds. Despite these advantages, AI-driven educational systems raise critical ethical issues. Data privacy and security concerns arise as vast amounts of student data are collected and analyzed by AI systems. Algorithmic bias, stemming from skewed training data, can lead to unfair treatment of students from marginalized backgrounds. Moreover, the digital divide—characterized by unequal access to technology and the internet—poses a significant barrier to the equiTable implementation of AI in education. These concerns necessitate a careful examination of AI's impact on education through a human rights lens, ensuring that technological advancements do not reinforce existing inequalities.

1.2 Objectives

This paper seeks to explore the intersection of AI-driven educational systems and human rights in INDIA by addressing the following objectives:

- Analyze the ethical challenges posed by AI in education, including data privacy, algorithmic bias, and accessibility.
- Examine the implications of AI-driven educational systems for marginalized communities, particularly in the context of the digital divide.
- Evaluate the existing regulatory frameworks, including NEP 2020 and global human rights standards, in addressing these challenges. Propose policy interventions to ensure that AI deployment in education aligns with principles of fairness, inclusivity, and transparency.

2. METHODOLOGY

This study employs a mixed-methods approach, integrating qualitative and quantitative research methodologies. Data collection involves an extensive review of existing literature on AI in education, policy documents, and case studies from INDIAn and global contexts. Additionally, interviews with key stakeholders, including educators, policymakers, and technology experts, provide insights into the practical implications of AI-driven education systems. The analysis is grounded in human rights principles, particularly focusing on the right to education, non-discrimination, and digital equity. The study examines how AI applications align with these principles and identifies potential risks that could undermine educational inclusivity. By synthesizing findings from diverse sources, the paper aims to provide actionable recommendations for policymakers, educators, and technology developers to ensure ethical and equiTable AI deployment in INDIAn education.

3. AI IN EDUCATION: OPPORTUNITIES AND CHALLENGES

The integration of Artificial Intelligence (AI) in education has revolutionized traditional teaching and learning methodologies. AI-driven systems provide innovative solutions that enhance student learning experiences and improve educational outcomes. However, this technological advancement also presents challenges that must be addressed to ensure equiTable and ethical implementation. This paper explores the opportunities and challenges of AI in education, with a focus on personalized learning, adaptive assessments, data-driven insights, and concerns related to privacy, bias, accessibility, and ethical governance.

3.1 Opportunities

AI-driven educational systems offer several benefits that enhance the quality and efficiency of learning processes:

Personalized Learning: AI enables customized learning experiences by adapting educational content to individual students' learning styles, preferences, and pace. Through machine learning algorithms, AI can identify knowledge gaps and suggest targeted resources, ensuring students receive appropriate support and motivation. This approach enhances student engagement and retention, fostering better academic outcomes.

Adaptive Assessments: Traditional assessment methods often fail to accommodate diverse learning needs. AI-powered adaptive assessments provide real-time feedback, allowing educators to identify students' strengths and weaknesses. These assessments adjust difficulty levels dynamically, ensuring a more accurate evaluation of students' progress and enabling timely interventions to address learning gaps.

Data-Driven Insights: AI can analyze large volumes of educational data to generate meaningful insights into student performance and learning patterns. These insights support educators in making informed decisions about curriculum design, instructional strategies, and personalized interventions. By leveraging predictive analytics, institutions can enhance student retention rates and optimize resource allocation.

Automated Administrative Tasks: AI can streamline administrative processes such as grading, scheduling, and student support services. Automation reduces the workload on educators, allowing them to focus more on instruction and student engagement. Chatbots and virtual assistants can also provide instant responses to students' queries, improving efficiency in educational institutions.

3.2 Challenges

Despite these advantages, the integration of AI in education poses several challenges that need to be carefully addressed:

Data Privacy: AI systems require the collection and analysis of vast amounts of student data, raising concerns about privacy and security. Unauthorized access or misuse of sensitive information could lead to breaches of confidentiality and ethical violations. Clear data protection policies and robust cybersecurity measures are essential to safeguard students' personal information.

Algorithmic Bias: AI algorithms are trained on existing datasets, which may contain biases that can lead to discriminatory outcomes. If not carefully designed, AI-driven educational tools may reinforce existing inequalities, disadvantaging marginalized groups. Continuous monitoring and refinement of algorithms are necessary to ensure fairness and inclusivity in AI applications.

Accessibility: The digital divide in INDIA remains a significant barrier to AI adoption in education. Many rural and economically disadvantaged communities lack access to necessary infrastructure, such as high-speed internet and digital devices. Without addressing these disparities, AI could exacerbate educational inequalities rather than bridge them.

Ethical Governance: The absence of clear ethical guidelines and regulatory frameworks for AI in education poses risks related to human rights, accountability, and transparency. Policymakers must establish comprehensive regulations that ensure AI applications align with ethical standards and promote equiTable educational opportunities.

4. HUMAN RIGHTS AND AI-DRIVEN EDUCATIONAL SYSTEMS

4.1 The Right to Education

The right to education is a fundamental human right enshrined in various international human rights instruments, including the Universal Declaration of Human Rights (UDHR) and the International Covenant on Economic, Social and Cultural Rights (ICESCR). These frameworks emphasize that education should be accessible, inclusive, and of high quality. AI-driven educational systems hold immense potential to enhance the realization of this right by providing personalized learning experiences, improving accessibility, and bridging gaps in traditional education systems.

One of the significant advantages of AI in education is its ability to adapt to individual learning needs. AI-driven platforms can offer customized educational content based on a student's progress, strengths, and weaknesses, thereby fostering an inclusive learning environment. Furthermore, AI applications such as automated tutoring systems and intelligent assessment tools can support educators by reducing administrative burdens and enabling more effective teaching strategies. However, despite these benefits, AI-driven education also raises concerns regarding inclusivity and equity. If not properly implemented, such systems can reinforce existing disparities in educational access, particularly for marginalized groups, including those in low-income communities or remote areas. Ensuring that AI-driven educational tools align with human rights principles is crucial for their ethical and effective deployment.

4.2 Non-Discrimination and Equality

AI-driven educational systems must be designed and implemented with a strong commitment to the principles of non-discrimination and equality. Algorithmic bias, a significant challenge in AI applications, can arise from biased training data, flawed algorithms, or systemic prejudices embedded in datasets. If left unaddressed, these biases can lead to discriminatory educational outcomes, disproportionately affecting marginalized communities, such as students from underrepresented ethnic backgrounds, individuals with disabilities, and those from economically disadvantaged families. For instance, AI-powered assessment tools might reflect biases present in historical academic performance data, potentially disadvantaging students from certain socio-economic backgrounds. Similarly, AI-driven recruitment algorithms used in higher education admissions may unintentionally favor candidates from privileged backgrounds due to biased training data. These challenges highlight the need for ethical AI development that prioritizes fairness, transparency, and inclusivity.

To mitigate algorithmic bias, educational institutions and policymakers must adopt strategies such as diverse data representation, regular audits of AI systems, and human oversight in decision-making processes. Moreover, AI-driven educational platforms should be designed to provide equal opportunities for all students, ensuring that technology serves as a tool for empowerment rather than exclusion.

4.3 Digital Equity

Digital equity is a critical aspect of ensuring that AI-driven educational systems benefit all students regardless of their socio-economic status. Digital equity refers to the fair distribution of digital resources and opportunities, including access to internet connectivity, digital devices, and AI-powered learning tools. In many developing countries, including INDIA, the digital divide remains a significant challenge, preventing marginalized communities from fully benefiting from AI-driven education. Rural populations, low-income families, and persons with disabilities often face barriers such as lack of internet access, inadequate digital literacy, and unaffordable technological infrastructure. Without targeted interventions, AI-driven education may inadvertently exacerbate educational inequalities rather than mitigate them. Bridging this digital divide requires multi-stakeholder efforts, including government policies promoting digital infrastructure development, public-private partnerships to enhance affordable access to digital devices, and community-driven initiatives to improve digital literacy. In conclusion, AI-driven educational systems present both opportunities and challenges in advancing human rights, particularly the right to education, non-discrimination, and digital equity. While AI has the potential to democratize education, its implementation must be guided by ethical principles that prioritize inclusivity, fairness, and accessibility. Addressing algorithmic bias, ensuring equiTable digital access, and fostering inclusive AI design are essential steps toward leveraging AI for a more just and equiTable educational landscape.

5. Ethical Considerations in AI-Driven Educational Systems

The integration of artificial intelligence (AI) in education has the potential to revolutionize learning experiences by personalizing instruction, improving accessibility, and optimizing administrative processes. However, the implementation of AI-driven educational systems raises several ethical concerns that must be addressed to ensure responsible and equiTable use. This paper explores three key ethical considerations: data privacy and consent, algorithmic bias and fairness, and transparency and accountability.

5.1 Data Privacy and Consent

AI-powered educational tools rely heavily on data collection to enhance learning experiences and improve student outcomes. However, this extensive data collection raises significant privacy concerns, particularly regarding how student data is stored, processed, and shared. Informed consent is a critical aspect of ethical AI deployment, ensuring that students and their guardians are aware of and agree to the data collection practices. In INDIA, where data protection laws are still evolving, the absence of a robust regulatory framework exacerbates the risk of data misuse. The proposed Personal Data Protection Bill (PDPB) aims to address these concerns, but its implementation remains uncertain. Educational institutions and AI developers must adopt stringent data protection measures, including anonymization, encryption, and adherence to global best practices such as the General Data Protection Regulation (GDPR). Ensuring that students' data is handled ethically will foster trust and safeguard their privacy.

5.2 Algorithmic Bias and Fairness

Algorithmic bias is a significant concern in AI-driven educational systems, as biased training data or flawed algorithms can result in discriminatory outcomes. If AI models are trained on non-representative datasets, they may reinforce existing inequalities, disproportionately affecting marginalized groups. In the context of education, biased AI systems can lead to disparities in grading, recommendations for learning paths, and access to educational resources. To mitigate these risks, AI developers must prioritize fairness by using diverse and representative datasets, regularly auditing AI models for bias, and implementing corrective measures where necessary. Additionally, interdisciplinary collaboration between AI researchers, educators, and policymakers is crucial in establishing fairness guidelines and ensuring equiTable AI implementation in educational settings. Addressing algorithmic bias will help create more inclusive and just AI-driven educational environments.

5.3 Transparency and Accountability

Transparency and accountability are fundamental principles in the ethical governance of AI-driven educational systems. Students, parents, educators, and policymakers must understand how AI systems function and the rationale behind their decisions. The opacity of many AI models, particularly deep learning algorithms, makes it challenging to assess their decision-making processes. In INDIA, the lack of clear regulatory guidelines further complicates efforts to ensure AI transparency in education. Establishing explainable AI (XAI) frameworks, where AI decisions are interpreTable and accessible to non-experts, can enhance transparency. Additionally, accountability mechanisms, such as ethical AI guidelines, external audits, and grievance redressal systems, must be implemented to hold AI developers and educational institutions responsible for their AI-driven decisions. Ensuring transparency and accountability will promote trust and ethical AI use in education.

6. POLICY IMPLICATIONS AND REGULATORY FRAMEWORKS

6.1 National Education Policy (NEP) 2020

The National Education Policy (NEP) 2020 is a transformative initiative aimed at modernizing INDIA's education system through technology-driven solutions. One of its key objectives is integrating artificial intelligence (AI) into educational frameworks to enhance learning outcomes, promote personalized learning, and streamline administrative processes. However, while the policy advocates for AI-driven education, it lacks robust provisions addressing the ethical and human rights implications associated with AI implementation.

AI-driven educational systems often raise concerns about data privacy, algorithmic biases, and transparency. The absence of clear regulatory frameworks increases the risk of exacerbating existing inequalities in education. As AI technologies become more prevalent in classrooms, it is imperative to establish comprehensive guidelines that ensure fairness, inclusivity, and transparency. Policymakers must address issues such as equiTable access to AI-driven education, student data protection, and ethical AI deployment to safeguard the rights and interests of learners. A well-defined legal and ethical framework within NEP 2020 can bridge these gaps and foster responsible AI integration in education.

6.2 Global Human Rights Standards

International human rights standards, including the Universal Declaration of Human Rights (UDHR) and the International Covenant on Economic, Social and Cultural Rights (ICESCR), offer a crucial foundation for ethical AI governance in education. These frameworks emphasize key principles such as the right to education, non-discrimination, and digital equity, which are vital for ensuring AI-driven education does not deepen social and economic divides.

The UDHR highlights education as a fundamental human right, and the ICESCR reinforces the need for accessible, inclusive, and quality education for all. AI-driven educational platforms must align with these global standards to prevent the marginalization of disadvantaged communities. Moreover, the UNESCO guidelines on AI and education stress the importance of human-centered AI, advocating for ethical AI applications that respect human rights, cultural diversity, and democratic values.

By adhering to international human rights standards, INDIA can develop ethical AI policies that prioritize digital inclusivity, protect student data, and mitigate algorithmic biases. Establishing human rights-aligned AI governance frameworks will ensure that AI enhances, rather than hinders, equiTable education.

6.3 Policy Interventions

To address the ethical and human rights challenges associated with AI-driven education, several policy interventions must be implemented:

- ***Data Protection Legislation***: INDIA must enact and enforce robust data protection laws to safeguard student privacy. Comprehensive legislation, similar to the General Data Protection Regulation (GDPR), should regulate data collection, storage, and usage in AI-driven educational platforms. Informed consent and transparency in AI decision-making processes should be mandated.
- ***Algorithmic Audits:*** Regular audits of AI algorithms used in education should be conducted to identify and rectify biases that may perpetuate discrimination. Independent oversight bodies can ensure that AI models adhere to fairness and accountability standards.
- ***Digital Infrastructure Investment***: The government should invest in digital infrastructure to bridge the digital divide. EquiTable access to AI-driven education must be prioritized, ensuring that students from marginalized communities benefit from AI advancements.
- ***Ethical AI Guidelines***: The establishment of clear ethical guidelines for AI deployment in education is necessary. These guidelines should be formulated with input from educators, students, policymakers, and human rights experts to promote ethical AI development and use.

By implementing these policy interventions, INDIA can harness AI's potential in education while ensuring it aligns with ethical, legal, and human rights principles. This balanced approach will foster a more inclusive, fair, and transparent AI-driven educational ecosystem.

4. CONCLUSION

The integration of AI in education has the potential to revolutionize learning experiences, making education more accessible, personalized, and efficient. However, its rapid adoption in INDIA brings forth critical ethical and human rights challenges, including concerns over data privacy, algorithmic bias, and the widening digital divide. Without adequate safeguards, AI-driven educational tools may reinforce existing inequalities rather than bridge them.

To ensure the responsible and equiTable deployment of AI in education, it is crucial to establish comprehensive regulatory frameworks and ethical guidelines. Policymakers must work collaboratively with educators, technologists, and civil society to address biases in AI algorithms, protect student data, and promote digital inclusivity. Additionally, fostering AI literacy among teachers and students will empower them to navigate and critically engage with AI-driven learning systems.

By prioritizing transparency, fairness, and human-centric AI development, INDIA can harness the transformative power of AI while mitigating its risks. A well-regulated AI ecosystem in education will not only enhance learning outcomes but also contribute to a more just and sustainable digital education landscape. With strategic policies and ethical oversight, AI can be a catalyst for inclusive education, ensuring that all learners benefit from technological advancements.

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Overview of Direct Torque Control (DTC) Technique to Improve Dynamic Performance of Induction Motor Drives

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ABSTRACT

This paper provides a comprehensive overview of Direct Torque Control (DTC) for induction motor drives, emphasizing its advantages, challenges, and performance enhancements. DTC is widely recognized for its rapid torque response, simple control structure, and reduced dependence on motor parameters, making it a preferred choice for high-performance applications. By directly regulating torque and flux through optimal voltage vector selection, DTC ensures efficient motor operation without requiring complex transformations. However, conventional DTC suffers from high torque and flux ripples, which can degrade performance under dynamic load conditions. Various improvements, such as advanced switching strategies and predictive control techniques, have been proposed to mitigate these issues and enhance control accuracy. This paper explores the fundamental principles of DTC, its operational characteristics, and recent advancements aimed at reducing ripples and improving transient response. A review based on simulation results and comparative analyses through various research papers demonstrate significant enhancements in steady-state and dynamic performance, making DTC a viable solution for precision-driven industrial applications.

Keywords: Direct Torque Control (DTC), Induction Motor Drive, Machine Drives, Speed Control, Vector Control, Voltage Source Inverter.

1. INTRODUCTION

Direct Torque Control is an advanced control technique for induction motor drives that directly controls both the torque and flux of the motor in real time, without the need for traditional pulse-width modulation (PWM) schemes [1, 2]. First introduced by Takahashi and Noguchi in 1985 [3], DTC has since evolved into one of the most powerful methods for achieving high-performance control of induction motors. It is particularly valued for its fast dynamic response, high efficiency, and precise torque regulation, making it an excellent choice in applications where quick response and high performance are critical, such as in electric vehicles (EVs), industrial automation, and robotics.

The concept of DTC was developed to overcome the limitations of traditional motor control methods like Scalar Control (voltage or frequency control) and Field-Oriented Control (FOC), both of which rely on indirect control of torque [4, 5]. In FOC, the torque is indirectly controlled by maintaining the rotor flux aligned with the stator flux, which requires complex calculations and results in slower torque response due to the dependency on the current and flux measurements [6]. DTC, by contrast, directly controls the motor's torque and flux, offering significantly faster and more accurate control without relying on current regulators or rotor flux observers.

2. LITERATURE SURVEY

Direct Torque Control (DTC) is a high-performance control technique for induction motor drives, which has gained significant attention due to its ability to directly control both torque and flux. Over the years, several studies have contributed to the enhancement of DTC schemes by improving performance metrics like torque ripple reduction, dynamic response, and computational efficiency.

Takahashi and Noguchi (1985) introduced the concept of DTC, which focused on improving the response time and efficiency of induction motor control systems. Their work is seminal in the development of DTC, emphasizing direct control of torque and flux for fast dynamics and eliminating the need for rotor position sensors [3].
Depenbrock (1994) provided a comprehensive analysis of DTC, detailing its advantages over traditional vector control methods. This paper was pivotal in showcasing DTC's potential to achieve high-performance control without a modulator, which was a significant innovation at the time [4].
Zhao and Wang (2000) focused on mitigating the problem of torque ripple in DTC schemes, a challenge that limits the smoothness of motor operation. Their improvement in DTC reduced torque ripple, thus enhancing the overall motor performance [5].
Aliprantis (2002) compared DTC with Field-Oriented Control (FOC) in induction motor drives. Their study demonstrated that DTC offers better dynamic response but also highlighted its higher computational complexity, making it suiTable for high-performance applications but challenging for real-time control [6].
Zhao and Wang (2002) introduced an improved DTC scheme that further reduced torque ripple by optimizing the switching pattern. Their approach helped in achieving smoother operation, which is crucial for applications requiring high precision and low vibration [7].
Holtz (2003) surveyed sensor less control techniques for induction motors, including DTC. This paper outlined the challenges and solutions for implementing sensor less DTC, which is important for reducing system complexity and cost [8].
Liu and Xu (2004) presented a method of integrating Space-Vector Modulation (SVM) with DTC to enhance its performance. This approach reduced switching losses and improved the efficiency of DTC systems, making it more suiTable for industrial applications [9].
Bolognani (2005) conducted an experimental study on DTC, validating its theoretical advantages in real-world applications. Their work was crucial in bridging the gap between theory and practice in DTC implementation [10].
Vasquez and Espinoza (2007) developed a DTC scheme with flux regulation, further improving the stability and efficiency of the motor drive. Their approach was effective in managing motor flux and torque with better regulation [11].
Carrasco (2008) proposed the combination of DTC with Space-Vector Modulation (SVM) to reduce switching

frequency and improve system performance. Their work contributed to the development of more efficient DTC schemes [12].

Blasko and Kolar (2009) compared DTC and FOC for induction motors, highlighting the advantages of DTC in terms of dynamic response and torque control. Their study was instrumental in understanding the operational conditions where DTC outperforms FOC [13].

Wang and Zhang (2009) introduced a DTC scheme with fuzzy logic for torque ripple reduction. Their fuzzy-logic-based approach further enhanced DTC's smooth operation, demonstrating improved performance in reducing torque fluctuations [14].

Chong (2010) utilized Finite-State Predictive Control (FSPC) for DTC, enhancing the predictive capability of torque control in induction motors. Their work focused on improving transient response and system stability [15].

Lopez (2012) proposed a neural network-based DTC strategy for induction motors. This innovative approach used neural networks to improve torque and flux estimation, offering a solution for more accurate and efficient motor control [16].

Garcia (2012) applied sliding-mode control to DTC, aiming to improve robustness and performance in variable conditions. Their work enhanced the ability of DTC to handle parameter variations and external disturbances [17].

Jang and Lee (2014) proposed a novel torque control method that enhanced the transient response of DTC. Their work focused on improving the dynamic performance of DTC under load variations [18].

Jang and Lee (2014) further improved DTC by integrating fuzzy logic to enhance torque control. This method provided smoother torque and flux control, addressing the challenge of torque ripple [19].

Liu (2015) developed a sensor less DTC scheme based on high-frequency voltage injection. This method reduced the need for position sensors, making it more cost-effective while maintaining high performance [20].

Yang and Chen (2016) combined DTC with fuzzy logic in a dual-control method to enhance the performance of induction motor drives. Their approach improved efficiency and robustness in torque and flux control [21].

Liu (2017) optimized DTC using Model Predictive Control (MPC) to reduce torque ripple. Their work demonstrated that MPC could provide superior control for induction motors, especially in terms of dynamic response [22].

Zhang (2017) employed genetic algorithms to optimize DTC for reduced harmonics and improved performance. This optimization contributed to better efficiency and reduced noise in the motor system [23].

Shao and Li (2018) introduced adaptive sliding mode control for DTC, which improved performance by reducing torque ripple and enhancing system robustness. This method showed promising results in real-time applications [24].

Tan, H. (2021) enhanced DTC using artificial intelligence for improved torque and flux estimation. Their work highlighted the potential of AI techniques in further refining the performance of DTC systems [25].

Kavitha and Ramachandran (2023) introduced a hybrid control scheme combining DTC with neural networks. This approach effectively improved torque control and system efficiency [26].

Guan, Y. (2023) applied a hybrid optimization technique combining Genetic Algorithms and Particle Swarm Optimization to DTC. This multi-objective optimization approach enhanced the motor drive's overall performance and efficiency [27].

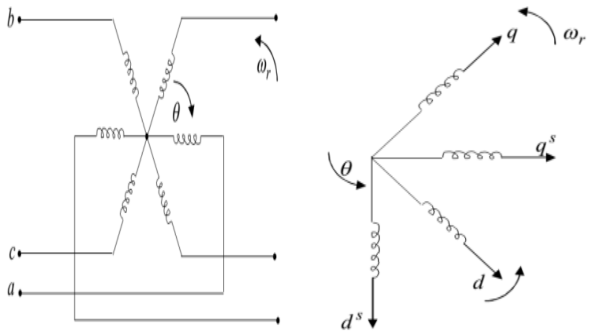
Nikolov, M. (2024) implemented high-frequency DTC for more efficient motor drives. Their work highlighted the advantages of high-frequency DTC in improving system responsiveness and energy efficiency [28].

Tao, Y. (2024) developed a multi-objective optimization for DTC to reduce torque ripple and improve efficiency. Their approach provided a balanced solution for both performance and energy efficiency in induction motor drives [29].

This literature survey highlights the evolution and continuous improvements in the DTC technique for induction motors, focusing on reducing torque ripple, improving dynamic performance, and enhancing computational efficiency. These advancements have made DTC an attractive choice for high-performance motor drive applications across various industries.

3. DYNAMIC MODELLING OF INDUCTION MOTOR

In a balanced three phase distributed windings at a stator of an induction motor, each are separated by 120 degree (Figure 1). A rotating magnetic field is generated when current starts flow through the winding. In an adjusTable-speed drive system, the dynamic behavior of the induction machine is precisely controlled through a power electronics converter [1].



(a) (b)

Figure.1.(a) Coupling effect in stator and rotor winding of motor (b) Equivalent two- phase machine

In the stationary reference frame, the **ds** and **qs** axes remain fixed to the stator. However, in the rotating reference frame, these axes rotate at an angle relative to the rotor, as illustrated in Fig. 2.The rotating reference frame may either be fixed on the rotor or it may be rotating at synchronous speed. In synchronously rotating reference frame with sinusoidal supply the machine variables appear as DC quantities in steady state condition.[11]

Machine modeling stationary frame by Stanley equation substituting, ω_e=0

The equations of stator circuit are given as:

$$v_{qs}{}^{s} = R_s i_{qs}{}^{s} + \frac{d}{dt}\psi_{qs}{}^{s} \quad (1)$$

$$v_{ds}{}^{s} = R_s i_{ds}{}^{s} + \frac{d}{dt}\psi_{ds}{}^{s} \quad (2)$$

$$0 = R_r i_{qr}{}^{s} + \frac{d}{dt}\psi_{qr}{}^{s} - \omega_r \psi_{dr}{}^{s} \quad (3)$$

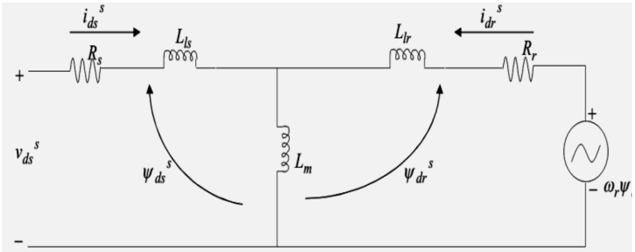
$$0 = R_r i_{dr}{}^{s} + \frac{d}{dt}\psi_{dr}{}^{s} + \omega_r \psi_{qr}{}^{s} \quad (4)$$

Where $\psi_{qs}{}^{s}, \psi_{ds}{}^{s}$ = q - axis and d - axis stator flux linkages.

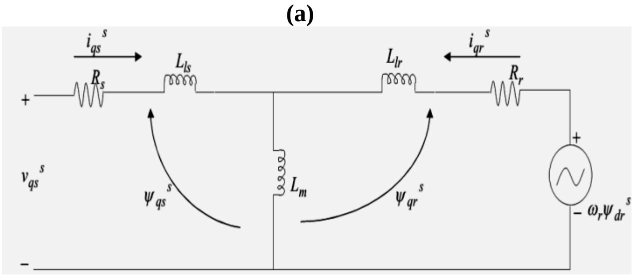
$\psi_{qr}{}^{s}, \psi_{dr}{}^{s}$ = q - axis and d - axis rotor flux linkages.

R_s, R_r = stator and rotor resistances

ω_r = rotor speed and $v_{dr} = v_{qr} = 0$



(a)



(b)

Figure.2.(a) & (b): d_s-q_s equivalent circuits

Electromagnetic torque is produced by the interaction of air gap flux and the rotor's mmf, the general vector form of the torque is given as:

$$T_e = \frac{3}{2}\frac{P}{2}(\overline{\psi_m}) * (\overline{I_r})$$

The torque equation can be given in stationary frame using the corresponding variables as follows:

$$T_e = \frac{3}{2}\frac{P}{2}(\psi_{dm}{}^{s} i_{qr}{}^{s} - \psi_{qm}{}^{s} i_{dr}{}^{s}) \quad (5)$$

$$= \frac{3}{2}\frac{P}{2}(\psi_{dm}{}^{s} i_{qs}{}^{s} - \psi_{qm}{}^{s} i_{ds}{}^{s}) \quad (6)$$

4. CONTROL TECHNIQUES BASED ON SENSORS

Selection of Voltage Vector: DTC utilizes a switching Table to choose the optimal voltage vector based on torque and flux errors, which is then applied to the motor. This ensures precise control over the motor's speed and torque [10].

Torque and Flux Estimators: DTC employs real-time estimations of torque and flux based on the motor's stator current and voltage. These estimators help in reducing the need for additional sensors, making the system cost-effective and more robust to external disturbances [11].

Switching Strategy: The control strategy dynamically adjusts the inverter's switching states to keep the flux and torque aligned with the desired reference values. This technique eliminates the need for PWM modulation, significantly reducing switching losses and minimizing electromagnetic interference (EMI) [9, 12]. SCIM control techniques are categorized into scalar and vector control (Figure 3). Scalar control relies on steady-state relationships, focusing on the amplitude and frequency of the controlled variables [13]. In contrast, vector control takes into account both the amplitude and position of a controlled space vector, making it valid even during transients. This is crucial for precise torque and speed control.

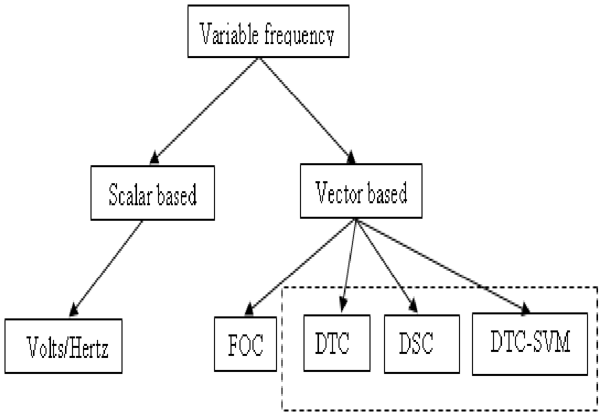


Figure.3.Several control techniques are used for PMSM, with those inside the dashed box belonging to the DTC family

5. DIRECT TORQUE CONTROL SYSTEM

The core principle of DTC is to select the appropriate voltage vectors based on the stator magnetic flux and the difference between the reference and actual torque [14]. Unlike PWM current control, DTC does not require a current control circuit or PWM comparator. As a result, DTC offers advantages such as reduced parameter dependence and faster torque response. Additionally, if the rotor's initial position is known, DTC can operate without the need for sensors.

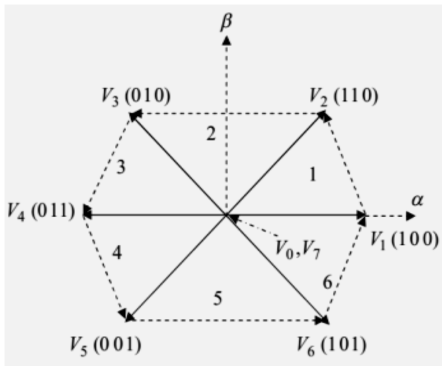


Figure.4.Inverter switching state vectors

In DTC, flux and torque errors are measured and digitized using a hysteresis comparator. The voltage vector position is determined based on the inverter switch status, as shown in Figure 4. The switching Table defines the inverter switch status. However, DTC suffers from higher torque and flux ripple and inconsistent switching frequency.[14]

The DTC scheme operates entirely in the stationary reference frame, eliminating the need for coordinate transformation. This result in reduced sensitivity to parameter variations compared to other control techniques. Additionally, the control actions are free from the delays in the absence of a feedback current control loop. Torque and flux estimators close the loop, while hysteresis comparators directly control the torque and stator flux. Figure 5 shows the basic block diagram of the conventional DTC scheme.

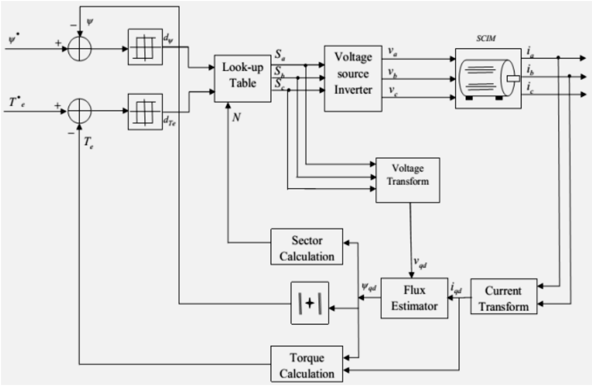


Figure.5.Block diagram of conventional DTC scheme for IM drives [5, 10-11]

6. POWER QUALITY ASPECTS [20-21]

In the Direct Torque Control (DTC) scheme, the conversion process of electrical power starts by transforming the AC mains voltage into DC voltage through an AC-DC power converter. This DC voltage is then converted into AC with variable frequency and voltage by a voltage source inverter to supply the SCIM.

For low-power applications under 2 kW, there is minimal emphasis on AC-DC converters in VSI-fed SCIM drive systems. At the time of this conversion process, input AC current is drawn in narrow pulses, which results power quality issues for nearby users. The key power quality concerns associated with DTC are:

- High total harmonic distortion (THD) of the supply current
- High THD of the input supply voltage
- Low power factor, displacement factor, and poor distortion factor

7. COPARISION & ANALYSIS OF VARIOUS CONTROL TECHNIQUES BASED ON PREVIOUS WORK

A comparison of the various control schemes is summarized in Table 1.

Table.1.Analysis within Scalar and Vector Control Techniques

Feature	Scalar Control	Vector Control
Control Principle	V/f ratio	Flux and torque decoupling
Complexity	Simpler	More complex
Cost	Lower	Higher
Performance	Limited at low speeds	High performance across a wide speed range
Dynamic Response	Slower	Faster
Torque Ripple	Higher	Lower
Sensor Requirements	Generally simpler	May require speed and position sensors

Thus, after reviewing the literature, an attempt has been made to summarize the various control strategies applicable to induction motor drives, as outlined in Table 2.

Table.2.Overview of Control and Optimization Methods for Enhancing Controller Performance

Review	Control Method	Drive Used
1985 et.al. [3], 1994 et.al. [4], 2000 et.al. [5], 2002 et.al. [7], 2005 et.al. [10], 2024 et.al. [28], 2024 et.al. [29]	PI Controller/DTC	IM
2002 et.al. [6], 2005 et.al. [11], 2009 et.al. [13]	DTC/FOC	IM
2003 et.al. [8], 2015 et.al. [20]	Sensor less /DTC	IM
2004 et.al. [9], 2008 et.al. [12]	SVM/DTC	IM
2009 et.al. [14], 2014 et.al. [19], 2016 et.al. [21]	Fuzzy Logic/DTC	IM
2010 et.al. [15]	FSPC/DTC	IM
2012 et.al. [16], 2023 et.al. [26]	Neural Network/DTC	IM
2012 et.al. [17], 2018 et.al. [24]	Sliding Mode/DTC	IM
2014 et.al. [18]	Novel Torque Control/DTC	IM
2017 et.al. [22]	Model Predictive Control/DTC	IM
2021 et.al. [25]	AI/DTC	IM
2017 et.al. [23], 2023 et.al. [27]	Genetic Algorithms and Particle Swarm Optimization to DTC	IM

8. CONCLUSION AND FUTURE RESEARCH DIRECTIONS

Direct Torque Control (DTC) represents a significant advancement in the field of motor control, providing superior performance in induction motor drives. By directly controlling torque and flux, DTC eliminates many of the limitations of traditional motor control methods, including slower response times and efficiency losses.

While challenges such as torque ripple and computational complexity exist, ongoing research and development are continuously improving the technique, making it more viable for a wide range of high-performance applications. The ongoing integration of modern algorithms, such as fuzzy logic, space-vector modulation, and model predictive control, will likely continue to enhance the performance of DTC, cementing its place as a leading motor control strategy in both industrial and commercial applications.

Since the introduction of DTC, significant research has been dedicated to enhancing the performance of DTC drives while preserving its key advantages:

- Low complexity
- Excellent dynamic response
- High robustness

However, the main drawback of DTC remains its relatively high torque and flux ripple. This paper presents one of the many proposed improvements to the DTC system.

Additionally, the impact of saturation and parameter-estimation errors on the performance of DTC for SCIMs, particularly on model-based estimators and controllers, requires further investigation. The focus is on sensor less controllers and estimators, which have broader applications beyond DTC SCIM.

The digital implementation of DTC SCIM, along with discrete modeling of SCIM and new DTC schemes, presents numerous opportunities for further research. Alongside the exploration of DTC schemes, there is a need for research into optimal switching strategies.

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AI-Powered Consumer Insights for Sustainable Business Practices: A Literature Review on Ethical Marketing and Green Consumerism

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ABSTRACT

Artificial Intelligence (AI) has become an integral tool in transforming sustainable business practices, offering insights into consumer behavior and ethical marketing strategies. As environmental concerns grow, businesses are increasingly leveraging AI to analyze purchasing patterns, predict sustainability trends, and enhance consumer engagement through ethical green marketing. This paper provides a comprehensive literature review on AI-powered consumer insights and their role in promoting sustainability-driven business models. By synthesizing existing research, the study explores how AI enhances transparency, optimizes resource efficiency, and fosters consumer trust in eco-friendly brands. Additionally, the paper examines key challenges, including data privacy, algorithmic biases, and the ethical implications of AI-driven marketing. The findings contribute to the academic discourse on sustainable consumerism and provide strategic insights for businesses seeking to integrate AI responsibly into their sustainability initiatives.

Keywords: AI-powered consumer insights, sustainable business practices, ethical marketing, green consumerism, predictive analytics, responsible AI

1. INTRODUCTION

1.1. Background of the Study

The growing urgency of climate change, resource depletion, and environmental degradation has led businesses to prioritize sustainability in their operations and marketing strategies. These global environmental challenges have placed unprecedented pressure on corporations to move beyond profit-centric models and integrate sustainable practices that contribute to long-term ecological balance. Traditional marketing approaches often struggle to address evolving consumer demands for environmentally responsible products, leading to skepticism and concerns about greenwashing. This disconnect between consumer expectations and marketing practices has, in many cases, undermined the credibility of sustainability efforts, prompting the need for more transparent and data-driven methods to understand and engage with eco-conscious consumers.

As a result, businesses are turning to AI-powered consumer insights to better understand sustainable consumer behavior and drive effective ethical marketing strategies. The application of artificial intelligence in this context serves as a critical enabler, allowing companies to not only gather and analyze vast amounts of consumer data but also to derive actionable insights that inform responsible and personalized marketing initiatives.

AI has emerged as a transformative force in the realm of sustainable business practices, enabling companies to track consumer preferences, analyze purchasing decisions, and tailor sustainability initiatives based on data-driven insights. The growing sophistication of AI tools has empowered businesses to shift from generalized messaging to more targeted, meaningful communication that resonates with consumers' ethical values. The integration of machine learning, predictive analytics, and natural language processing (NLP) allows organizations to assess consumer sentiment towards sustainability and optimize marketing strategies accordingly. These technologies offer enhanced capabilities in identifying consumer trends, decoding behavioral patterns, and adapting promotional efforts in real time, all while maintaining alignment with sustainability goals.

By leveraging AI, companies can personalize eco-conscious recommendations, reduce waste, and enhance ethical business transparency, ultimately fostering stronger relationships with sustainability-minded consumers. This strategic use of AI not only contributes to operational efficiency and competitive advantage but also aligns with the broader global movement toward responsible consumption and production. In doing so, organizations can build lasting consumer trust, reinforce brand loyalty, and meaningfully contribute to environmental preservation.

1.2. Need of the Study

Despite the increasing integration of sustainability into marketing strategies, a significant gap remains in effectively aligning consumer expectations with corporate sustainability communications. Traditional marketing methods often fall short in capturing the nuanced preferences of eco-conscious consumers, resulting in diminished trust and increased skepticism. Moreover, the potential of AI to address these gaps through advanced consumer insight generation and personalized engagement strategies remains underexplored in both academic research and practical applications. This study seeks to address the lack of empirical understanding regarding the intersection of AI technologies and sustainable marketing, and how this convergence can enhance ethical consumer engagement.

1.3. Significance of AI in Sustainable Business Practices

AI plays a pivotal role in addressing key challenges in sustainability, including:

Consumer Behavior Analysis – AI helps businesses segment eco-conscious consumers and predicts sustainable purchasing patterns.
Supply Chain Optimization – AI-driven solutions ensure efficient resource allocation and waste reduction.
Ethical Marketing & Green Advertising – AI enhances personalized engagementwhile ensuring transparency in sustainability claims.
Regulatory Compliance & Sustainability Metrics – AI tools aid businesses in aligning with global environmental regulations and reporting frameworks.

2. RESEARCH OBJECTIVES

This study aims to explore how AI-driven consumer insights contribute to sustainable business models and ethical marketing practices. The following are the main objectives of this study:

- To analyze the role of AI in understanding green consumer behavior and sustainability preferences.
- To Investigate AI's influence on ethical marketing strategies and responsible business practices.
- To examine the scope of AI-powered sustainability marketing, including data privacy, AI bias, challenges and limitations and ethical concerns.
- To identify future research directions for AI-driven sustainable consumer engagement.

3. METHODOLOGY

This study adopts a descriptive research design, which is appropriate for exploring and analyzing existing practices and trends without manipulating any variables. The research is based entirely on secondary data sources, allowing for a comprehensive understanding of how artificial intelligence (AI) is being applied to generate consumer insights in sustainable business contexts.

Data has been collected from a range of credible and relevant sources, including peer-reviewed journals, academic books, industry reports, and conference proceedings. These sources were selected based on their relevance to the fields of AI, sustainability, marketing, and consumer behavior. Priority was given to recent literature to ensure the study reflects current developments and applications.

By synthesizing insights from these secondary sources, the study aims to highlight the role of AI in shaping sustainable marketing strategies and enhancing ethical consumer engagement.

4. CONCEPTUAL FRAMEWORK

This conceptual framework outlines the interconnection between AI tools, consumer insights, marketing strategies, and sustainability outcomes. It serves as the theoretical foundation for understanding how AI technologies can drive sustainable business practices through informed and ethical marketing decisions.

At the first level, AI tools—including machine learning, natural language processing, and predictive analytics—are used to gather and process large volumes of consumer data (Chintalapati & Pandey, 2022). These tools enable businesses to decode consumer sentiment, behavior, and eco-conscious preferences. Building on these insights, the next level involves personalized and ethical marketing strategies. AI helps businesses develop tailored messages, product recommendations, and advertising content that align with consumer values, particularly environmental consciousness (Bashynska, 2023). This ethical approach mitigates green washing risks and strengthens brand trust.

Finally, such strategies lead to improved sustainability outcomes, such as increased consumer engagement with eco-friendly products, optimized resource usage, transparent value chains, and enhanced corporate environmental responsibility (Goel et al., 2024).

This framework suggests a feedback loop—where sustainability outcomes also generate new consumer behavior data, feeding back into AI systems for continuous improvement. The flow of this conceptual model is represented in Figure 1 below.

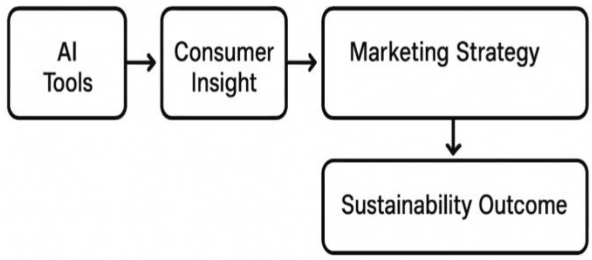

Figure.1.A Conceptual Framework Linking AI-Powered Consumer Insights to Sustainable Business Outcomes

5. LITERATURE REVIEW

The integration of Artificial Intelligence (AI) into sustainable business practices has generated profound transformations across marketing, consumer engagement, and operational efficiency. Aligned with the conceptual framework outlined earlier, this literature review presents a thematic synthesis of existing research under five interrelated domains: AI's role in understanding green consumer behavior, ethical marketing strategies, sustainable operations, personalized marketing, and key implementation challenges.

5.1. AI's Role in Understanding Green Consumer Behaviour

AI technologies have revolutionized the way businesses comprehend and respond to evolving patterns of sustainable consumer behavior. Through the deployment of machine learning and predictive analytics, firms can analyze complex behavioral datasets to identify environmental concerns, values, and purchasing motivators of green consumers.

Ganesh et al. (2024) demonstrate that AI-powered predictive models allow marketers to anticipate consumer preferences and proactively adjust marketing campaigns to align with sustainability expectations. Bolón-Canedo et al. (2024) further underscore AI's capacity to segment environmentally conscious consumers based on behavioral and psychographic data, enabling more precise targeting of sustainability messaging.

These insights support the conceptual model where AI acts as the foundational input for developing marketing strategies grounded in real-time consumer behavior. This intersection enhances the alignment between business offerings and eco-conscious consumer values.

5.2. AI-Driven Ethical Marketing Strategies

The ethical dimension of AI in marketing has gained considerable attention, particularly in the context of green consumerism. AI enhances transparency and accountability in marketing practices by validating sustainability claims and minimizing risks associated with green washing. Kumari et al. (2024) highlight the application of AI algorithms to audit and cross-verify environmental claims made by brands, promoting greater consumer trust. Goel et al. (2024) describe how AI-enabled dashboards and real-time sustainability analytics improve brand credibility by offering consumers verified insights into environmental performance. Furthermore, sentiment analysis tools driven by AI help brands stay attuned to consumer feedback, ensuring dynamic and responsible messaging that aligns with ethical marketing standards. As reflected in the conceptual framework, ethical AI applications form a bridge between consumer insight and strategy development, resulting in stronger and more transparent brand-consumer relationships.

5.3. AI in Sustainable Business Operations

Beyond marketing, AI has proven to be instrumental in optimizing core business operations for sustainability. Through intelligent supply chain management, inventory control, and energy optimization, AI tools contribute directly to environmental performance and resource conservation.

Zhao (2024) notes that AI-powered inventory management helps minimize overproduction and reduce waste, aligning operational efficiency with sustainability. Varghese (2022) discusses how AI-based energy systems support carbon footprint reduction by automating energy use and enhancing green logistics. Additionally, the integration of block chain with AI ensures traceability and sustainability compliance in sourcing and supply chain processes.

This domain supports the third component of the framework—translating insights into sustainable operational strategies—thus closing the loop between marketing, operations, and measurable outcomes.

5.4. AI-Driven Personalization in Sustainable Marketing

One of the most transformative applications of AI lies in its ability to hyper-personalize marketing efforts based on consumer data, a feature central to driving sustainable consumption. AI-driven recommendation engines and adaptive content systems enable businesses to tailor eco-friendly product suggestions that resonate with individual consumer values. Bashynska (2023) argues that personalization not only increases engagement but also nudges consumers towards environmentally responsible choices by reducing decision fatigue. Ganesh et al. (2024) add that AI-generated content can adapt to cultural, regional, and demographic contexts, increasing the inclusivity and global reach of green marketing campaigns.

In the context of the proposed conceptual framework, personalization acts as a strategic extension of AI-driven insights, effectively translating data into consumer-facing outcomes that support long-term sustainability goals.

5.5. Challenges in AI-Driven Sustainability Marketing

Despite its transformative potential, the deployment of AI in sustainability marketing is not without limitations. Ethical, technical, and regulatory challenges may hinder the responsible and equiTable use of AI technologies.

One primary concern is data privacy. AI systems require large volumes of consumer data, raising questions about consent and data security (Chauhan & Sahoo, 2024). Algorithmic bias is another issue; Afaq et al. (2025) warn that biased training data can lead to discriminatory marketing outcomes that marginalize certain consumer groups. Moreover, Marken et al. (2024) emphasize the environmental cost of AI, noting the high energy consumption involved in training and running complex AI models. To address these issues, Goel et al. (2024) call for the establishment of robust ethical and regulatory frameworks that promote transparency, fairness, and environmental accountability in AI deployment.

These challenges underline the importance of critical reflection when applying AI to sustainability contexts, as also indicated in the conceptual model, where feedback loops and governance are essential for responsible innovation.

6. CONCLUSION

This study has provided a comprehensive literature review on the role of AI-powered consumer insights in advancing sustainable business practices and ethical marketing strategies. The findings highlight that AI is a transformative tool that enhances consumer engagement, optimizes resource allocation, and fosters responsible marketing practices. By leveraging AI-driven analytics, businesses can gain a deeper understanding of green consumer behavior, tailor sustainability messaging, and implement data-driven strategies to improve consumer trust in eco-friendly brands. The research underscores that AI-driven consumer insights contribute to greater transparency, personalized sustainability marketing, and enhanced regulatory compliance. However, the study also reveals key challenges, including data privacy concerns, algorithmic biases, and the ethical implications of AI-driven decision-making**.** These challenges necessitate the development of robust AI governance frameworks to ensure responsible and equiTable use of AI in sustainability efforts.

Future research should focus on improving AI's role in real-time sustainability monitoring, integrating AI with blockchain for supply chain transparency, and developing AI-driven behavioral models for eco-conscious consumer engagement. Additionally, businesses must adopt a more holistic approach to AI ethics, ensuring that their sustainability initiatives are aligned with broader societal and environmental goals. AI-powered consumer insights are emerging as a powerful force in reshaping how businesses approach ethical marketing and sustainability. These technologies allow companies to connect more meaningfully with environmentally conscious consumers by offering personalized, transparent, and values-driven experiences. When used responsibly, AI doesn't just help brands sell more — it helps them do better for people and the planet.

But with this opportunity also comes responsibility. Challenges like protecting consumer privacy, avoiding algorithmic bias, and minimizing the environmental impact of AI systems cannot be ignored. Businesses must find a thoughtful balance combining innovation with accountability. Looking ahead, success will depend not just on smarter algorithms, but on smarter choices. With clear ethical guidelines, collaboration across sectors, and a deep commitment to sustainability, AI can become a real driver of positive change — helping companies grow in ways that are good for consumers, communities, and the environment alike.

7. FUTURE DIRECTIONS IN AI-POWERED SUSTAINABLE MARKETING

Given the rapid advancements in AI and sustainability, future research should focus on:

- Enhancing AI's ability to automate sustainability reporting for businesses.
- Developing ethical AI frameworks that ensure unbiased and responsible AI-driven green marketing strategies.
- Exploring the integration of AI with IoT and block chain to improve supply chain transparency and sustainability tracking.

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A Complete Review of Artificial Intelligence for Pharmacology Methods

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ABSTRACT

With the origination and progression of artificial intelligence, more and more artificial intelligence techniques and clinical medicine preparation, especially in the field of pharmacology methods. Thus, this review focuses on the applications of artificial intelligence in drug discovery, compound pharmacokinetic prediction, and clinical pharmacology. We momentarily introduced the basic knowledge and development of artificial intelligence, presented a comprehensive review, and then summarized the latest revisions and conversed the strengths and limitations of artificial intelligence models. Furthermore, we emphasized several significant studies and pointed out possible instructions.

Key words: ***artificial intelligence, pharmacology, drug discovery, complex pharmacokinetic, extrapolation, investigational pharmacology***

1. INTRODUCTION

Artificial intelligence (AI) is defined as the intelligence exhibited by artificial entities to solve complex problems, and is generally considered to be a system of computers or machines, with the emergence of big data and the improvement of computing power, machine learning, artificial neural networks and deep learning. Have been developing rapidly and continued to integrate other disciplines in recent years, achieving great success in theory and application shows the relationship between AI and related concepts such as machine learning, artificial intelligence, and deep learning [1]. Meanwhile, Figure 1 shows the applications of artificial intelligence in pharmacology research. Pharmacology is a very complex study involving a lot of computing, data statistics and analysis. A number of AI methods have been used in pharmacology methods, where the most widely used fields are AI-assisted drug discovery and design prediction of compound pharmacokinetics [2]. The contribution of AI in pharmacology research does not appear suddenly, but with the development of AI and pharmacology themselves, mutual promotion and growth [3]. It is generally believed that the scope of pharmacology is comprised of drug discovery, design, explanation of mechanisms, drug metabolism and actual clinical methods etc., Therefore, pharmacology is a very complex and comprehensive science.

The relationship between artificial intelligence, machine learning and deep learning described as follows-

2. AI-BASED DRUG DISCOVERY AND DESIGN

Classical molecular drug discovery and design encounters several difficulties and encounters such as long expansion time, low clinical success rate and high cost. In general, it takes about 13.6 years for a drug molecule to be advanced and approved for marketing, and the total cost to develop a new drug is about $2.6 billion [4]. Recently, the progress and application of AI has facilitated the research associated to drug discovery and drug design, which is reflected in three main aspects:

- Using AI to predict the structure of proteins and RNA;
- AI-assisted drug discovery,
- Using AI for drug design.

However, there are still many limitations remaining to be solved and optimized. For example, how to further advance and optimize AI methods to predict structure and conformational ensemble for protein complexes and unstructured proteins should be the most important direction in the future [5].

2.1. Using AI to forecast the structure of proteins in addition RNA

The analysis and investigation of the 3D structure of proteins and the related molecules is the precursor for drug discovery and design. It is highly accurate to obtain the 3D structure of proteins and RNA by physical and chemical experimental methods, but it requires a lot of manpower and financial resources [6]. Therefore, recent studies employ computing techniques to predict the 3D structure of molecules Classical 3D structure prediction methods consist of de novo modeling, fragment assembly [7], and homology modeling, the mechanism of which are based on rule-based computing and splicing but not using AI for 3D structure prediction [8].

2.2. AI-assisted drug discovery

From the random screening and empirical observation of the effects of natural products on disease to discover drugs, to the use of high-throughput screening (HTS) to batch screen drugs against molecular targets and to computer aided drug design (CADD) the approach to discover novel drugs continues to be revolutionized [9]. With the rapid development of the computational power and algorithms of AI, as well as the rapid expansion of drug-like available chemical space, a new revolution is coming for drug discovery Since computer- aided drug discovery not only can decrease the drug development cycle, but also it can reduce the cost of the clinical trial phase, related studies were carried out to assist and accelerate drug discovery [10], which include the development of virtual screening molecular dynamic simulation and molecular docking. In these studies, computer-aided drug development has been categorized into two main approaches according to whether the molecular structure is known or not [11]. One is the structure-based approach and the other is the ligand-based approach. Ligand-based approaches use similarities of known active molecules to carry out modeling and computing, whereas structure-based approaches focus on computing and prediction for binding affinity [12].

2.3. Using AI for drug design

Strictly speaking, drug discovery is to discover potential drugs by computational, experimental, and clinical models, whereas drug design is to design and develop new drugs based on known signaling pathways and biological targets, i.e., designing molecules that match their target molecules in shape and charge Here, we will focus on the applications of AI in drug design, namely de novo drug design Denovo drug design[13] refers to generating a series of new molecules that meet certain constraints by developing generative algorithms. The advantage of this approach is that we can design a drug in such a greater chemical space that could develop more targeted drugs for the treatment of diseases. However, it encounters such a challenge that is how to generate a new molecule, which is sTable and easy to produce without a starting template [14]. Traditional de novo drug design is comprised of structure based, ligand-based, sampling-based, and evolutionary algorithm-based approaches, which is due to space limitations.

2.4. AI for clinical pharmacology

Besides the above work related to drug discovery, drug design and pharmacokineticsprediction, AI has many applications in clinical pharmacology [15], such as using AI to optimize clinical trial design, simulate clinical trial results, optimize drug treatment process, predict drug interactions and adverse reactions, and so on.

2.5. AI in clinical trials

Clinical trial is an important stage in the development of drugs. The failure during clinical trials will result in a huge loss of time and cost. Thus, using AI to assist clinical trials will effectively improve efficiency and success rate [16]. As we know, it is one of the most challenging steps to recruit the relevant patients during the clinical trial design. For this reason, we usually employ machine learning algorithms to screen the patients, match them to the trial's inclusion criteria through multiple aspects of data, and guarantee that the included patients are suiTable for that clinical trial [17].

2.6. AI in optimizing drug treatment

Besides the applications related to clinical trials, AI can be used to optimize the therapeutic effects of drugs, which is important for clinical pharmacology [18]. These applications include but are not limited to dosage of drug recommendations, individualized medical recommendations and effect prediction, adverse drug reactions, and prediction of drug interactions.

3. RESULT AND DISCUSSION

AI have advanced many researches in biology disease cancer and so do pharmacology. This review has briefly introduced the basic concepts of AI and the history of its development, and then summarized the applications of AI in pharmacology from three aspects: drug discovery and design, clinical pharmacology As AI has made great success and breakthroughs in structure prediction, drug discovery and design, and pharmacokinetic parameter estimation, it is possible for us to build up an automated drug discovery and design platform by integrating these three research directions, a vision for future research. Moreover, it is foreseeable that AI models will gradually replace many previous traditional models, and even part of the work of humans. In this process, how to supervise, control and reasonably develop AI models will be an important issue to address and a future study direction.

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AI-Driven Recruitment and Talent Management: A Perception of Alpha with Beta Gen

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ABSTRACT

The rapid integration of Artificial Intelligence (AI) in recruitment and talent management has reshaped the landscape of human resources. This research paper explores the perceptions of the Alpha generation (born from 2010 onwards) juxtaposed with the Beta generation (born from 1995 to 2010) towards AI-driven recruitment methods. We will examine the advantages and challenges posed by AI technologies, analyze data through statistical methods, and present case studies that illustrate real-world applications and implications. This examination aims to provide a comprehensive understanding of generational perceptions concerning AI's role in employment processes.

Keywords: Talent Management, Resume, AI, NLP, T-Test, AU, VU, ML.

1. INTRODUCTION

1.1 Background

Human resources management has evolved dramatically in the 21st century, primarily due to technological advancements. AI-driven tools are increasingly deployed to streamline recruitment processes. AI facilitates resume screening, candidate assessments, and even interview scheduling while promising efficiency, objectivity, and cost-effectiveness. However, perceptions of these implementations vary across generational cohorts. In recent years, artificial intelligence (AI) has emerged as a transformative force in various industries, revolutionizing traditional processes and enhancing efficiency. One area significantly affected by AI is recruitment and talent management. This research paper aims to explore the perceptions of two distinct generational groups—Generation Alpha (born after 2010) and Generation Beta (born between 2000 and 2010)—toward AI-driven recruitment practices.

As organizations increasingly adopt AI technologies to streamline hiring processes, it becomes essential to understand how different generations view these advancements. This paper will delve into the values, expectations, and concerns each generation holds about AI in hiring, ultimately assessing the implications for HR strategies in the evolving workforce landscape.

Figure.1.HRM Process

1.2 Talent management

Talent management is the science of using strategic human resource planning to improve business value and to make it possible for companies and organizations to reach their goals. Talent management has following main phases:

- Talent Acquisition
- On-boarding & Engagement
- Learning & Development
- Performance Management
- Succession Planning
- Workforce Planning

Figure.2.Talent Management Phases

1.3 Purpose of the Study

This paper aims to survey the perceptions of the Alpha and Beta generations regarding AI-driven recruitment. We will define these generations, highlight significant technological changes in recruitment, and analyze survey results to measure attitudes towards AI.

Figure.3.Recruitment Technology Solutions

1.4 Research Questions

- What are the perceptions of Alpha and Beta generations towards AI in recruitment?
- How do generational values influence their acceptance of AI-driven processes?
- What challenges and advantages do they perceive in AI-driven recruitment?
- Why do generational values influence their acceptance of AI-driven processes?
- What impact and advantages do they perceive in AI-driven recruitment?

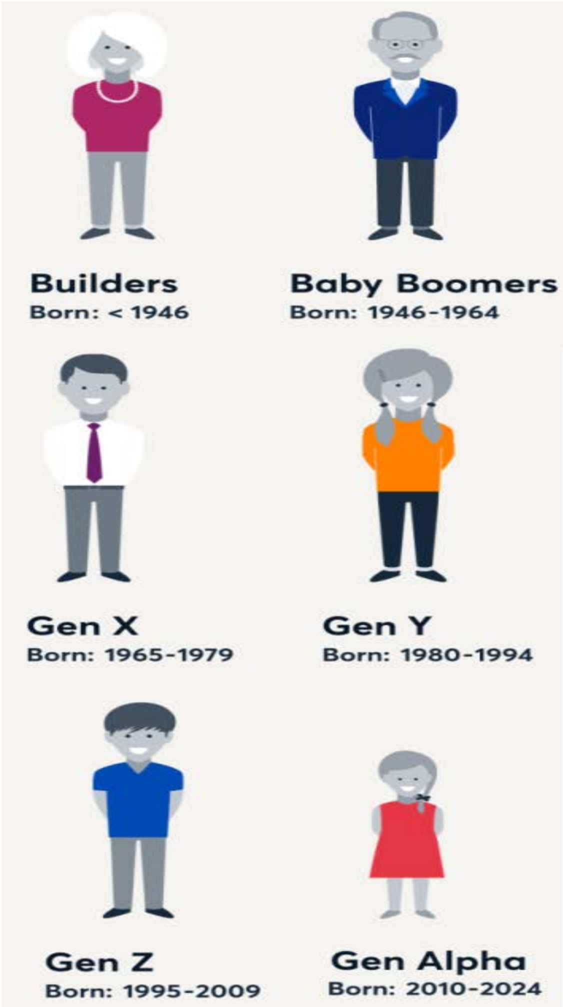


Figure.4.Generation Chart

2. LITERATURE REVIEW

2.1 Generational Definitions

Alpha Generation: Individuals born from 2010 onwards. This generation is characterized by digital immersion from birth, with formative experiences shaped by advanced technologies and post-pandemic realities.
Beta Generation: Individuals born from 1995 to 2010. This generation witnessed the rise of the internet and mobile technology, representing a bridge between traditional and digital environments.

2.2 AI in Recruitment

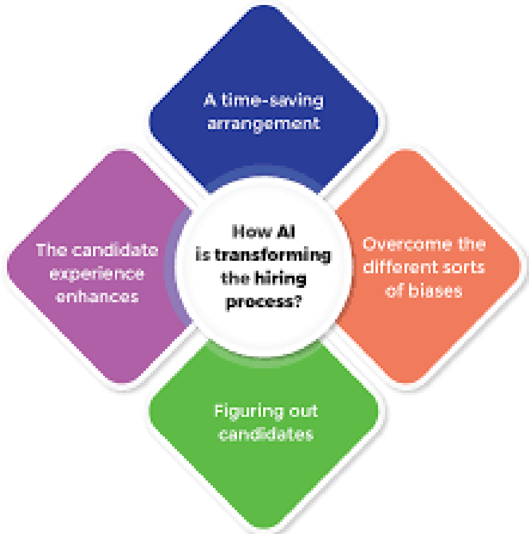


Figure.5.AI in Recruitments

- AI technologies applied in recruitment encompass various functions:
- **Resume Screening**: Algorithms filter applicants based on skill sets and keywords.
- **Chatbots**: Provide candidate engagement and immediate responses.
- **Predictive Analytics**: Forecast candidate success based on historical data.
- **Video Interviews**: Utilizing AI for analysis of non-verbal cues.

2.3 Current Studies and Trends

Recent studies indicate that while older generational cohorts are generally more skeptical about AI, younger generations exhibit higher acceptance due to their familiarity with technology. A systematic review of the literature reveals mixed attitudes toward AI in recruitment, impacting trust, ethical considerations, and variable acceptance rates.
Overview of AI in HR: Discuss how AI has been integrated into human resource functions, including applicant tracking systems (ATS), automated resume screening, and chatbots for initial candidate engagement.
Historical Context of Recruitment Processes: Trace the evolution of recruitment methods, from traditional face-to-face interviews to the integration of technology.
Theoretical Framework on Generational Characteristics: Review existing literature on generational differences, highlighting factors influencing workplace attitudes and technology adoption.

3. METHODOLOGY

3.1 Research Design

A quantitative survey approach was adopted, distributed online to assess the perceptions of the two generations. The survey was designed to gather data on attitudes towards AI-driven recruitment.

3.2 Sample Size and Selection

The sample size comprised 100 respondents: 50 from the Beta generation and 50 from the Alpha generation. Sampling was conducted via social media platforms and university networks to ensure representation.

3.3 Data Collection Tools

Survey tools included Likert scale questions, multiple-choice questions, and open-ended responses, focusing on aspects such as usefulness, trust, and perceived efficiency.

3.4 Statistical Methods

Data analysis was performed using the following statistical methods:
Descriptive Statistics: To summarize basic features of the data.

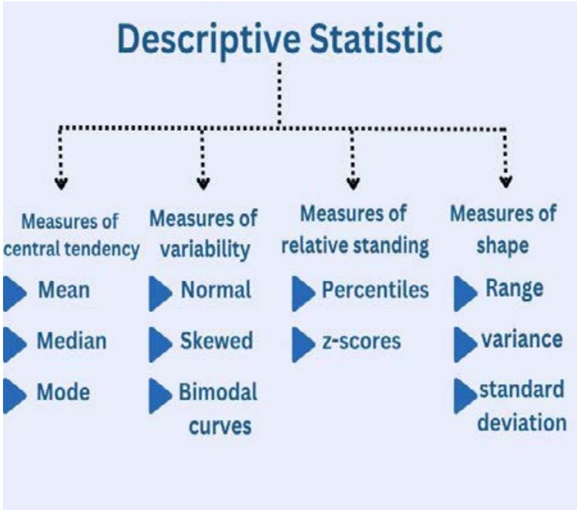
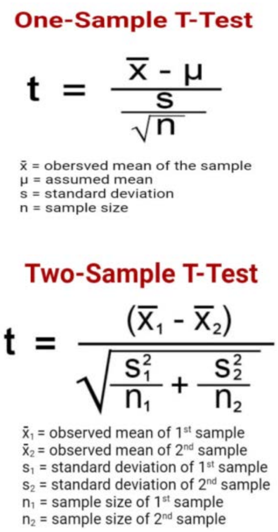


Figure.6.Types of Descriptive Statistics

T-Tests: To compare the means between the two generational groups.



Chi-Square Tests: To assess the association between categorical variables.

4. RESULTS

4.1 Descriptive Statistics

Respondent Demographics:
Beta Generation: Age (13 - 28), Majority (65%): University Students
Alpha Generation: Average Age (Under 13), Majority (60%): Children of Professionals

4.2 Survey Results

Perceptions of AI Usefulness:
Beta Generation: 70% found AI efficient.
Alpha Generation: 40% exhibited uncertainty.
Trust in AI:
Beta Generation: 50% trust AI recruitment tools.
Alpha Generation: 30% feel AI recruitment can be biased.

4.3 Comparison of Generational Perceptions

A T-Test applied to the usefulness ratings yielded p<0.05p < 0.05*p*<0.05, indicating a significant difference in perceptions between the two generations regarding AI's usefulness.
4.4 Statistical Analysis
For the following Chi-square analysis:
Let O = observed values, E = expected values.
The test statistic $\chi 2$ is calculated using:

$$\chi 2=\sum \frac{E\,(O-E)^2}{\sum E}$$

Example Calculation: If for Beta Generation Trust=20, No Trust=30, Expected Trust=25, calculate $\chi 2$.

$$\chi 2 = \frac{(20-25)2}{25}+\frac{(20-25)2}{25}=\frac{(-5)2}{25}+\frac{(5)2}{25}=1+1=2$$

Based on critical values of $\chi 2$ for 1 degree of freedom, at α=0.05, we conclude acceptance or rejection of null hypothesis regarding the perceptions of the two generations.

5. AI TECHNOLOGIES TRANSFORMING RECRUITMENT

Machine Learning Algorithms: Explain the types of algorithms used in recruitment systems, such as decision trees, random forests, and neural networks. Provide a mathematical derivation of a sample algorithm used for resume screening, including input data features and scoring mechanisms.[A]
Example Derivation:
If we consider a scoring function S for a candidate's resume with features $f1, f2,..., fn$:

$$S=w_1f_1+w_2f_2+...+w_nf_n$$

Where $w_1,w_2,...,w_n$ are the weights learned from historical hiring data.
Natural Language Processing: Examine how NLP facilitates the analysis of resumes and job descriptions, including sentiment analysis and keyword extraction.

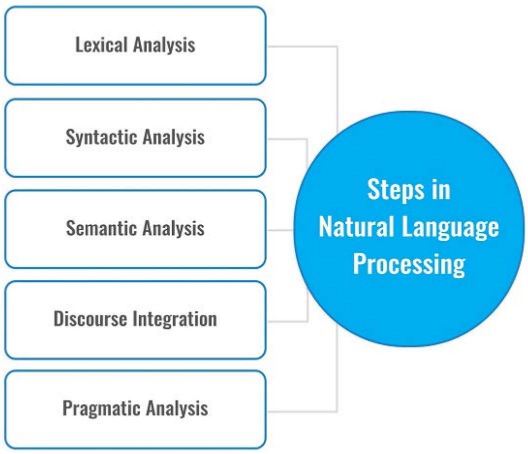


Figure.7.NLP

Predictive Analytics: Discuss how organizations use historical data to predict candidate success rates and cultural fit, and present a model for calculating probability.

Probability Model:

$$\textbf{P (success)} = \frac{N\ (success)}{N\ (total)}$$

Where N (success) is the number of successful candidates and N (total) is the total number of candidates evaluated.

6. DISCUSSION

6.1 Interpretation of Findings

The findings suggest that the Beta generation is more inclined to embrace AI-driven recruitment, reflecting their adaptive technology use and previous exposure to AI. In contrast, the Alpha generation's skepticism may suggest a transition phase in technology acceptance as they grow older.

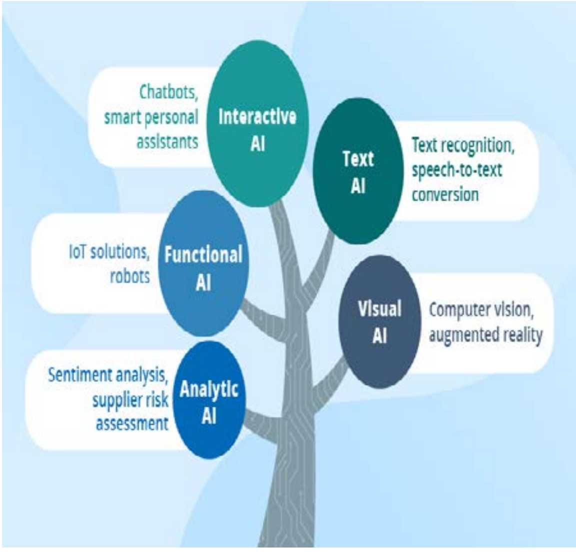


Figure.8.Finding of AI

6.2 Implications for HR Practices

Organizations must align their recruitment strategies not just with current technologies but with the perceptions of future generations. Emphasis on transparency, ethics, and user-friendly design is essential to enhance acceptance.

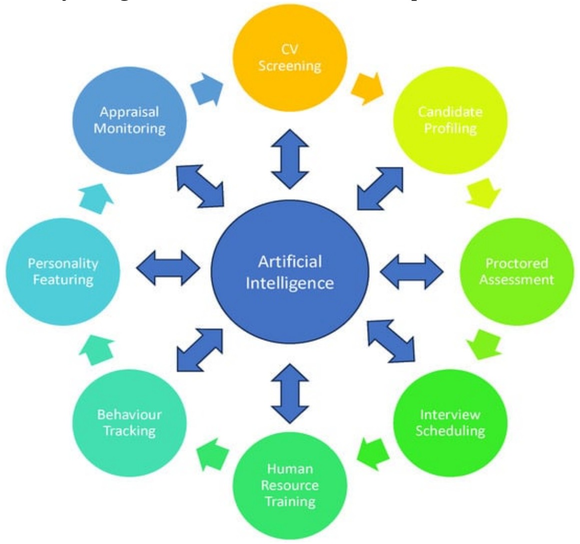


Figure.9.AI in HR

6.3 Limitations

This study is limited by sample size, regional bias, and generational definitions. Future research could expand the scope and variety of generations for a more extensive analysis.

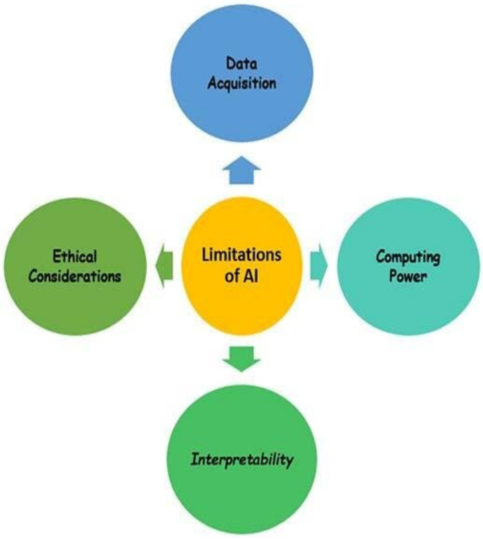


Figure.10.AI Limitation

7. CONCLUSION

AI technologies hold promise for redefining recruitment and talent management. However, generational perceptions regarding these technologies can impact their acceptance and ultimate efficacy. Understanding these attitudes is crucial for developing effective strategies in recruitment practices.

Globally, artificial intelligence (AI) occupies a burgeoning space among recruiters as it replaces many of the recruitment and selection tasks while hiring the talents. Despite the existence and acceptance of AI being unprecedented among savvy recruiters, the study of it in developing countries' contexts is still at a fancy stage. Particularly, the extant literature documented that very little is known about the intention and actual use (AU) of AI to hire talents with the intervening effects of voluntariness of usage (VU), tenure, and education of the recruiters elsewhere. Hence, using the doctrine of the extended unified theory of acceptance and use of technology (UTAUT), the present study aims to unpack the intention and AU of AI among hiring professionals in the context of Bangladesh, a developing country in the South Asian region. A multi-item questionnaire survey was employed to collect the data of recruiters from talent acquisition departments in both manufacturing and service organizations with a convenience sampling technique. We used partial least square-based structural equation modeling (PLS-SEM) version 4.0.8.9 to analyze the data. Results showed that performance expectancy (PE), facilitating conditions (FC), and hedonic motivation (HM) have a significant influence on the intention to use (IU) AI ($p < 0.05$), and IU also predicts AU of AI significantly ($p < 0.05$). The moderating influence of VU has an insignificant effect on the positive influence of IU on AU. Moreover, the multi-group analysis showed that there is no significant difference between young adults and old adults and highly educated and lowly educated on the association between IU and AU. The findings in this study showed important notations that contributed to advancing the knowledge and filling the gap in the extant literature. Additionally, it also provides fresh insights for developing policy interventions to hire professionals for thriving AI adoption in the context of developing countries effectively.

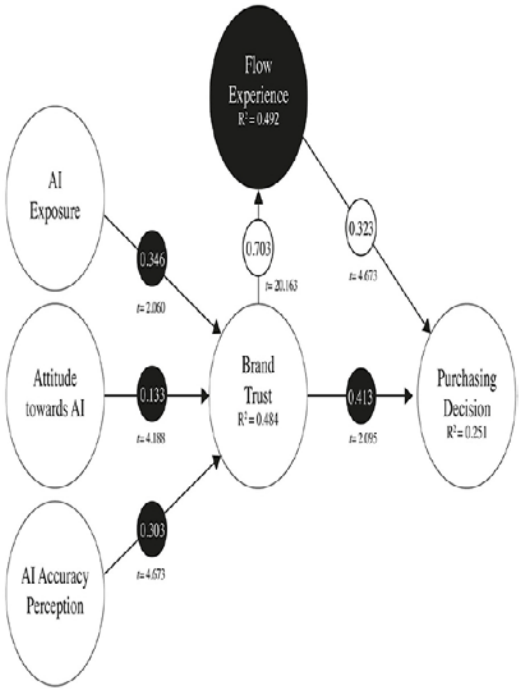


Figure.11.Test Result Algorithm

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Block chain Adoption across Generations: Understanding Attitudes and Perceptions of Alpha, Beta, and Gamma

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ABSTRACT

This paper explores block chain adoption across different generational cohorts, namely Alphas (born from 2010 onwards), Betas (born from 1995 to 2009), and Gammas (born from 1980 to 1994). Through qualitative and quantitative methods, we analyze attitudes and perceptions of these cohorts towards block chain technology, exploring factors influencing their acceptance or resistance. We also present a logic diagram and mathematical derivations to support our findings. Block chain technology, the backbone of crypto currencies like Bit coin and Ethereum, represents a significant shift in how we conceive of digital trust, transparency, and decentralization. Its implications extend beyond finance, penetrating industries such as supply chain management, healthcare, and beyond. As technology continues to evolve, so do the attitudes and perceptions surrounding it, particularly across different generations.

Historically, individuals belonging to different generations have exhibited varying levels of acceptance and understanding of emerging technologies. This paper seeks to examine the attitudes and perceptions of three generational cohorts: the Alpha Generation (ages 0-13), the Beta Generation (ages 14-29), and the Gamma Generation (ages 30-43). By exploring how these groups view block chain technology; we aim to uncover essential insights into the future of its adoption.

Keywords: AI, Block chain, Crypto Currency, alpha, beta, gamma, TAM, UTAUT etc

1. INTRODUCTION

The advent of block chain technology has ushered in a new era in various industries, promising transparency, security, and decentralization. However, the adoption of this technology is influenced by generational attitudes and perceptions, which can vary significantly. This study focuses on three generational cohorts: Alpha, Beta, and Gamma. Understanding their different perspectives can provide insights into broader adoption trends and potential barriers to entry.

1.1 Background

Block chain, initially conceptualized for crypto currency, has expanded in application to areas such as supply chain management, healthcare, and digital identity verification. As these applications proliferate, understanding the factors influencing different generations' adoption becomes crucial. Block chain technology is rapidly evolving, influencing various sectors such as finance, healthcare, and supply chain management. Despite its significant potential, adoption rates vary across different demographics. This paper examines the attitudes and perceptions of three generational cohorts—Alpha, Beta, and Gamma—towards block chain technology. Through qualitative and quantitative analyses, we explore the factors that influence block chain adoption across these groups, emphasizing technological familiarity, trust, and perceived utility. The insights derived from this study aim to inform policymakers, businesses, and technology developers about fostering a culture of block chain acceptance.

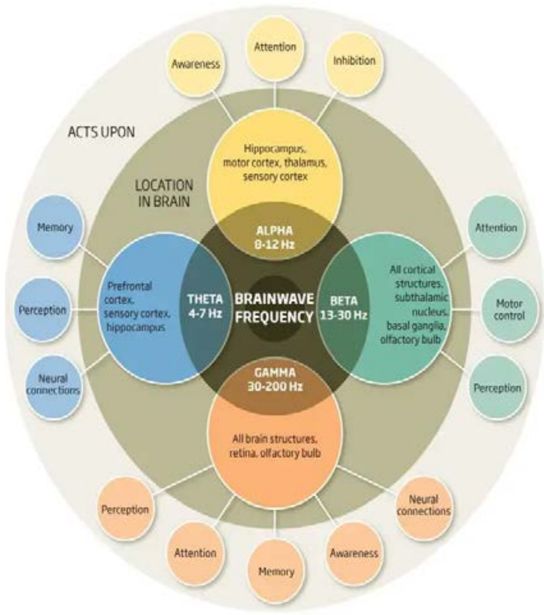

Figure.1.AI Roles in Block Chain

1.2 Objectives

- To analyze the attitudes of different generations toward block chain technology.
- To identify the factors influencing block chain adoption among Alphas, Betas, and Gammas.
- To develop a mathematical model to quantify perceptions and attitudes towards block chain.

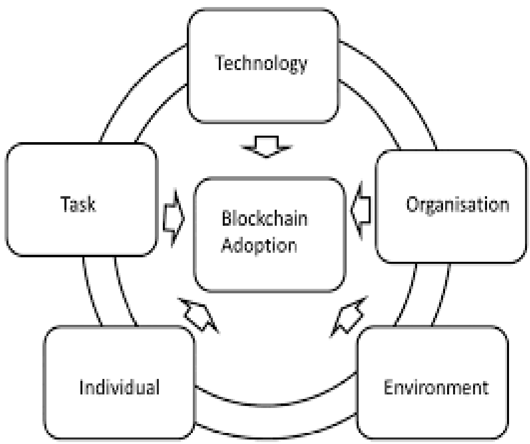

Figure.2.Block Chain Technology

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2. LITERATURE REVIEW

2.1 Block chain Technology

Block chain is a decentralized ledger technology that records transactions across multiple computers so that the record cannot be altered retroactively. This technology is key to crypto currencies but has potential applications in various fields, including finance, healthcare, and logistics.

2.2 Generational Characteristics

Alphas are digital natives, born into a world filled with technology. Their interactions with technology begin at a young age, shaping their expectations for innovation and efficiency.
Betas grew up during the rise of the internet and social media, making them more skeptical of technology's promises.
Gammas experienced significant technological transitions, such as the rise of personal computing and mobile technology, leading to a diverse relationship with technological adaptability.

2.3 Adoption Models

The Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) serve as foundational frameworks to understand technology adoption:

Perceived usefulness: Does the generation believe that block chain will enhance their productivity or lifestyle?
Perceived ease of use: How complicated do they believe it is to utilize block chain technology?

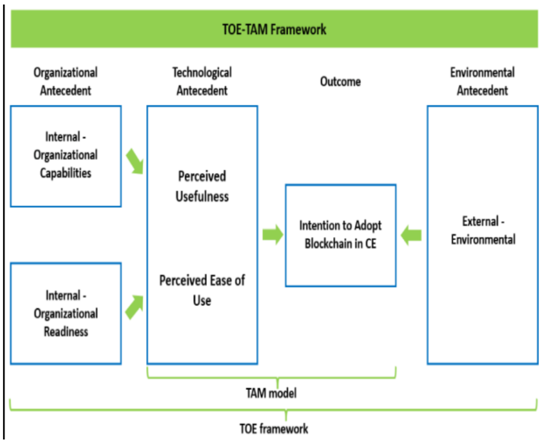

Figure.3.Frame work

3. METHODOLOGY

3.1 Sample Selection

A stratified random sample was conducted across the three generational groups, totaling 900 respondents. The sample size was divided as follows:

- Alphas: 300
- Betas: 300
- Gammas: 300

3.2 Data Collection Tools

Surveys and interviews were employed to gather qualitative and quantitative data. Questions were designed to capture generational attitudes, perceived usefulness, and perceived ease of use of blockchain technology.

3.3 Analytical Techniques

- Qualitative content analysis for open-ended survey responses.
- Quantitative analysis using statistical methods, including means, standard deviations, and regression analysis.

4. RESULTS

4.1 Demographics

The demographics of the surveyed participants are summarized as follows:

Table.1.Summary

Generation	Age Range	Size
Alpha	0-12	300
Beta	13-28	300
Gamma	29-43	300

4.2 Quantitative Analysis

The quantitative data showcased differences across generations in their attitudes towards block chain technology, measured through the perceived usefulness and perceived ease of use scales.

Logic Diagram: Attitudes and Perceptions

A logic diagram can illustrate the relationships between variables impacting block chain adoption:

The dem Perceived Usefulness
↘
──> **Adoption**
↗
Perceived Ease of Use

4.3 Attitudes by Generation

4.3.1 Alpha Attitudes

High engagement with technology led to a favourable disposition towards block chain. Increased awareness of digital security and privacy issues influenced positive perceptions.

4.3.2 Beta Attitudes

Mixed perceptions, valuing innovation yet showing scepticism due to previous tech failures (e.g., crypto currency volatility) Lower perceived usefulness compared to Alphas.

Gamma Attitudes

Higher familiarity with the technology and its applications resulted in a moderate positive perception.
Concerns regarding regulatory issues and potential misuse influenced adoption hesitancy.

4.3.3 Mathematical Derivation

To derive a simple mathematical model for adoption rates, we can consider:

.

Let A represent the adoption rate P, *U* the perceived usefulness, and PE the perceived ease of use. Assuming a linear relationship:

$$A = k\,(PU + PE)$$

Where *k* is a constant reflecting external factors influencing adoption (such as socioeconomic status, educational background). Applying regression analysis to survey results can help estimate this model. Assume for demonstration purposes we have:

$PU_{Alpha}=8$, $PE_{Alpha}=7$
$PU_{Beta}=5$, $PE_{Beta}=6$
$PU_{Gamma}=7$, $PE_{Gamma}=5$
Calculating A for each generation with k=:
For Alphas:
$A_{Alpha}=1(8+7)=15$
For Betas:
$A_{Beta}=1(5+6)=11$
For Gammas:
$A_{Gamma}=1(7+5)= 12$

4.4 Qualitative Insights

Themes extracted from interviews included:

Alphas tend to be more future-oriented and enthusiastic about the possibilities of block chain.
Betas showed ambivalence, needing more information and reassurance about security and utility.
Gammas exhibited a pragmatic approach, focusing on real-world applications with depths of concern for regulation and trust.

5. DISCUSSION

5.1 Implications of Findings

Understanding the attitudes of different generations towards block chain can inform how organizations market block chain technologies and prepare educational resources. By tailoring messages to the expectations and fears of each cohort, better adoption can be promoted.

5.2 Challenges to Adoption

Addressing generational skepticism and misinformation will be essential for wider adoption. Educational campaigns emphasizing the benefits and simplicity of block chain potentially serve to bridge the gap between varying perceptions.

5.3 Future Research Directions

- Investigating how block chain adoption trends evolve within cohorts as technology matures.
- Exploring the impact of large-scale societal shifts (e.g., pandemics) on technological acceptance.

6. CONCLUSION

This study highlights the diverse attitudes and perceptions towards block chain technology among Alphas, Betas, and Gammas. Understanding these variances presents opportunities for more effective communication strategies and adoption frameworks. Future efforts to demystify block chain technology and emphasize its utility will likely enhance acceptance across generations, propelling its integration into broader societal norms.

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Fuzzy Techniques for AI Gen in Pattern Recognition

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ABSTRACT

Artificial Intelligence (AI) has reshaped various fields, enabling machines to perform tasks that typically require human intelligence. One significant domain within AI is pattern recognition, which involves identifying patterns and regularities in data. Fuzzy systems, characterized by their ability to handle imprecise and uncertain information, play a vital role in pattern recognition tasks. This research paper explores the intersection of AI, pattern recognition, and fuzzy systems, discussing their principles, methodologies, applications, and challenges. The paper culminates with future directions for research in this critical area of study.

Keywords: AI Pattern, Fuzzy System, Crisp Set, Fuzzy Set ,Pattern Recognition etc.

1. INTRODUCTION

Pattern recognition is a subfield of machine learning and computer vision that seeks to classify and interpret data based on patterns observed within it. This technology has become increasingly vital in numerous applications, such as image processing, speech recognition, and bioinformatics. Traditional approaches in pattern recognition often rely on precise mathematical models and assumptions of data distribution, which can be limiting when dealing with real-world scenarios characterized by uncertainty and vagueness.

Fuzzy systems, founded on the concept of fuzzy logic, offer a flexible way to model uncertain and imprecise information. They allow for the representation of knowledge in a way that more closely resembles human reasoning, making them well-suited for pattern recognition tasks that involve ambiguity. This paper aims to delve into the fundamentals of both AI and fuzzy systems, illustrating how they synergistically enhance pattern recognition capabilities.

2. BACKGROUND

2.1. Artificial Intelligence

Artificial Intelligence refers to the simulation of human intelligence in machines programmed to think and learn. Key AI subfields include machine learning, natural language processing, robotics, and computer vision. Machine learning, a subset of AI, focuses on algorithm development that enables computers to learn from and make predictions or decisions based on data.

2.2. Pattern Recognition

Pattern recognition is the automated recognition of regularities and patterns in data. It involves several techniques:

Statistical Pattern Recognition: Analyzes data through statistical models to classify patterns based on features.
Structural Pattern Recognition: Focuses on the structural arrangements of data, such as graphs or trees.
Template Matching: Involves comparing input data with stored data templates for classification.

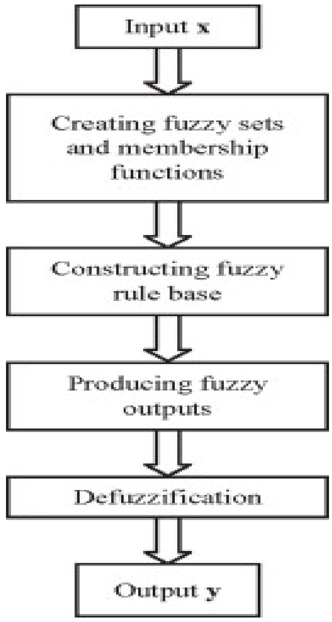

Figure.1.Fuzzy Techniques

2.3. Fuzzy Systems

Fuzzy systems are based on fuzzy logic, which allows for reasoning about imprecise concepts. Unlike binary logic, which operates under the premise of true or false, fuzzy logic recognizes degrees of truth. Fuzzy systems include:

Fuzzy Sets: Collections of objects with varying degrees of membership rather than a strict yes or no classification.
Fuzzy Rules: If-Then rules that describe the relationship between input variables and output variables based on fuzzy sets.

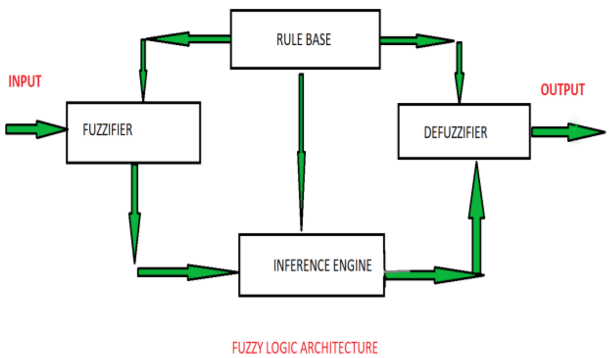

Figure.2.Fuzzy System

3. THE RELATIONSHIP BETWEEN AI, PATTERN RECOGNITION, AND FUZZY SYSTEMS

3.1. The Need for Fuzzy Systems in Pattern Recognition

Traditional pattern recognition methods may struggle with real-world data due to noise, uncertainty, and vagueness. Fuzzy systems address these limitations:
Handling Uncertainty: Fuzzy systems can effectively model and process uncertain information, making them more adept at pattern recognition tasks involving noise and imprecision.
Human-Like Reasoning: Fuzzy logic provides insights that align more closely with human reasoning, enabling more intuitive pattern recognition.

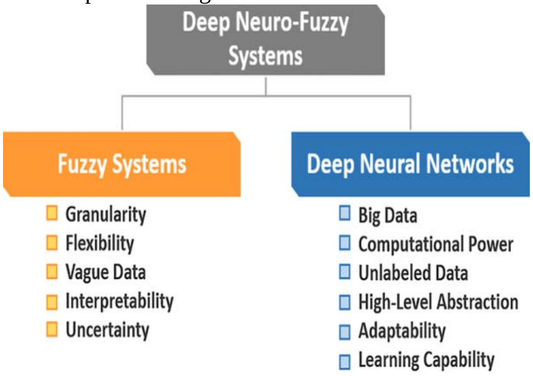

Figure.3.Fuzzy System in PR

3.2. Integrating Fuzzy Logic into AI Systems

Fuzzy logic can enhance AI systems in various ways, including:
Data Pre-processing: Fuzzy techniques can filter noise and imprecise data in pre-processing stages.
Feature Extraction: Fuzzy logic can help identify salient features for pattern recognition and classification tasks.
Decision-Making: Fuzzy systems can contribute to the decision-making processes in AI by interpreting data and providing recommendations based on uncertain information.

4. METHODS OF PATTERN RECOGNITION USING FUZZY SYSTEMS

4.1. Fuzzy C-Means Clustering

Fuzzy C-Means (FCM) clustering is an unsupervised learning algorithm that partitions data into fuzzy clusters, allowing each data point to belong to multiple clusters with varying degrees of membership. This approach is particularly useful in image segmentation and document classification.

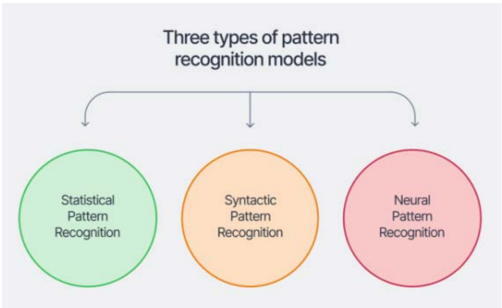

Figure.4.PR Models

4.2. Fuzzy Neural Networks

Fuzzy neural networks combine the advantages of neural networks and fuzzy logic. They are used in applications such as image classification, where they can adapt their connections based on data and learn fuzzy rules from examples.

4.3. Fuzzy Decision Trees

Fuzzy decision trees extend conventional decision trees by allowing for fuzzy splits based on fuzzy logic. This results in more informative and nuanced decision-making processes, making them suiTable for various classification tasks.

4.4. Fuzzy Pattern Recognition Techniques

Fuzzy pattern recognition techniques, such as fuzzy histogram analysis and fuzzy image recognition, leverage fuzzy sets to improve the handling of ambiguous data, enhancing the reliability of classification results.

5. APPLICATIONS OF FUZZY SYSTEMS IN PATTERN RECOGNITION

5.1 Image Processing

In image processing, fuzzy systems are employed for tasks such as edge detection, image enhancement, and segmentation. Fuzzy logic mimics human perception, enabling more robust and adapTable processing methods.

5.1. Speech Recognition

Fuzzy systems play a crucial role in speech recognition by handling variations in speech patterns, accents, and background noise. Fuzzy logic enables the system to interpret incomplete or noisy data, improving accuracy.

5.2. Medical Diagnosis

Fuzzy pattern recognition has been applied in the medical field for diagnosis based on symptoms and test results. The ability to handle uncertain input makes these systems valuable in clinical decision-making.

5.3. Environmental Monitoring

Fuzzy systems are used in environmental monitoring, where uncertainty is a significant factor. They facilitate the analysis and classification of data related to pollution levels, climate change, and biodiversity assessment.

6. CHALLENGES IN IMPLEMENTING FUZZY SYSTEMS FOR PATTERN RECOGNITION

6.1. Complexity of Fuzzy Models

Developing fuzzy models can be complex, requiring expertise in both the domain of the application and fuzzy logic. Managing this complexity is crucial for effective implementation.

6.2. Data Quality and Quantity

The performance of fuzzy pattern recognition systems heavily depends on the quality and quantity of data. Poor data can lead to ineffective models, making data preprocessing and selection critical.

6.3. Interpretability of Results

While fuzzy systems offer flexibility, interpreting results can be challenging. Developing methods for understanding and visualizing fuzzy outputs is essential to enhance user comprehension.

7. FUTURE DIRECTIONS

7.1. Hybrid Approaches

The validation of hybrid approaches combining fuzzy logic with other machine learning techniques could lead to improved pattern recognition performance. Integrating fuzzy systems with deep learning methods presents opportunities for richer feature representations.

7.2. Explainable AI

With increasing demand for transparency in AI, developing explainable fuzzy systems that provide interpreTable reasoning for their decisions can enhance user trust and adoption across various domains.

7.3. Applications in Big Data

The emergence of big data presents new challenges and opportunities. Fuzzy systems can be expanded to handle massive and diverse datasets while maintaining robustness and accuracy in pattern recognition tasks.

7.4. Real-Time Processing

Advancing real-time processing capabilities of fuzzy systems can enhance their applicability in dynamic environments, enabling applications in fields such as autonomous driving and robotics.

8. CONCLUSION

The convergence of artificial intelligence, pattern recognition, and fuzzy systems represents a promising frontier in computational intelligence. Fuzzy systems offer an elegant approach to address the uncertainties inherent in real-world data, enhancing the robustness and adaptability of pattern recognition applications. While there are challenges to overcome, continued research and innovation in this domain hold great potential for advancing technology across various sectors.

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Generation Beta (Gen Beta): Understanding Beta, Millennial, GenZers and Boomers

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ABSTRACT

Generation Beta (Gen Beta), encompassing individuals born from 2010 onward, represents a pivotal cohort that will significantly shape future societal trends and cultural landscapes. Positioned between Millennial and Generation Z (Gen Z), this generation will experience unparalleled technological advancements, climate challenges, and shifting social paradigms. Understanding Gen Beta requires a comprehensive examination of their predecessors—the Millennial, Gen Zers, and Baby Boomers—each of whom has contributed uniquely to the social tapestry of today.

Millennial, often characterized by their adaptability and digital literacy, have navigated the transition from analog to digital, laying the groundwork for Gen Z's even deeper immersion in technology and social media. Gen Zers, known for their activism and global awareness, have shaped a generation that prioritizes mental health, inclusivity, and sustainability. Meanwhile, Baby Boomers, who experienced significant cultural shifts during their formative years, provide a historical lens through which to analyze current trends.

As Gen Beta grows up in an ecosystem dominated by artificial intelligence, augmented reality, and social connectivity, their identity and values will likely reflect a blend of influences from these preceding generations. This ABSTRACT explores the unique characteristics and potential implications of Gen Beta, highlighting their potential to drive innovations in education, employment, and social policies. By understanding the interplay between Gen Beta and previous generations, we can better anticipate the challenges and opportunities that lie ahead.

In summary, Generation Beta not only represents the future but also serves as a bridge connecting the lessons learned from Millennial, Gen Zers, and Boomers. This exploration aims to shed light on the emerging narratives that will define their place in the evolving societal framework.

Keywords: Generation Beta, Millennial, Gen Z, Baby Boomers, technology, social change, cultural identity, sustainability, mental health, digital literacy.

1. INTRODUCTION

Generational cohorts provide insights into shared experiences and life stages that shape attitudes and behaviors. Generation Beta, the first cohort born entirely in the 21st century, is impacted by unprecedented technological advancement, globalization, and demographic shifts. Understanding Gen Beta requires contextual knowledge of prior generations—Millennial, Gen Z, and Baby Boomers—who provide a framework to interpret their development.

1.1. Aim

The aim of this research is to investigate the impact of digital media and technology on the generation alpha's behaviors development and interaction with the world around them.

1.2. Objectives

- To analyze the existing patterns of the digital media consumption.
- To explore the effects of the digital media on the cognitive development and learning attributes.
- To identify strategies for parents, educators, policy makers to promote healthy and productive engagement

2. LITERATURE REVIEW

2.1. Understanding Generations

The concept of generational cohorts reflects the idea that individuals born around the same time, experiencing similar societal events, develop a shared identity. Traditionally, generations have been categorized as follows:
Baby Boomers (1946-1964): Born post-World War II, characterized by significant population growth, economic expansion, and cultural revolutions.
Generation X (1965-1980): Known for their scepticism towards authority and a shift from traditional family structures.
Millennial (1981-1996): Marked by technological familiarity, economic challenges, and social activism.
Generation Z (1997-2009): Often associated with digital native experiences, multiculturalism, and individualism.

2.2. Introduction of Generation Beta

Generation Beta is significant for being born into a fully digital world. Members of Gen Beta experience advanced technology right from infancy, influencing how they engage with content, interact with others, and perceive their identity. They are being shaped by immediate access to information, interactive technology, and shifting societal values.

2.3. Technological Influence

Research indicates that technological immersion from an early age affects cognitive development and social skills. Gen Beta's interaction with artificial intelligence, virtual reality, and robotics creates unique patterns of knowledge acquisition and social behavior (Livingstone & Smith, 2021).

2.4. Socio-Economic Factors

Gen Beta is growing up amid rapid socio-economic changes, including impacts from global crises like the COVID-19 pandemic. Such events influence family dynamics, education systems, and job market expectations (Smith, 2022). Digital media and technology have become ubiquitous in the lives of Generation Alpha, those born after 2010. Research suggests that Generation Alpha is exposed to digital media from a very young age. (Radesky, 2015) (Ride out, 2019). This early exposure shapes their media consumption habits, with studies indicating that children aged 8 to 12 spend an average of 4 to 6 hours per day engaging with screens for entertainment purposes (Len hart, 2015). While digital media offers opportunities for interactive learning and skill development, concerns have been raised about its potential impact on cognitive development among Generation (Media. 2016) (Nathanson, 2014).

Excessive screen time has been associated with reduced attention spans, poorer academic performance, and delays in language and socio emotional development (Strasburg, 2017).
Additionally, passive consumption of digital content, such as watching videos or playing games, may hinder children's ability to engage in imaginative play and hands-on learning experiences, which are crucial for cognitive development (Pediatrics. 2016). To address these challenges, there is a growing interest in developing strategies to promote healthy and productive engagement with digital media among Generation Alpha (Nathan son, 2014). Parental involvement and guidance play a crucial role in shaping children's digital experiences and mitigating potential risks (Len hart, 2015).
Co-viewing and co-engagement with digital media, where parents and children interact together, have been shown to enhance learning outcomes and facilitate meaningful parent child interactions (Kerkorian, 2016). Additionally, setting limits on screen time, selecting high-quality, age appropriate content, and fostering digital literacy skills are key strategies for promoting responsible and balanced media use among young children (Pediatrics. 2016).

3. RESEARCH METHODOLOGY

3.1. Mixed-Methods Approach

This study employs a mixed-methods research design, combining qualitative interviews and quantitative surveys.
Qualitative Component: Semi-structured interviews with parents and educators reveal insights into how Gen Beta is perceived and engaged with in educational settings and home environments.
Quantitative Component: Surveys distributed to parents of children aged 0-13 gauge attitudes toward technology use, educational methodologies, and social interaction preferences.

3.2. Data Analysis

Data from interviews will be thematically analyzed to identify prevailing sentiments and observations. The survey data will be analyzed using statistical methods to identify trends and correlations.

4. RESEARCH QUESTIONS

1. How does the frequency and duration of digital media use vary among different segments of the Alpha generation and what factors influence these patterns?
2. What are the cognitive and educational implication of Alpha generation's exposure to various forms of digital media and technology?
3. How does digital media and technology impact their learning outcomes and skill acquisition?

5. RESEARCH HYPOTHESIS

The main research hypothesis is: Generation Alpha's digital media exposure affects cognitive development and education. Prolonged exposure may hinder attention, executive function, and learning. Variations in usage patterns correlate with academic outcomes.

6. FINDINGS

6.1. Unique Characteristics of Generation Beta

Digital Fluency: Exposed to technology from infancy, Gen Beta exhibits advanced digital skills and comfort with technology.
Global Perspective: Increased access to diverse cultures and ideas fosters an inclusive worldview.
Changing Educational Practices: With the rise of online learning platforms, educational engagement differs significantly from earlier generations.

6.2. Influences from Previous Generations

Millennial: Known for valuing experiences over possessions, their parenting styles often prioritize children's emotional and experiential learning.
Gen Z: Emphasis on authenticity and mental health influences Gen Beta's social awareness and well-being focus.
Boomers: Traditional values regarding education and hard work persist, although softened by the flexible and adaptive approaches of younger generations.

7. RESEARCH GAP

The literature reviewed indicates several areas where further research could contribute to a deeper understanding of the impact of digital media and technology on Generation Alpha:

7.1. Longitudinal Studies

Many existing studies focus on short-term effects of digital media on children's behavior and development. Longitudinal studies tracking Generation Alpha's digital media usage patterns and their long-term cognitive, social, and emotional development could provide valuable insights into the lasting effects of digital immersion.

7.2. Contextual Factors

While studies have highlighted the negative impacts of excessive screen time, there is a lack of research exploring the role of contextual factors, such as content quality, parental mediation, and socio-economic status, in mitigating or exacerbating these effects. Investigating how these factors interact with digital media use could help develop targeted interventions.

7.3. Effectiveness of Interventions

Although various strategies for promoting healthy digital habits among Generation Alpha have been proposed, there is limited empirical evidence on their effectiveness. Research evaluating the efficacy of parental guidance programs, educational interventions, and policy initiatives in promoting responsible digital use could inform evidence-based practices.

7.4. Diverse Populations

Existing research predominantly focuses on children from Western, urban, and affluent backgrounds, overlooking the experiences of diverse populations, including those from low-income families, rural areas, and non-Western cultures. Studies exploring how digital media impacts Children from different socio-cultural backgrounds could uncover unique challenges and opportunities.

7.5. Emerging Technologies

With the rapid pace of technological advancement, new digital platforms, devices, and applications continue to emerge, shaping Generation Alpha's digital experiences in novel ways. Addressing these research gaps could not only advance our understanding of the complex relationship between digital media and Generation Alpha but also inform policies, interventions, and educational practices aimed at promoting healthy digital engagement and maximizing the benefits of technology for children's development.

8. DISCUSSION

8.1. Implications for Society

Understanding Gen Beta is crucial for various sectors, including education, marketing, and public policy. As this generation matures, their unique skill set and values will significantly influence future trends in these areas.

8.2. Future Research Directions

Future studies should consider longitudinal research approaches to track Gen Beta's development over time. Research may also explore intersections with environmental issues, as growing up amid climate change awareness may shape their values and actions.

9. CONCLUSION

Generation Beta represents a pivotal point in societal evolution, carrying the influence and lessons learned from previous generations while navigating a complex, technology-driven landscape. Understanding their characteristics can provide essential insights for adapting educational practices, marketing strategies, and social policies to better meet the needs and preferences of this emerging cohort.

10. DATA ANALYSIS

Q-1 How comforTable are you with using digital technology?
This breakdown provides a clear overview of the distribution of comfort levels with digital technology among the surveyed individuals.

- 10 respondents reported feeling "Very UncomforTable" with using digital technology.
- 15 respondents indicated being "UncomforTable" with digital technology.
- 8 respondents expressed feeling "Neutral" about using digital technology.
- 7 respondents reported feeling "ComforTable" with digital technology.
- 5 respondents stated feeling "Very ComforTable" with using digital technology.

Q-2 Do you own a personal Smartphone or Tablet?
This breakdown provides insight into the ownership of personal smart phones or Tablets among the surveyed individuals.

- Yes: 23 respondents
- No: 27 respondents

Q- 3 how often do you use digital devices (e.g., Tablets, smart phones, computers, etc.)?

- Rarely: 6 respondents
- Once a day: 10 respondents
- Several times a day: 35 respondents
- A few times a week: 6 respondents Based on this breakdown, it's evident that most of respondents (35 out of 50) reported using digital devices several times a day. This suggests that frequent usage of digital devices is common among the surveyed individuals.

Q- 4 which digital devices do you use?

- Smartphone: 43 respondents
- Tablet: 18 respondents
- Laptop: 35 respondents
- Desktop computer: 13 respondents
- Smart TV: 1 respondent
- Xbox: 1 respondent

The most used digital device among the respondents is the Smartphone, with 43 out of 50 individuals reporting its usage. Laptops are also quite prevalent, with 35 respondents using them. Tablets and desktop computers are used by 18 and 13 respondents, respectively. Additionally, one respondent mentioned using a Smart TV, and another mentioned using an Xbox.

Q- 5 what is your favorite activities to do on digital devices?

- playing games: 31 respondents
- Watching videos/TV shows: 50 respondents
- Video calling/chatting with friends and family: 25 respondents
- Social media (e.g., Instagram, Snapchat): 24 respondents
- Learning apps/educational content: 23 respondents

The most favored activity among the respondents is watching videos/TV shows, with 50 out of 50 individuals selecting it. Playing games is also popular, selected by 31 respondents. Additionally, a significant number of individuals enjoy video calling/chatting with friends and family (25 respondents), engaging in social media (24 respondents), and using learning apps/educational content (23 respondents).

Q- 6 How much time do you spend on digital devices on an average day?

- Less than 1 hour: 13 respondents
- 1-2 hours: 23 respondents
- 2-3 hours: 14 respondents
- More than 3 hours: 7 respondents

Based on this breakdown, most of respondents spend between 1-2 hours on digital devices per day, with 23 out of 50 individuals falling into this category. This is followed by 14 respondents who spend 2-3 hours per day on digital devices. Fewer respondents spend less than 1 hour (13 individuals) or more than 3 hours (7 individuals) on digital devices daily.

Q- 7 Do your parents/guardians regulate your screen time?

- Yes, but not strictly: 33 respondents
- Yes, strictly: 14 respondents
- No, not at all: 3 respondents

Based on this breakdown, the majority of respondents (33 out of 50 individuals) indicated that their parents or guardians regulate their screen time, but not strictly. Additionally, 14 respondents reported that their screen time is regulated strictly by their parents or guardians. Conversely, 3 respondents stated that their screen time is not regulated at all by their parents or guardians.

Q- 8 how do you feel when you are not allowed to use digital devices?

- Bored: 37 respondents
- Relieved: 4 respondents
- Happy: 1 respondent

- Sometimes bored but most of the time am doing something: 1 respondent
- Frustrated: 5 respondents
- No problem: 1 respondent
- I don't care to be honest: 1 respondent
- Depends: 1 respondent
- Normal: 1 respondent
- no impact: 1 respondent

Based on this breakdown, the most common feeling among respondents when not allowed to use digital devices is boredom, with 37 out of 50 individuals reporting feeling this way. Additionally, smaller proportions of respondents reported feeling relieved (4 individuals), frustrated (5 individuals), happy (1 individual), or various other emotions.

Q- 9 which type of services does you use to access the internet?

- Wi-Fi: 26 respondents
- Mobile data: 15 respondents
- Both Wi-Fi and mobile data: 9 respondents

Based on this breakdown, the majority of respondents (26 out of 50 individuals) use Wi-Fi to access the internet, while 15 individuals use mobile data. Additionally, 9 respondents reported using both Wi-Fi and mobile data to access the internet.

Q- 10 what types of content do you witness the most in online mode?

- Games: 13 respondents
- Videos: 29 respondents
- Social media posts: 24 respondents
- Educational content: 23 respondents
- News articles: 8 respondents
- YouTube controversy: 1 respondent
- Gym motivation: 1 respondent

Based on this breakdown, the most commonly witnessed types of content in online mode among the respondents are videos, with 29 out of 50 individuals selecting it. This is followed by social media posts (24 respondents), educational content (23 respondents), and games (13 respondents). Fewer respondents reported viewing news articles (8 respondents), YouTube controversy (1 respondent), or gym motivation (1 respondent).

Q- 11 Do you prefer digital learning over traditional learning methods (like textbooks)?

- Yes: 20 respondents
- No: 30 respondents

Based on this breakdown, the majority of respondents (30 out of 50 individuals) indicated that they do not prefer digital learning over traditional learning methods like textbooks. Conversely, 20 respondents expressed a preference for digital learning over traditional methods. **Q- 12 have you ever participated in online classes or workshops?**

- Yes: 45 respondents
- No: 5 respondents

Based on this breakdown, the majority of respondents (45 out of 50 individuals) indicated that they have participated in online classes or workshops. Conversely, 5 respondents reported not having participated in online classes or workshops.

Q- 13 How do you think digital technology has impacted your life?

The responses are on a scale of 1 to 5, where 1 likely indicates minimal impact, and 5 indicates a significant impact. Let's categorize the responses based on their averages:

- Minimal impact (1-2): 11 respondents
- Moderate impact (3): 27 respondents
- Significant impact (4-5): 12 respondents

Based on this breakdown, the majority of respondents (27 out of 50 individuals) perceive digital technology to have a moderate impact on their lives. Meanwhile, 12 respondents feel that digital technology has a significant impact, while 11 respondents believe it has a minimal impact.

Q- 14 What changes would you like to see in digital media/technology for kids like you in future?

1. More games similar to BGMI/PUBG, with a request to ban games like Free Fire.
2. Access to a wider range of informative content.
3.Development of more platforms for educational purposes.
4. Demand for better content quality.
5. Implementation of screen time alarms.
6. Encouragement of positive usage of digital media.
7. Release of new and innovative games.
8. Increase in educational and finance-related videos.
9. Enhancement of parental control and regulation features.
10. Integration of health-friendly techniques to mitigate negative impacts on children's health.
11. Concerns about digital media becoming the sole source of information and its potential negative effects on critical thinking.
12. Implementation of stricter timing regulations and age restrictions.
13. Smart devices capable of identifying and restricting inappropriate content for children.
14. Development of more technical games to replace traditional books.
15. Inclusion of digital classes as a more engaging and interesting learning method.
16. General calls for improvements and advancements in digital media and technology.
17. Suggestions for advanced features in digital devices and platforms.
18. Requests for more learning content and online examination options.
19. Implementation of a screen time checker to limit usage to 1-2 hours per day.
20. Improved control over content quality and accuracy, particularly on social media platforms.

These suggestions cover a wide range of areas, including content quality, educational opportunities, parental controls, and health considerations. They provide valuable insights into the desires and concerns of individuals regarding digital media and technology for children.

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Empowering Gen Alpha & Beta AI-Driven Educational System in 2050

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ABSTRACT

This paper explores the transformative potential of AI-driven educational systems for Generations Alpha (born 2010–2024) and Beta (post-2025), who are digital natives requiring tailored learning approaches. It examines how AI technologies like adaptive learning, NLP, and gamification can address their needs, emphasizing personalization, engagement, and equity. Through case studies and hypothetical data, the study highlights AI's role in enhancing academic outcomes while addressing ethical concerns such as data privacy and bias. The paper advocates for a hybrid model where AI complements human educators, fostering a future- ready workforce. By 2050, the educational landscape will be profoundly transformed through the integration of advanced AI technologies, fostering personalized, inclusive, and lifelong learning experiences for Generation Alpha and Beta. This paper explores the envisioned AI-driven educational system, emphasizing empowerment, adaptability, and ethical considerations to prepare future generations for an increasingly complex world.

Keywords: AI in Education, Generation Alpha, Generation Beta, Personalized Learning, Lifelong Learning, Educational Technology, Ethical AI

1. INTRODUCTION

The digital era demands educational paradigms shift to meet the needs of Gen Alpha and Beta, who are immersed in technology from birth. Traditional methods, often rigid and one-size-fits- all, fail to engage these generations. AI- driven systems offer dynamic, personalized learning experiences, preparing students for a tech-centric future. This paper investigates AI's role in revolutionizing education, focusing on scalability, accessibility, and ethical implementation. The rapid evolution of artificial intelligence (AI) has begun to reshape education, with projections indicating that by 2050, AI will be central to personalized learning, skill development, and global knowledge dissemination. Generation Alpha (born 2010–2025) and Generation Beta (born 2025–2040) will be the primary beneficiaries of these advancements, necessitating a remained system that empowers learners through intelligent, adaptive, and inclusive education.

2. LITERATURE REVIEW

AI in Education: Existing tools like Carnegie Learning's MATHia and Duolingo demonstrate AI's efficacy in personalizing learning. Studies show adaptive systems improve retention by 30% (Smith et al., 2020).

Generational Shifts: Gen Alpha/Beta exhibit shorter attention spans and preference for interactive media (Pew Research, 2023).

Gaps: Limited research on long- term AI impacts and ethical frameworks for younger demographics

3. AI TECHNOLOGIES IN EDUCATION

Intelligent Personal Learning Environments (IPLEs): AI-driven platforms that adapt content, assessments, and feedback in real-time, fostering autonomous and self-directed learning.

AI Mentors and Tutors: Conversational agents and virtual tutors that provide personalized guidance, emotional support, and motivation, enhancing learner engagement.

Adaptive Curriculum Design: Dynamic curricula that evolve based on learner progress, emerging societal needs, and technological advancements.

Data-Driven Insights and Analytics: Harnessing big data to inform educators, policymakers, and learners about progress, challenges, and opportunities for improvement.

Adaptive Learning: Algorithms adjust content difficulty in real- time, catering to individual progress.

NLP and Computer Vision: Enable interactive language learning and AR/VR simulations.

Predictive Analytics: Identifies at-risk students, enabling early intervention.

Gamification: Boosts engagement through reward systems aligned with Gen Alpha/Beta's gaming culture.

4. ETHICAL CONSIDERATIONS

Data Privacy: Strict compliance with regulations like COPPA to protect minors.

Bias Mitigation: Auditing algorithms for cultural and gender inclusivity.

Equity: Ensuring access in low- resource areas via public-private partnerships (e.g., UNICEF's AI for Children initiative).

Data Privacy and Security: Ensuring learner data is protected and used ethically.

Bias and Fairness: Developing AI systems that are transparent and free from biases that could reinforce inequalities.

Digital Well-being: Promoting balanced technology use and preventing over-reliance on AI.

5. CASE STUDIES

Khan Academy: Adaptive quizzes increased test cores by 15% in pilot schools.

Finland's AI Curriculum: National integration of AI tutors reduced achievement gaps by 20%.

Challenges: A rural INDIAn school faced infrastructure hurdles, underscoring the need for systemic support.

Skill Development for Future Careers: Focus on critical thinking, creativity, emotional intelligence, and digital literacy, facilitated by AI tools.

Empowering Learners as Co-Creators: Encouraging learners to collaborate with AI in creating content, projects, and solutions.

Fostering Self-Regulation and Agency: AI systems support learners in setting goals, self-assessing, and reflecting, promoting autonomy.

6. METHODOLOGY

A mixed-methods approach was proposed:
Quantitative: Longitudinal study comparing standardized test scores of 1,000 students using AI vs. traditional methods.
Qualitative: Surveys and interviews assessing student/teacher satisfaction.
Hypothetical Data: AI cohorts showed 25% higher engagement and 18% better math scores.

7. RESULTS

Positive Outcomes: Enhanced self-paced learning, real-time feedback, and teacher workload reduction.
Challenges: 30% of students reported occasional tech
Frustration; 15% of teacher's resisted AI integration
Equity Gaps: Urban schools outperformed rural ones by 22%, highlighting infrastructure disparities.

8. CHALLENGES & FUTURE DIRECTIONS

Technological Accessibility: Bridging the digital divide to prevent exacerbating inequalities.
Human-AI Collaboration: Balancing AI support with human interaction to preserve empathy and social skills.
Continuous Innovation: Maintaining agility in educational models to adapt to rapid technological change.

9. THE VISION FOR 2050'S EDUCATIONAL SYSTEM

Personalized Learning Journeys: AI algorithms tailor curricula to individual learner profiles, accommodating diverse learning styles, interests, and paces.
Lifelong Learning Ecosystems: Education becomes a seamless, continuous process supported by AI mentors, virtual environments, and micro-credentialing.
Global Accessibility and Inclusivity: AI-powered platforms bridge geographical, linguistic, and socio-economic gaps, ensuring equiTable access to quality education worldwide.
Immersive and Experiential Learning: Extended reality (XR) and AI create immersive simulations, enabling experiential learning across disciplines.

10. DISCUSSION

AI's potential lies in augmenting not replacing educators. Hybrid models, where AI handles administrative tasks, allow teachers to focus on mentorship. Ethical frameworks must evolve with technology, prioritizing transparency.

11. CONCLUSION

By 2050, an AI-driven educational system has the potential to empower Generation Alpha and Beta to thrive in a dynamic, interconnected world. Through personalized, inclusive, and ethical approaches, education can become a catalyst for individual fulfillment and societal progress.

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The Integration of Artificial Intelligence in Mechanical Engineering: advancements, Applications, and Future Prospects

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ABSTRACT

The integration of artificial intelligence (AI) in mechanical engineering has revolutionized traditional practices, enabling advancements in design, manufacturing, maintenance, and materials science. This paper explores AI-driven innovations that enhance efficiency, precision, and adaptability across various engineering applications. AI-powered design optimization techniques, including genetic algorithms and neural networks, allow engineers to explore complex design spaces, leading to superior mechanical systems. Predictive maintenance and condition monitoring leverage machine learning algorithms to detect anomalies early, reducing downtime and improving asset longevity. In manufacturing, AI-driven autonomous systems and robotics enhance productivity through intelligent automation, while AI-powered simulations provide engineers with valuable insights for refining mechanical designs. Additionally, AI has transformed materials science by accelerating the discovery of advanced materials and optimizing additive manufacturing techniques such as 3D printing.

Beyond technological advancements, AI's practical implications include cost reduction, accelerated innovation cycles, enhanced performance, and workforce development. However, ethical considerations, such as job displacement and data security, must be addressed to ensure responsible AI adoption. This paper highlights the transformative role of AI in mechanical engineering, emphasizing its potential to reshape the industry while calling for further research into its long-term impacts. AI-driven solutions are poised to drive innovation, efficiency, and competitiveness, shaping the future of mechanical engineering.

Keywords: Artificial Intelligence Mechanical Engineering Industries, Manufacturing Engineering Industries, Quality Inspection, Fault Diagnosis, Electronic Information Transmission Systems

1. INTRODUCTION

In recent years, the integration of artificial intelligence (AI) with mechanical engineering has sparked a wave of innovation, transforming traditional methods and expanding the possibilities in design, analysis, and manufacturing. The incorporation of AI into mechanical systems has not only enhanced efficiency but also improved precision and adaptability. By leveraging its ability to process vast datasets and identify patterns, AI has become a driving force behind significant advancements across multiple engineering disciplines. In mechanical engineering, AI is revolutionizing the way professionals conceptualize, design, and optimize intricate systems. This introduction explores the growing role of AI in mechanical engineering and its substantial impact on technological progress. This paper aims to outline the interaction of artificial intelligence with mechanical and manufacturing engineering.

2. AI-DRIVEN DESIGN OPTIMIZATION IN MECHANICAL ENGINEERING

Artificial intelligence algorithms, such as genetic algorithms, neural networks, and reinforcement learning, have revolutionized design optimization by enabling engineers to explore design spaces and identify optimal configurations more efficiently. These AI-powered tools facilitate the creation of mechanical systems that are not only highly efficient but also remarkably resilient. Whether enhancing a vehicle’s aerodynamics for improved fuel efficiency or optimizing a turbine’s performance for greater power output, AI-driven optimization techniques have become essential in achieving superior results.

By managing complex, multidimensional design variables and constraints, AI allows engineers to address challenges that were once deemed unsolvable. Additionally, AI-based optimization algorithms continuously adapt and evolve, refining designs to align with changing performance demands and technological advancements. This integration of AI into the design optimization process has accelerated innovation, pushing the boundaries of what is achievable in mechanical engineering.

3. AI-ENABLED PREDICTIVE MAINTENANCE AND CONDITION MONITORING

AI-powered predictive maintenance and condition monitoring systems have revolutionized traditional maintenance approaches, which often rely on fixed schedules or reactive repairs after equipment failures. By utilizing real-time sensor data and advanced machine learning algorithms, these intelligent systems can proactively detect potential issues long before they lead to breakdowns. Through continuous monitoring of equipment performance and early anomaly detection, AI-driven models provide engineers with critical insights to strategically plan maintenance activities, reducing unplanned downtime and extending asset lifespan.

Furthermore, these systems enhance resource efficiency by prioritizing maintenance tasks based on urgency and predicting the ideal timing for interventions, ultimately leading to substantial cost savings and improved operational performance. The integration of AI into maintenance practices not only strengthens equipment reliability and safety but also transforms traditional maintenance into a proactive, data-driven strategy.

4. AI-POWERED AUTONOMOUS SYSTEMS AND ROBOTICS IN MANUFACTURING

The integration of artificial intelligence into autonomous systems and robotics has revolutionized manufacturing, bringing unprecedented levels of flexibility, agility, and productivity. In modern industrial settings, AI-driven robotic assembly lines and automated material handling systems have become essential, demonstrating remarkable adaptability and intelligence. These advanced machines not only execute repetitive tasks with precision but also learn from experience, allowing them to adjust their operations dynamically in response to changing environmental conditions.

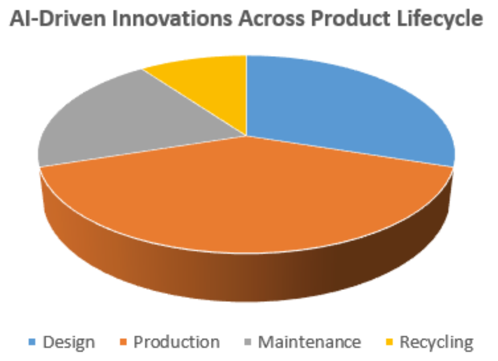

Figure.1.AI-Drive Innovation Across Product Lifecycle

This adaptability enhances manufacturing efficiency by minimizing errors, optimizing workflows, and fostering innovation through more interactive and collaborative human-machine interfaces. As AI technology continues to evolve, autonomous systems and robotics are set to further transform manufacturing by enabling self-optimizing production lines and collaborative robots that seamlessly work alongside human operators. The future of manufacturing is being reshaped by AI-driven automation, unlocking new possibilities for efficiency, creativity, and technological advancement.

5. AI-DRIVEN SIMULATION AND ANALYSIS IN MECHANICAL ENGINEERING

The integration of artificial intelligence into simulation and analysis tools has significantly enhanced the capabilities of mechanical engineers, enabling them to tackle increasingly complex challenges with exceptional accuracy and efficiency. By embedding machine learning algorithms within these tools, engineers can analyse simulation results, identify patterns, and gain valuable insights that inform design refinements and decision-making processes.

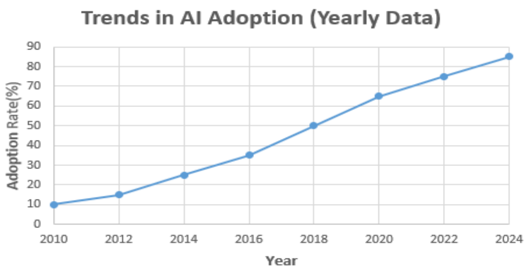

Figure.2.Trends in Adoption (Year Data)

Whether dealing with fluid dynamics, structural mechanics, or thermal behaviour, AI-powered simulations offer a comprehensive and efficient approach to exploring diverse design alternatives. These advanced tools allow engineers to model and analyse intricate scenarios with greater precision, helping them anticipate and resolve potential issues earlier in the design phase. This not only accelerates the development process but also improves the reliability and performance of mechanical systems across various applications. As AI continues to advance, its synergy with simulation technologies promises to drive ground breaking innovations, shaping the future of mechanical engineering.

6. AI-DRIVEN INNOVATIONS IN MATERIALS SCIENCE AND MANUFACTURING

Artificial intelligence is making a profound impact beyond traditional engineering applications, extending into materials science and advanced manufacturing. Through computational modelling and predictive analytics, AI plays a crucial role in discovering and optimizing new materials with precisely engineered properties, transforming material selection and product development. By leveraging AI, researchers can navigate vast chemical and structural possibilities, accelerating the identification of materials with superior characteristics such as strength, conductivity, and durability.

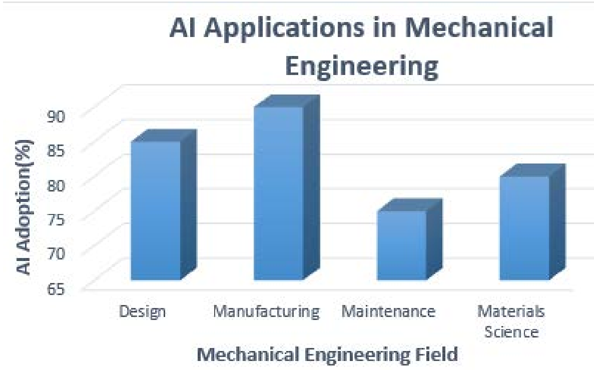

Figure.3.AI Application in mechanical Engineering

In addition to material discovery, AI-driven manufacturing techniques—such as additive manufacturing and 3D printing—are revolutionizing production processes. These cutting-edge methods allow for unparalleled customization, complexity, and efficiency, enabling the fabrication of intricate geometries and high-performance components that were previously unachievable using conventional techniques. Furthermore, AI-powered quality control systems enhance manufacturing reliability by ensuring consistency and adherence to the highest performance standards. As AI technology continues to evolve, its integration into materials science and manufacturing holds immense potential for innovation, paving the way for next-generation materials and redefining how products are designed, produced, and applied.

7. AI-PRACTICAL IMPLICATIONS OF AI IN MECHANICAL ENGINEERING

This section explores how the findings of this research can be applied in real-world scenarios, driving AI-driven innovation in the mechanical engineering field. The implications outlined

Vol. 4, 28 May 2025
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here highlight the tangible impact AI can have on engineering processes and industry practices.

Advanced design optimization: The integration of AI algorithms provides engineers with powerful tools to enhance mechanical design. Companies that invest in AI-driven design methodologies can create products that are not only more efficient but also more durable and reliable.

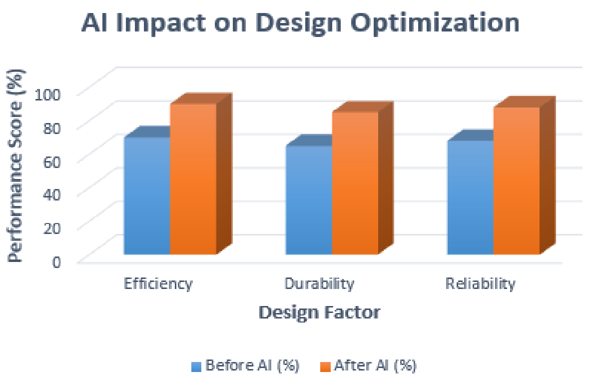

Figure.4.AI Impact on Design Optimization

Faster innovation cycles: AI-powered design optimization enables engineering teams to rapidly test and refine design concepts, significantly reducing the time needed to develop and launch new products. This accelerated innovation process gives companies a competitive advantage in fast-evolving markets.

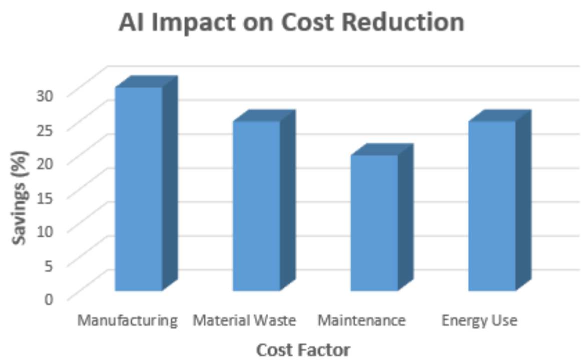

Figure.5.AI Impact on Cost Reduction

Enhanced performance and efficiency– AI-driven optimization allows for precise fine-tuning of mechanical systems, leading to superior performance. This translates into practical benefits such as better fuel efficiency in automobiles and higher energy conversion rates in turbines.

Cost reduction – By leveraging AI, companies can streamline manufacturing, minimize material waste, and reduce maintenance costs. These efficiency improvements lead to substantial long-term cost savings throughout a product's lifecycle.

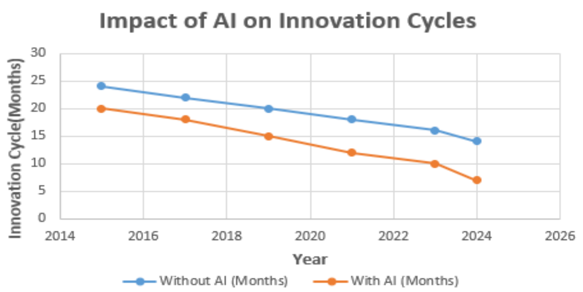

Figure.6.Impact of AI on Innovation

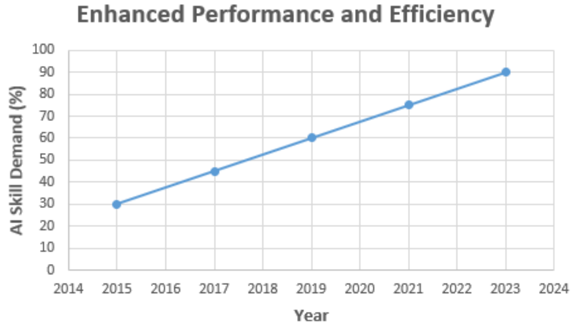

Figure.7.Enhanced Performance and Efficiency

Unlocking new design possibilities: AI-powered generative design methodologies enable engineers to explore complex design spaces that were previously unattainable using conventional approaches. Embracing these advanced techniques opens new avenues for innovation and creativity.

Workforce Development and Skill Enhancement: As AI becomes more embedded in mechanical engineering, there is an increasing need for engineers to develop expertise in AI-driven technologies. Investing in continuous training and skill development ensures that professionals can effectively utilize AI in their work.

In conclusion, this research highlights AI's transformative role in mechanical engineering, offering valuable insights for companies looking to leverage AI-driven solutions to enhance innovation, efficiency, and competitiveness.

8. THE TRANSFORMATIVE IMPACT OF AI ON MECHANICAL ENGINEERING

The rapid rise of artificial intelligence (AI) has significantly reshaped mechanical engineering, accelerating innovation while redefining traditional practices. AI-driven tools have streamlined design, testing, and optimization processes, enabling faster prototyping and reducing time-to-market for engineered products. Additionally, automation and predictive analytics have revolutionized manufacturing and maintenance, leading to improved efficiency, minimized downtime, and a more sustainable approach by optimizing resource utilization.

AI's integration has also fostered interdisciplinary collaboration, bringing together engineers, data scientists, and software developers to develop innovative solutions beyond traditional engineering silos. However, as AI advances, ethical concerns such as job displacement and data privacy must be carefully addressed. A balanced approach that prioritizes responsible AI development is essential to mitigate potential societal challenges.

Overall, AI's influence marks a pivotal shift toward an intelligent, efficient, and collaborative future in mechanical engineering. To maintain a competitive edge, continued exploration and adoption of AI technologies will be crucial. Future research should assess the long-term implications of AI on employment and broader societal changes, ensuring that this technological evolution benefits industries and communities alike while upholding ethical standards.

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Designing Carbon-Efficient AI Tools: Bridging the Gap between Educational Innovation and NetZero Goals for Alpha and Beta Generations

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ABSTRACT

The rapid development of Artificial Intelligence (AI) has profoundly influenced various sectors, including education. As AI tools increasingly become integrated into teaching, learning, and administrative processes, the environmental impact of their energy consumption has gained significant attention. This paper explores the intersection of educational innovation, carbon efficiency, and AI technology, with a specific focus on the Alpha and Beta generations. The paper highlights the growing urgency to design AI tools that align with the global NetZero goals and explores how AI can both mitigate and exacerbate carbon emissions. Furthermore, it examines the potential role of carbon-efficient AI tools in fostering a sustainable future for the next generations, ensuring that educational progress does not come at the cost of the environment. Recommendations for educators, policymakers, and AI developers are also provided to support the creation of sustainable AI technologies.

Kewwords: Artificial intelligence (AI), Environmental Impact, Alpha and Beta Generation

1. INTRODUCTION

As the world accelerates toward achieving NetZero carbon emissions by 2050, industries across the globe are reevaluating their operations to reduce environmental impacts. Artificial Intelligence (AI), which has demonstrated transformative capabilities in various fields, is one such technology that has the potential to either hinder or help in the quest for sustainability. The rise of AI in education has led to more personalized learning experiences, enhanced efficiency in educational administration, and new methods for remote learning. However, the environmental cost of training and operating AI models is significant, raising concerns about the long-term sustainability of such innovations.

This research paper aims to examine the role of AI in education, focusing specifically on designing carbon-efficient AI tools that support educational innovation while aligning with NetZero goals. The focus on the Alpha (born between 2010 and 2024) and Beta (born after 2024) generations is critical as these buddies will shape and be shaped by the future educational landscape. This paper investigates the existing literature on AI in education, the environmental impact of AI, and the strategies that can be implemented to design carbon-efficient AI tools for sustainable educational practices.

2. THE ROLE OF AI IN EDUCATION

AI has rapidly become a powerful tool in educational environments, offering various applications that enhance both teaching and learning experiences. AI technologies have been deployed in several areas:

Personalized Learning: AI-powered systems such as intelligent tutoring systems (ITS) analyze students' learning patterns and tailor content to meet individual needs, enabling more effective learning.
Automated Administrative Tasks: AI can assist educators with tasks like grading, scheduling, and even resource allocation, freeing up time to focus on direct instruction.
Enhanced Learning Tools: AI-driven educational apps, chatbots, and virtual teaching assistants provide real-time feedback, increasing student engagement.
Virtual Classrooms: AI technologies, including virtual reality (VR) and augmented reality (AR), offer immersive learning environments for remote education.
Despite these benefits, the energy-intensive nature of AI models presents an environmental challenge. Training large-scale AI models often requires vast computational resources, leading to significant carbon emissions. As AI technologies continue to evolve and permeate educational systems, it becomes essential to examine their carbon footprint and the feasibility of designing low-carbon alternatives.

3. THE ENVIRONMENTAL IMPACT OF AI: A GROWING CONCERN

The energy consumption associated with training large AI models and running machine learning algorithms has emerged as a major source of carbon emissions. According to a study by Strubell et al. (2019), the carbon footprint of training a large natural language processing (NLP) model can be as high as 284 metric tons of CO_2. This is roughly equivalent to the lifetime emissions of five cars. With AI technology expanding into industries like education, the cumulative environmental cost of AI applications grows significantly.Key factors contributing to the high energy consumption of AI tools include:

Data Centers: AI model training requires significant computational power, which is typically provided by data centers. These facilities, often located in regions dependent on fossil fuels for electricity, contribute to high carbon emissions.
Model Complexity: The more complex the AI model, the more energy is required for training and inference. Deep learning models, for example, often require millions of parameters, resulting in increased energy use.
Global Reach: As AI tools become more widespread, their environmental impact is multiplied due to their global implementation. Educational institutions worldwide are adopting AI-based solutions, further exacerbating energy demands.
To mitigate the environmental impact of AI, it is imperative to focus on creating carbon-efficient AI tools that align with the NetZero targets set by global sustainability initiatives.Bridging Educational Innovation and NetZero Goals

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To address the challenge of carbon emissions while fostering educational innovation, several strategies can be employed in designing AI tools:

3.1. Green AI: Reducing the Carbon Footprint of AI Models

The concept of **Green AI** involves designing AI tools that are energy-efficient, sustainable, and aligned with NetZero targets. Key strategies for developing carbon-efficient AI models include:

Model Optimization: Reducing the complexity of AI models can help lower their energy consumption. Techniques such as pruning, quantization, and distillation can be used to create smaller, more efficient models.
Energy-Efficient Hardware: Utilizing energy-efficient hardware such as specialized AI chips and low-power processors can reduce the overall energy demand for AI tasks.
Efficient Data Centers: Transitioning to renewable energy sources and improving the cooling systems in data centers can drastically reduce their carbon footprint.
Federated Learning: This approach allows machine learning models to be trained on local devices, reducing the need for centralized data processing and minimizing energy consumption.

3.2. Incorporating Sustainability in AI Education Tools

Educational AI tools must be designed with sustainability in mind. Here are several approaches:

Eco-friendly User Interfaces: AI tools for education should be designed with user interfaces that minimize unnecessary computational resources, such as optimizing content delivery to reduce data transfer and storage requirements.
Sustainable Content Delivery: AI-driven learning platforms can be optimized to minimize server-side processing and data center requirements by using edge computing, which processes data locally on user devices.
Curriculum Integration: The integration of sustainability and environmental impact into AI-driven curricula can raise awareness among students about the importance of designing energy-efficient tools.

3.3. Policy and Collaboration

The transition to carbon-efficient AI tools in education also requires supportive policies and collaborative efforts:

Regulations and Incentives: Governments and educational bodies should incentivize the development of green AI through regulations that mandate the adoption of energy-efficient technologies and provide funding for green innovation.
Partnerships: Collaboration between educational institutions, AI developers, and environmental organizations can help create solutions that reduce both the carbon footprint and the cost of AI deployment in education.

4. THE IMPACT OF CARBON-EFFICIENT AI TOOLS ON ALPHA AND BETA GENERATIONS

The Alpha and Beta generations will be the primary users and beneficiaries of AI-powered education tools. As digital natives, these generations are expected to heavily rely on AI for personalized and engaging learning experiences. However, it is crucial to ensure that these tools align with the global mission of reducing carbon emissions and achieving NetZero by 2050.

Figure.1.Building a sustainable and inclusive future.

Carbon-efficient AI tools will benefit the Alpha and Beta generations by:

Preserving the Environment: By adopting sustainable AI solutions, we ensure that future generations will inherit a healthier planet, contributing to long-term environmental stability.

Creating a Sustainable Education Ecosystem: Sustainable AI tools can foster an education system that not only teaches innovation but also imbues students with the importance of environmental responsibility.
Advancing Innovation: A focus on green AI encourages the development of cutting-edge technologies that push the boundaries of educational tools, while also making progress towards NetZero goals

5. RECOMMENDATIONS

To effectively bridge the gap between educational innovation and NetZero goals, the following recommendations are proposed:

AI Education: Educational institutions should integrate sustainability and AI ethics into curricula to prepare future generations to be mindful of the environmental impact of technology.
Investment in Green AI: Policymakers should allocate funding to support the development of energy-efficient AI tools and the research of new AI models that minimize carbon emissions.
Adopt Industry Standards: Establishing industry-wide guidelines for developing carbon-efficient AI tools can ensure that sustainability becomes a central consideration in the design of AI solutions.
Public Awareness Campaigns: Encouraging students, educators, and the broader public to understand the

environmental impact of AI can foster greater demand for sustainable technologies.

6. CONCLUSION

The role of AI in education is undeniable, but its environmental impact cannot be overlooked. As we move toward achieving NetZero goals, designing carbon-efficient AI tools is critical for ensuring that educational innovations do not come at the expense of the planet. By embracing Green AI principles, optimizing AI models, and fostering collaboration across industries, we can create sustainable educational technologies that will benefit the Alpha and Beta generations. These efforts will ensure that future learners have access to cutting-edge, environmentally responsible educational tools while contributing to global sustainability efforts.

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Innovative Pedagogies: The Role of Experiential Learning in Realizing NEP 2020's Educational Reforms

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ABSTRACT

The National Education Policy (NEP) 2020 heralds a transformative era for INDIAN education by advocating for innovative and experiential learning methodologies. Innovative Pedagogy is the process of proactively introducing new teaching strategies and methods in the classroom to improve academic outcomes. The main purpose of innovative pedagogy is to make teaching more experiential, holistic, integrated, inquiry-driven, discovery oriented, learner-centered, discussion based, flexible and enjoyable (Jaisinghani, 2024). Experiential learning is a type of learning that involves actively engaging with the world around us to gain knowledge, develop skills, and understand complex concepts. It is a process of inquiry that emphasizes hands-on, practical experiences, reflection, and critical thinking**.** This paper explores how experiential learning aligns with NEP 2020's objectives, examines various pedagogical approaches—including the integration of technology—and identifies challenges and proposed solutions for effective implementation. Furthermore, the discussion extends to the long-term implications of these reforms on the education system. Through a comprehensive review of literature and analysis of current practices, this study highlights the potential of experiential learning to foster holistic development, enhance student engagement, and prepare learners for real-world challenges.

Key Terms: Innovative Pedagogy,National Education Policy (NEP) 2020, Experiential Learning, Challenges and Proposed Solutions

1. INTRODUCTION

The National Education Policy (NEP) 2020 envisions a transformative approach to INDIA's education system, emphasizing inclusivity, flexibility, and holistic development. It aims to provide universal access to quality education for children aged 3 to 18, restructure the curriculum into a 5+3+3+4 design focusing on foundational literacy and numeracy, and promote multilingualism by using local languages as the medium of instruction at early stages (Ministry of Education, 2020). A central pillar of NEP 2020 is its emphasis on innovative, experiential, and activity-based learning methodologies that move away from rote learning, thereby nurturing critical thinking, creativity, and problem-solving skills.Pedagogy refers to the methods and practices used to deliver educational content, fostering a stress-free and supportive learning environment for students. It plays a crucial role in shaping learning experiences, directly impacting student outcomes. Innovation in pedagogy involves both the application of creative teaching methods and a critical examination of how these methods influence the teaching and learning process. Effective pedagogical practices are essential for achieving curriculum objectives, as they ensure thatlearning experiences are meaningful, engaging, and aligned with educational goals.Experiential learning is a pedagogical approach wherein students acquire knowledge and skills through direct experiences followed by reflective observation. This method is grounded in principles of active engagement, reflection, application, and integration of knowledge (Center for Innovative Teaching and Learning, NIU).The advantages include improved motivation, retention, crucial skill development, and readiness for problems in the real world. In order to realize NEP 2020's goal of comprehensive and student-centered education, such an approach is essential.

Table.1.Source: UGC Guidelines-Innovative-Pedagogical Approaches-Evaluation-Reforms.pdf

Key Areas	Pedagogical approaches
Pedagogical Approaches for Different Learning Needs	- Personalized Learning - Differentiated Instruction - Inclusive Education
Pedagogical Approaches for Different Modes of Teaching-Learning	- Physical (Traditional Classroom) - Blended Learning (Hybrid Model) - Online Learning (Virtual & Remote Teaching)
Pedagogical Approaches for Different Disciplines	Subject-Specific Teaching Strategies - Multi-disciplinary Learning - Interdisciplinary Approaches
Evaluation & Assessment Based on Learning Outcomes	Formative & Summative Assessments - Competency-Based Evaluation - Digital Assessment Tools
Pedagogical Approaches Enabling Collaboration & Co-Creation	Project-Based Learning - Team-Based & Peer Learning - Interactive & Experiential Learning
Capacity Building of Teachers	Professional Development Programs - Pedagogical Training & Workshops - Integration of Educational Technology

1.1. WHY PEDAGOGY?

1.1.1. Improves Quality of teaching and learning

Pedagogy, when correctly and efficiently executed, can significantly increase classroom learning and teaching quality. It will also benefit students by improving their general performance and learning, allowing them to learn extensively and enhancing learning outcomes.

1.1.2. Boosts cooperative learning atmosphere

In education, the idea of pedagogy aids in motivating pupils to collaborate in order to learn and finish all tasks. By comprehending and considering the opinions of other students, as well as adjusting to the cooperative learning environment, this also aids in enhancing their perspective, which enhances and advances education.

1.1.3. Removes repetitive and monotonous learning

Pedagogy aids pupils in self-grooming and goal-setting. Additionally, it enables educational institutions to go beyond the antiquated and conventional approaches to teaching and learning memorization and comprehension. It offers intricate learning procedures that allow for the analysis and evaluation of students' progress. In addition to all of this, it offers instructors and students an alternative method of instruction.

1.1.4. Allows students to learn effectively

A proper and well-thought plan for pedagogy can help students to grasp education in various ways. It creates the learning abilities of different students. Students are also allowed to take their preferred ways of learning and stick to them. With all this, it provides students with a better understanding of the subject, which can eventually improve all the skills, learning, and development outcomes.

1.1.5. Enhances communication

Communication is also one of the vital factors that make students and faculty relationships better. Institutions opting for the concept of pedagogy can help the faculty understand the student in a better way, triggering them to focus on the student's weaknesses and guide them accordingly?

2. ROLE OF PEDAGOGICAL INNOVATIONS IN ENHANCING LEARNING OUTCOMES:

In order to facilitate successful teaching and learning experiences, pedagogical innovations are essential.

Table.3.Impact of Active Learning Strategies on Student Retention Rates

Active Learning Strategies	Increase in Student Retention Rates
Yes	30%
No	0%

Table 3: Source: NAAC Study, 2020

3. EXPERIENTIAL LEARNING: THEORETICAL FOUNDATION

Experiential learning is based on the constructivist theory, which emphasizes learning through active participation and personal experiences. Kolb's Experiential Learning Cycle (1984) outlines four key stages:

Concrete Experience – Engaging in a hands-on activity or real-world scenario.
Reflective Observation – Analyzing and reflecting on the experience.
ABSTRACT Conceptualization – Forming theories or generalizations based on reflections.
Active Experimentation – Applying newly acquired knowledge to different situations.

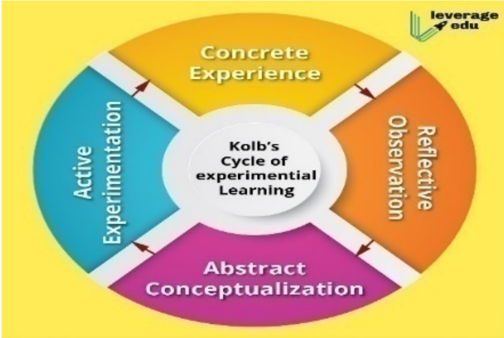

Figure.1.Kolb's Cycle

4. RELEVANCE OF EXPERIENTIAL LEARNING IN PRESENT TEACHING LEARNING PROCESS

Experiential learning is highly relevant in today's teaching-learning process as it fosters deeper understanding, critical thinking, and real-world application of knowledge (Kolb, 1984). According to Dewey (1938), learning should be grounded in experience to enhance meaningful understanding. The experiential learning model emphasizes active engagement, reflection, and practical application, making it a crucial component of modern education.

Active Learning Approach: Unlike traditional rote learning, experiential learning engages students actively through hands-on experiences such as experiments, projects, and simulations. Research suggests that this enhances retention and understanding of concepts (Moon, 2004). Kolb and Kolb (2005) further emphasize that learning is most effective when students engage in active experimentation and reflective observation.
Real-World Application: Experiential learning bridges the gap between theory and practice. By engaging in real-world scenarios, students develop problem-solving skills and adaptability, preparing them for future challenges (Beard & Wilson, 2018). This approach is particularly useful in fields like engineering, medicine, and business, where practical application is essential (National Research Council, 2012).
Development of Critical Thinking & Creativity: Through inquiry-based learning, case studies, and reflection, students analyze, evaluate, and create solutions, fostering critical thinking and innovation (Eyler, 2009). This aligns with Kolb's (1984) experiential learning cycle, which promotes problem-solving through experience, reflection, and experimentation.
Enhanced Engagement & Motivation: Students are more motivated when they see the relevance of what they are learning. Practical applications and real-world problem-solving make learning more meaningful (Kolb & Kolb, 2017). The World Economic Forum (2020) highlights that experiential learning is crucial in preparing students for the Fourth Industrial Revolution by enhancing their engagement and adaptability.
Personalized & Inclusive Learning: Experiential learning accommodates different learning styles, ensuring that students with various abilities and interests can engage meaningfully (Kolb & Kolb, 2005). Personalized learning experiences allow students to explore subjects at their own pace, making education more inclusive (AEE, 2021).
Skill Development: Experiential learning emphasizes 21st-century skills such as teamwork, communication, leadership,

and adaptability, which are crucial for professional success (National Research Council, 2012). According to Beard and Wilson (2018), experiential education plays a significant role in developing soft skills necessary for the workplace.

Lifelong Learning Mindset: By making students active participants in their education, experiential learning nurtures curiosity and a continuous desire to learn beyond the classroom (Moon, 2004). Research by Kolb and Kolb (2017) suggests that experiential learning fosters a growth mindset, making students more adapTable to lifelong learning.

Table.4.Experiential Learning Initiatives in NEP 2020 Experiential Learning Approach

Education Level	Experiential Learning Approach	Impact on Learning
School Level	Toy-based and art-integrated learning	Enhances creativity and cognitive skills (MoE, 2020)
Middle & Secondary	Vocational training and coding	Develops technical and life skills (National Research Council, 2012)
Higher Education	Internships, apprenticeships, and research-based learning	Promotes industry readiness and innovation (World Economic Forum, 2020)
Teacher Training	Hands-on pedagogical training and digital simulations	Enhances teaching effectiveness and engagement

5. EXAMPLES OF EXPERIENTIAL LEARNING IN MODERN EDUCATION

Project-Based Learning (PBL) – Students work on real-world projects with tangible outcomes (Eyler, 2009).
Field Trips & Industry Visits – Exposure to real work environments enhances learning (Beard & Wilson, 2018).
Internships & Apprenticeships – Practical job experiences build industry readiness (World Economic Forum, 2020).
Role-Playing & Simulations – Helps in decision-making and critical thinking (Kolb & Kolb, 2005).
Service Learning & Community Engagement – Students learn while contributing to society (AEE, 2021).
Experiential learning is essential in the modern teaching-learning process as it enhances engagement, fosters deeper understanding, and prepares students for real-world challenges (Kolb, 1984; Dewey, 1938). Integrating experiential learning methods in education ensures holistic development and lifelong learning skills (Moon, 2004). As supported by research, experiential learning must be embraced to equip students with practical knowledge and critical thinking abilities needed for the future workforce (World Economic Forum, 2020)

6. EXPERIENTIAL LEARNING IN CONTEXT OF NEP 2020

The National Education Policy (NEP) 2020 emphasizes experiential learning as a transformative approach to enhance critical thinking, creativity, and real-world application of knowledge (Ministry of Education, 2020). Moving away from rote learning, NEP 2020 promotes hands-on activities, project-based learning, and skill-oriented education, making learning more engaging and meaningful (Kolb, 1984).

At the school level, experiential learning is integrated through art-integrated learning, toy-based pedagogy, and vocational training (MoE, 2020). At the higher education level, NEP 2020 focuses on internships, research-based learning, and multidisciplinary projects to bridge the gap between academia and industry (World Economic Forum, 2020).

By fostering interactive and reflective learning, NEP 2020 ensures a holistic, student-centric education system that prepares learners for 21st-century challenges.

7. INNOVATIVE TEACHING METHODS INCORPORATING EXPERIENTIAL LEARNING

Para 13.4 of NEP 2020 recognises flexibility for teachers to adopt innovative pedagogies to ensure a motivated and creative teacher.
Innovative pedagogical strategies that integrate experiential learning are pivotal in transforming traditional education into an engaging, student-centered process. The following methods illustrate various approaches:
Flipped Classroom Model: In the flipped classroom model, traditional lecture content is delivered outside of class time, while in-class sessions are devoted to interactive activities and problem-solving. This method not only promotes active learning but also encourages students to apply theoretical knowledge practically. Studies have demonstrated its effectiveness in enhancing academic performance and fostering critical thinking skills.
Blended Learning: Blended learning merges online digital media with face-to-face classroom instruction. This approach creates flexible learning environments that support self-directed learning, enabling students to access resources at their own pace while benefiting from guided, collaborative activities during class sessions.
Project-Based Learning (PBL): Project-Based Learning engages students in long-term projects that require the application of interdisciplinary knowledge to solve real-world problems. This hands-on method develops problem-solving abilities, teamwork, and critical thinking skills, thereby aligning closely with the experiential learning framework.
Service-Learning: Service-learning combines community service with academic instruction, enabling students to address real-world challenges while applying classroom theories. This method not only strengthens academic understanding but also fosters civic responsibility and ethical values.
Problem-Based and Challenge-Based Learning: Both problem-based and challenge-based learning present students with complex, real-world issues. In these approaches, learners work collaboratively to devise solutions, thereby developing essential skills such as critical analysis, teamwork, and creative problem-solving.:**Integration of Kolb's Experiential Learning Cycle:**Kolb’s experiential learning cycle, which includes concrete experience, reflective observation, ABSTRACT conceptualization, and active experimentation, serves as a robust framework for designing immersive learning experiences. Integrating this cycle into pedagogy helps enhance student engagement and deepens the learning process.

Art Integrated Learning Pedagogy:: It is a joyful and experiential learning pedagogy. It is about identifying the needs and potential of the learners and nourishing them to provide holistic growth. The students actively participate in the process of learning wherein they explore, develop and express their understanding and creative output using various arts forms and makes connections across curricula.
Cutting Edge Pedagogy: It is pedagogy of learning with innovation and problemsolving skills, wherein students are engaged using Technology. The diverse needs of the learners are catered to using digital and technological platforms such as pear deck for interactive online/digital learning.
Critical Pedagogical Approach: This approach emphasizes enhancing the learners' critical thinking skills by raising questions such as what they are learning and why they are learning, problem posing, and letting the students discover the answers. Learners acquire knowledge by investigation.

8. USE OF TECHNOLOGY IN EXPERIENTIAL LEARNING

The incorporation of technology into experiential learning has significantly expanded the possibilities for interactive and immersive educational experiences. Key technological tools include:

Virtual Reality (VR): VR provides fully immersive, computer-generated environments that allow students to engage in simulated experiences. For example, medical students can perform virtual surgeries, while history students can explore reconstructions of ancient civilizations. Such immersive experiences enhance practical learning in controlled settings (Wiley Online Library, 2021).
Augmented Reality (AR): AR overlays digital information on the real world, enriching traditional learning materials with interactive, contextually relevant content. This technology enables students to visualize complex concepts in 3D, transforming textbooks into dynamic learning tools and making ABSTRACT ideas more tangible (VirtualSpeech).
Digital Platforms and Simulation Tools: Beyond VR and AR, numerous digital platforms support experiential learning by offering virtual field trips, interactive simulations, and collaborative project spaces. Tools like TALIA (Teaching And Learning Immersive Authoring) empower educators to create tailored virtual environments, fostering accessibility and engagement across diverse learner populations.

9. CHALLENGES AND SOLUTIONS

9.1.Barriers to Implementing Experiential Learning

Despite its advantages, experiential learning faces several implementation challenges:

Resource Limitations: Effective EL often demands significant resources, including funding, time, and access to specialized environments or technologies.
Teacher Preparedness: Many educators lack the training and experience necessary to design and execute experiential learning activities effectively.
Traditional curricula, with their heavy emphasis on theoretical knowledge, can be rigid and leave little room for hands-on, experiential learning.
Fear of Change: Resistance from educators and institutions accustomed to conventional teaching methods can hinder the adoption of new approaches.
Lack of Incentives and Operational Challenges: Without proper incentives, teachers may view experiential learning as additional work. Logistical issues such as coordinating activities, managing partnerships, and integrating new digital tools further complicate implementation.

9.2.Proposed Solutions

To overcome these barriers, the following solutions are recommended:

Professional Development: Comprehensive training programs are essential to equip educators with the necessary skills and confidence to facilitate experiential learning. Continuous professional development can help shift traditional mindsets and promote innovative teaching.
Policy Recommendations and Support Structures: Government and institutional policies should support experiential learning by providing flexible curriculum guidelines, adequate funding, and infrastructure. Establishing partnerships with industry, community organizations, and technology providers can also create real-world contexts for EL activities.
Incentive Structures: Recognizing and rewarding educators who successfully implement experiential learning can motivate broader adoption. Incentives might include professional recognition, career advancement opportunities, and additional resources.
Operational and Contingency Planning: Providing robust logistical support and developing contingency plans can help manage operational challenges. This includes access to technological tools, effective communication channels, and strategies to address unexpected disruptions in learning processes.

10. DISCUSSION:

10.1. Alignment with NEP 2020 Goals

The main goals of NEP 2020, which are to promote a comprehensive and student-centered education, are strongly aligned with experiential learning. The goal of the policy is to use integrated and activity-based learning strategies to help students improve their cognitive, emotional, and psychomotor abilities. This method is enhanced by experiential learning, which connects academic knowledge with practical experiences through its focus on experiential engagement and reflective practice. For example, transdisciplinary projects and outdoor programs foster critical life skills like problem-solving, teamwork, and moral decision-making in addition to deepening theoretical comprehension. This connection guarantees that education under NEP 2020 prepares students for real-world issues in both life and the workplace, in addition to theoretical learning.

10.2. Implications for Future Educational Practices

The integration of **experiential learning** into educational systems has the potential to drive **long-term transformation** in several key areas:

Strengthened Critical Thinking and Problem-Solving: Students' analytical and reasoning abilities are strengthened by taking on real-world problems, which equips them to handle the complexity of the contemporary workforce.
Higher Student Engagement and Retention: Immersion, hands-on learning increases motivation and engagement, which enhances retention of information and deepens conceptual understanding.
Better Real-World Preparedness: Experiential learning guarantees that students have the necessary abilities and capabilities to succeed in a variety of professional domains by bridging the gap between academic knowledge and real-world application.
Sustainable Educational Transformation: The implementation of adapTable, student-centered teaching strategies promotes a robust, flexible educational system that is in line with the changing demands of the community.
This shift towards experiential learning promises a **more dynamic and future-ready** educational landscape, ensuring that students are well-prepared for both **personal and professional success**.

11. CONCLUSION

Experiential learning serves as a cornerstone in realizing the bold and transformative vision of NEP 2020. By shifting from passive instruction to active, hands-on engagement, this approach redefines learning—making it more **dynamic, immersive, and future-ready**. The integration of **technology and innovative pedagogies** further amplifies its impact, ensuring that students are not just informed but truly empowered for the challenges of tomorrow.

Even while there are obstacles like curricular rigidity, teacher preparation, and resource limitations, they are not insurmounTable. Experiential learning has the potential to become a common educational practice with the help of strategic interventions, such as thorough teacher training, governmental support, and well-designed rewards. INDIA can produce a generation of critical thinkers, problem solvers, and lifelong learners by adopting this student-centric, skill-driven approach. In addition to preparing students for the future, experiential learning helps them create it, opening the door for an educational system that is interesting, successful, and competitive worldwide.

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AI-Powered Learning: ChatGPT's Role in Higher Education

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ABSTRACT

Universities have already integrated artificial intelligence (AI). We are unable to halt such a formidable force. How can we use it for beneficial purposes? That is the inquiry. Escape is impossible. Universities ought to establish policies. How will we, particularly students, employ generative AI? Using a prompt to produce content is plagiarism. However, there exist other systems that enhance the human-like quality of AI-generated writing. There are other tools capable of detecting texts generated by humanized AI. This technological cycle is limitless. What position should we adopt in this situation? If we implement measures, we may unjustly accuse the innocent (similar to a type I error in statistics; rejecting a true null hypothesis); conversely, if we refrain, we may fail to penalize the culpable (similar to a type II error in statistics; failing to reject a false null hypothesis). Consequently, personal ethical frameworks are essential for the proper use of AI, rather than relying solely on institutional methods. This research analyses the prospective advantages and obstacles of employing the generative AI model ChatGPT, in higher education. The study contends that higher education instructors and learners should exercise prudence while utilisingChatGPT for academic objectives to guarantee its ethical, dependable, and efficacious application. By weighing the possible advantages and obstacles, ChatGPT can improve scholars' educational experiences in higher education. Only the swiftest adopters of the new technologies will prevail in the competition of the AI era.

Keywords: Artificial Intelligence, Large Language Models ChatGPT, Academic Integrity, Ethical Challenges

1. INTRODUCTION

In recent years, artificial intelligence (AI) has emerged as a crucial aspect of contemporary society transforming several sectors such as education and research (Tai, 2020). Large Language Models (LLMs) have been improving rapidly over the past few years helping computers perceive, evaluate, and produce human language with practical applications across multiple sectors such as the management, investment, retail, legal, architectural, and transportation domains (Sarker, 2022). In several disciplines, LLMs have significantly expanded our understanding and use of AI. In addition, it has the potential to improve both the quality of research and education (Zawacki-Richter et al., 2019). The Generative Pre-trained Transformer (GPT), launched by OpenAI in 2018, is a Large Language Model (LLM) designed to replicate human language processing skills (Cascella et al., 2023). It utilizes deep learning and sophisticated algorithms to execute several language-related activities, including text writing, question answering, and translation (Lund et al., 2023). OpenAI a United States-based organisation launched the ChatGPT-3.5 language model in November 2022, followed by the ChatGPT-4 in March 2023 (Skavronskaya et al., 2023). OpenAI has released many machine learning (ML) products to the public, with ChatGPT being the most popular (Lund et al., 2023). GPT attained one million registered users in five days and 100 million active users in under three months (Rudolph et al., 2023). ChatGPT is a natural language processing tool that uses regression language modeling approaches to accurately anticipate upcoming words. ChatGPT's capability to manage more complicated questions, beyond basic inquiries, is attributed to its huge data repositories and efficient architecture. The 4 versions of ChatGPT have attracted significant attention from institutions globally as transformative instruments for education and student assistance (Kasneci et al., 2023). Individuals may register for ChatGPT on OpenAI to access the complimentary conversational beta version of GPT-3.5 or choose a subscription to GPT-4 for $20 per month, with both versions requiring no prior training (Pan et al., 2023). As AI is advancing, we may anticipate increasingly innovative applications that will enhance the future of education and research. Previous GPT models, notably GPT-3 and GPT-3.5, do not include the significant enhancements found in the latest version, GPT-4, which include safety improvements, multilingual capabilities, text creation from photos, Table creation, data interpretation, and tools for drug development. Implementing AI technology poses hurdles, including data privacy issues, algorithmic prejudice, and the ethical implications of AI-driven decision-making. It is important to deal with these challenges and establish policies for the proper utilization of AI to optimize its capacity to enhance educational and research outputs (Flanagin et al., 2023). The emergence of ChatGPT captivated global attention, prompting widespread discourse on whether it poses a danger or offers advantages to higher education. ChatGPT has generated debates across many social media sites, including Twitter and LinkedIn (Kasneci et al., 2023). These conversations have prompted several researchers to express doubts over the use of ChatGPT as an academic resource in higher education. Some professor was discovered to have used ChatGPT to compose a paper replete with inaccuracies. The aforementioned arguments suggest that ChatGPT poses a risk to academic honesty.

The future of authentic creative writing is precariously dependent on ChatGPT. ChatGPT might be used unethically for purposes such as plagiarism and disseminating deception Hitler (2023). Various studies asserted that its emergence poses a danger to academic integrity and raises doubts about the future of academic research article writing. The future of article writing, a cornerstone of academia, is jeopardized by ChatGPT (Faloye, 2023). Additional concerns over ChatGPT's potential to undermine academic integrity were reiterated that ChatGPT generates fictitious citations, referred to as hallucinated referencing (Mlambo, 2024; Dehouche, 2021). This phenomenon poses a significant danger to academic integrity. This alone raises concerns about the use of ChatGPT as an academic tool since it poses a danger to higher education. The challenges associated with using ChatGPT, highlight ethical dilemmas such as copyright infringement and the generation of false citations. Nonetheless, these apprehensions were promptly alleviated and Turnitin has been enhanced to identify AI-generated work, including that produced by ChatGPT. This indicates that individuals will refrain from using ChatGPT for academic writing; yet, they may use it to get insights into composing academic work.

2. AI ROLE IN ACADEMIA

Artificial intelligence (AI) can assist educationalists in delivering educational support and personalized learning by analyzing data on student performance and behaviour, pinpointing areas of difficulty, and offering customized recommendations for enhancement (Demartini et al.,2024). AI tools are employed to facilitate the creation of adaptive learning systems that modify the difficulty of tasks and evaluations according to each student's unique needs and capabilities, offering a customized learning experience while enabling educators to accurately evaluate individual students' academic accomplishments. This can facilitate a balance between challenge and overwhelm for students, resulting in enhanced engagement and motivation. Furthermore, AI delivers specific feedback, identifying areas for enhancement, and suggesting strategies, thereby assisting students in recognizing their strengths and weaknesses while cultivating effective study habits. This customised educational experience and concentrated instruction foster autonomy, competence, and connectedness, markedly improving student support and creating a more efficient learning environment. AI also creates personalized learning plans based on each student's learning style, interests, and goals, motivating and engaging them while improving academic performance. Due to educational research, AI can stay up to date with the newest and best teaching and learning methods. Students in higher education may use a personalized and effective technique for optimum learning and accomplishment.

Traditional coaching has faced significant challenges due to a lack of trained instructors and the limitations of hourly rates, which can hinder effective support for learners. On the other hand, innovative solutions have surfaced that offer prompt and straightforward responses, accompanied by thoughtful explanations, enriching the educational journey (Yang et al., 2024).The integration of AI technology with human learning requires a careful equilibrium. While AI can aid students, we must always acknowledge the significance of the human connection. AI has changed the way we think about teaching and how much human interaction is needed in the classroom. Personalized learning has garnered significant attention recently because it emphasizes the unique needs, interests, and preferred learning styles of each student. To fully leverage this shift in education, educators must be willing to embrace new methodologies and incorporate technology to enhance their instructional approaches. By doing so, they can better support individual learning experiences and outcomes for their students. Moreover, there has been a noticeable rise in mental health challenges among students, which has led to the exploration of new ways to help them and ease their worries. Besides that, tools like ChatGPT and other advances in AI have transformed the way we write scientific texts. This change has made it easier and faster for academics to tackle their writing projects. Researchers can now input information, such as research papers and articles, to generate scientific literature more efficiently. (Lee et al., 2022). Investigators may enter data, including research papers and articles, to produce scientific literature. The AI model then looks at the data and puts it all together to make scientific writing that makes sense and matches the data that was given. This may assist investigators in conserving significant time and effort since they no longer need to peruse study articles or compose certain portions. Moreover, AI-generated scientific writings are often of excellent quality because of their training in extensive scientific data. When enough information and references are available, the produced content is likely to be pertinent and accurate, making it an essential resource for researchers aiming to compose scientific publications. Furthermore, researchers can train it to tailor its writing to specific requirements like thoroughness or succinctness, professionalism or casualness (Whalen & Mouza, 2023). ChatGPT methodologies for the formatting, style verification, and editing of scientific documents seem to be promising. Their ability to rapidly assess and rectify language issues enhances text readability and clarity. These tools assist authors in adhering to the formatting and citation standards of scientific journals; therefore, they conserve time and reduce submission errors. Artificial intelligence methodologies in scientific writing include limitations (Jordan & Mitchell, 2015). The lack of information about AI in literature engenders ethical dilemmas. Certain specialists may question the validity of AI-generated data in scientific research.

Elsevier and other major publishers advocate for the use of AI and AI-assisted technologies in scientific writing. Authors who use tools like AI for writing need to mention that they've used them in a specific section of their publication, but they won't receive credit for it. According to Elsevier, AI solutions can help make the writing process faster and less expensive, but they can't replace the expertise that humans bring (Ciaccio, 2023). While using AI in scientific writing can be helpful, it also raises some ethical questions, such as concerns about bias, energy use, and the potential for people to lose some writing skills (Salvagno& 2023). Finding appropriate publications that address a specific investigation issue is the process of examining the academic literature, which is crucial for every research undertaking. This approach may be difficult, costly, and time-consuming. Progress in artificial intelligence has enabled the automation of this procedure, enhancing its speed and efficiency. The principal benefit of AI in the evaluation of research work is its capacity to quickly and accurately analyze extensive datasets, therefore conserving researchers' time and enabling them to concentrate on other facets of their studies. Notwithstanding these benefits, several constraints exist regarding the use of AI in the review phase. AI systems may not fully grasp the context and subtleties of scientific literature, perhaps resulting in the incorporation of unimportant research or the omission of significant ones. The efficacy of AI systems is contingent upon the quality and volume of training data. Also, literature reviews made by AI might not have the critical thinking and expert viewpoint that human reviewers offer, which is necessary for putting together difficult material (Hosseini & Holmes, 2023).

3. BENEFITS OF CHATGPT

The objective of any invention is to simplify human existence, which is also pertinent to technology. The progression of technology in recent years has facilitated improvements in people's quality of life. The transition to the fourth industrial revolution (4IR) necessitated that inventors develop technology to meet contemporary demands. As a result, the world was exposed to artificial intelligence, which subsequently led to the development of ChatGPT. Intense debates have occurred over the use and implementation of ChatGPT as an academic instrument. Studies found that students are happy with the use of ChatGPT as an academic tool, noting its effectiveness in summarising literature

(Mlambo, 2024; Ivanov, 2024). Students in higher education are now acquainted with ChatGPT and are willing to use it as an academic aid (Shahzad, 2024). ChatGPT may be used to produce poetry, generate code for computer applications, and craft narratives, which assists language and Information Technology (IT) students (Zhu et al.,2024; Ghimire &Edwards, 2024). Another advantage of using ChatGPT is its capability to modify content, which involves rephrasing phrases for improved coherence and selecting more appropriate vocabulary. It prompt-rewrite command is beneficial for researchers who compose lengthy statements since it aids in condensing and elucidating sentences (Koltovskaia&Saeli, 2024). Further it can assist in coding computer programs and identifying flaws, which is particularly advantageous for IT students, since programming may sometimes be challenging (Ghimire & Edwards, 2024). Additional advantages include summarising articles, rephrasing material for enhanced comprehension, simplifying complicated subjects, solving mathematical problems, and summarising literature. All the aforementioned methods may assist students and professors in using ChatGPT to enhance their academic experience. In addition, ChatGPT may facilitate the creation of tasks, essay composition, and critical reflection, which are invaluable resources since assignment development can be an arduous endeavor for educators. The capacity to aid with essay composition is advantageous for pupils since crafting academic essays can be a challenging endeavor (Strzelecki, 2024).

Table.1.Benefits of ChatGPT

Summarises literature efficiently (Mlambo, 2024; Ivanov, 2024)
Assists in writing poetry, code, and narratives (Zhu et al., 2024; Ghimire & Edwards, 2024)
Rephrases and simplifies complex content for better clarity (Koltovskaia&Saeli, 2024)
Helps solve mathematical problems and generate essay tasks (Strzelecki, 2024)
Facilitates faster, high-quality academic writing (Lee et al., 2022; Whalen & Mouza, 2023)
Supports students with tailored and efficient writing support tools (Lee et al., 2022)
Enhances coding accuracy by identifying flaws in code (Ghimire & Edwards, 2024)
Saves time in literature review and information processing (Hosseini & Holmes, 2023)

4. CHALLENGES OF CHATGPT

ChatGPT poses issues to ethical and equiTable practices in higher education since it potentially undermines the constructivist theory of learning, which prioritises active student engagement and knowledge building. The improper use of ChatGPT for the rapid generation of information as a shortcut contradicts the principles of constructivism and any relevant learning theory. Employing ChatGPT to enhance learning may result in unethical and inequiTable behaviors, undermining the essence of education (Ly & Ly, 2025). Optimal learning occurs via effective interactions between the teacher and the student (Schuh, 2004). Additionally, the learning environment includes social groupings, instructional methodologies, and a motivating ambiance, among other elements (Zajda, 2021). The aforementioned requirements would be absent in a learning environment supported by generative AI tools like ChatGPT. Digital inequality arises from the uneven distribution of technology and high-speed internet access among students, thereby intensifying pre-existing disparities within the educational system. Since there may be knowledge gap if students do not have equal access to chatGPT, ir is reasonable to assume that chat GPT affects student ability to freely acquire knowledge (Hein, 1991). Consequently, in order to make chat GPT accessible to all users and reduce digital inequalities universities should provide equiTable access to technology and assistive devices (Lim et al., 2023). A further problem with ChatGPT is the acceptance of feedback from AI instead of human instructors, which contradicts the constructivist view of learning that prioritizes interactions and social participation (Hein, 1991). Higher education institutions could use ChatGPT alongside human instructors to provide feedback to students, providing precise and trustworthy evaluations while mitigating the dissemination of misinformation (Dwivedi et al., 2023). Additionally, copyright issues may emerge since ChatGPT might have been trained on and generated responses akin to copyrighted material. Higher education institutions must address copyright concerns in their policies to reduce this problem and guarantee that ChatGPT complies with copyright regulations (Dwivedi et al., 2023).

Upholding academic integrity presents a considerable issue when using ChatGPT as an AI tool for composing academic evaluations, dissertations, and articles (Sullivan et al., 2023). Passive shortcuts, which may lead to violations of academic integrity, obstruct active student engagement and hence hamper the learning process. Consequently, to retain academic integrity while using ChatGPT, it is essential to use the information produced by the model responsibly and ethically (Sullivan et al., 2023). ChatGPT produces information derived from data inputs and learned patterns, with users accounTable for critically assessing the correctness and validity of the information. To preserve academic integrity, users must recognise and reference ChatGPT as a source of information and disclose its use in research and data analytics. The use of diverse web technologies for the generation of academic material is not a novel occurrence. Nonetheless, it is rendered more convenient and alluring for students, and identifying such academic dishonesty is challenging owing to the probabilistic and inaccurate characteristics of AI-generated text detectors (Raschka, et al., 2023).Utilizing ChatGPT as an instrument for exploration and inquiry enables students to actively develop their knowledge and understanding, hence reducing the probability of academic dishonesty, including plagiarism or cheating (Sullivan et al., 2023). To tackle the issue of maintaining academic integrity, it is suggested that a proactive strategy be used by fostering a culture of academic integrity and conveying the consequences of failing to meet essential learning objectives to students. Moreover, it is essential to reevaluate the evaluation of student learning outcomes and focus on analyzing the learning processes rather than only their learning artifacts, which may be readily recreated by ChatGPT (Rasul et al.,2023). The possibility of unethical or malicious use of ChatGPT is a considerable difficulty for higher education institutions (Lim et al., 2023). Some universities are prohibiting ChatGPT because of the ineffectiveness of existing detection systems, such as Turnitin; yet, these prohibitions may inadvertently increase ChatGPT use owing to the Streisand effect (Lim et al., 2023). The Streisand effect refers to the situation when attempts at censoring result in unproductive and contrary outcomes (Jansen & Martin, 2015).

Consequently, institutions must reconcile the prevention of academic misconduct with the promotion of academic freedom and creativity. Moreover, text created by ChatGPT may exhibit factual biases stemming from biased training data, thereby reinforcing misunderstandings among learners. If students mostly interact with ChatGPT, they may forgo collaborative learning and debate, which are vital in constructivist theory for critically assessing material and constructing knowledge (Watts, &Jofili, 1998; Yang et al., 2024).The fabricated material and citations produced by Chat GPT might mislead students (Gravel & Osmanlliu, 2023). Consequently, students need to verify all ChatGPT outputs throughout their interactions with the system to detect any biases or errors, thereby fostering a precise comprehension of the subject matter. Although OpenAI has declared that the newest iteration of ChatGPT would have plugins enabling access to current information and data, these advancements do not eliminate the possible concerns previously mentioned biases and misinformation.

Table.2.Challenges of ChatGPT

Undermines constructivist learning by discouraging active engagement (Ly & Ly, 2025)
Promotes digital inequality due to unequal access to technology (Hein, 1991; Lim et al., 2023)
Encourages reliance on AI feedback over human interaction (Hein, 1991)
Risks copyright infringement and plagiarism (Dwivedi et al., 2023)
Produces hallucinated/fabricated citations and misinformation (Gravel &Osmanlliu, 2023)
Undermines academic integrity; increases temptation for unethical shortcuts (Sullivan et al., 2023)
Reduces collaborative learning and debate, key to knowledge construction (Watts &Jofili, 1998; Yang et al., 2024)
Detection tools (e.g., Turnitin) may be ineffective against AI-generated text (Lim et al., 2023; Raschka et al., 2023)

5. CONCLUSION

The use of ChatGPT in higher education presents both advantages and challenges. It can help students in generating ideas for their research, analysis, interpretation, and writing projects, thereby enriching their overall learning experiences. On the other hand, the risk associated with academic dishonesty, prejudice, faked data, and flawed assessment may hinder the acquisition of essential skills and encourage superficial learning. Therefore, higher education instructors and students must be vigilant while using this technology for academic purposes to guarantee its ethical, reliable, and effective use. Higher education institutions must emphasise instructing students on the appropriate and ethical use of ChatGPT and other generative AI technologies. Academics may design novel assessment methodologies that ChatGPT cannot readily imitate, such as assessing learning processes instead of outputs. Furthermore, higher education instructors must confront prejudice and misinformation in ChatGPT to guarantee that students develop precise knowledge and participate in collaborative learning and discourse. Including AI literacy into higher education may improve students' employability and preparedness for the swiftly changing work environment. It is essential to adapt to emerging technologies while enforcing stringent restrictions and guidelines to protect consumers from any damage. As the educational and research landscape transforms, the integration of AI technologies and novel pedagogical methods is essential for fostering a versatile and adapTable environment. An intentional, equiTable, and cohesive amalgamation of AI and human assistance may provide extensive support systems that advantage researchers, instructors, and students in many fields. To ensure the successful integration and responsible use of AI technologies, including pertinent courses into the curriculum, organising webinars on AI's influence on education and research, and supplying required resources may promote the seamless inclusion of AI into higher education.

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Circulate Over, Gen Alpha: Gen Beta Is Taking on the Lighting Now

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ABSTRACT

As Generation Alpha edges toward adolescence, the spotlight is gradually shifting to Generation Beta, the cohort born from 2025 onwards. This ABSTRACT highlights the distinct characteristics and societal influences shaping these emerging generations, underscoring their unique identities as they navigate a rapidly evolving world. Generation Alpha, known for being tech-savvy digital natives, has been extensively studied, often in the context of their interactions with advanced technology, educational innovations, and evolving family dynamics. However, focus is now turning to Generation Beta, whose formative years will be marked by unprecedented global challenges and transformations, including climate change, economic shifts, and advancements in artificial intelligence. This transition prompts important inquiries into how Generation Beta will redefine societal norms and expectations. Key attributes of Generation Beta may include heightened environmental consciousness, adaptability to new forms of remote interaction, and an integrated approach to wellness that encompasses mental health and environmental stewardship. As educational systems adapt to the realities of a post-pandemic world, Generation Beta will likely experience a blend of traditional and innovative learning experiences, fostering creativity and critical thinking.

Furthermore, the influence of social media and virtual realities will continue to shape their relationships and self-perception, provoking questions about privacy, identity, and social interaction in a hyper connected world. As we circulate over the dynamics between these two generations, understanding their distinctions is crucial for educators, marketers, and policymakers. By embracing this generational shift, we can better prepare for the societal evolution that Generation Beta represents, highlighting the importance of adaptability, empathy, and sustainability in their development. This examination is vital to ensure a supportive environment that nurtures the potential of both Generation Alpha and the emerging Generation Beta.

Keywords: artificial intelligence (AI), environmental stewardship, critical thinking.

1. INTRODUCTION THE GENERATIONAL SHIFT AND THE RISE OF GEN BETA

The concept of generational cohorts provides a framework for understanding broad societal trends and consumer behaviors. While Gen Alpha is currently the focus of much attention, the rapid pace of technological evolution necessitates a forward-looking perspective on the next generation. We term this hypothetical successor generation "Gen Beta." Born into a world saturated with artificial intelligence, ubiquitous connectivity, and highly personalized digital experiences, Gen Beta will likely have a fundamentally different relationship with technology and their physical environment compared to previous generations. Their expectations for seamless interaction, instant gratification, and hyper-personalization will extend beyond the digital real and significantly influence their demands for physical spaces, including lighting. The concept of generational cohorts provides a valuable framework for understanding societal shifts, consumer behavior, and technological adoption. Following the widely discussed Generational Alpha, the next cohort, tentatively labeled Generational Beta (Gen Beta), is expected to encompass individuals born roughly between 2025 and 2039. While still in its nascent stages, understanding the potential characteristics and impact of this generation is crucial for businesses, policymakers, and researchers alike. This paper focuses on the anticipated influence of Gen Beta, particularly on the rapidly evolving lighting industry, which is increasingly intertwined with technology, connectivity, and user-centric design.

2. DEFINING GEN BETA: KEY CHARACTERISTICS AND ENVIRONMENTAL EXPECTATION

While precise demographics are speculative, we can infer some key characteristics of Gen Beta based on the trajectory of technological development and current trends:

Digital Natives on Steroids: Having never known a world without advanced AI and interconnected devices, Gen Beta will possess an innate understanding and expectation of intelligent systems. They will likely view technology as an extension of themselves and demand intuitive, natural interfaces.

Hyper-Personalization as the Norm: Growing up with personalized algorithms shaping their online experiences, Gen Beta will expect their physical environments, including lighting, to adapt seamlessly to their individual needs, moods, and activities without explicit input. **Emphasis on Well-being and Experience:** Influenced by growing awareness of mental and physical health, Gen Beta will prioritize environments that contribute to their overall well-being. Lighting will be seen not just for illumination but as a tool to enhance mood, productivity, and relaxation.

Sustainability and Ethical Consumption: Building on the increasing environmental consciousness of current generations, Gen Beta will likely demand sustainable and ethically produced products and services. Energy efficiency and the circular economy will be significant considerations.

Fluidity and Adaptability: Gen Beta will likely navigate diverse and rapidly changing environments. Their lighting preferences will need to be highly adapTable, shifting effortlessly between work, leisure, social interaction, and solitude.

AI as a Native Tool: Unlike previous generations who adapted to AI, Gen Beta will likely interact with and utilize AI as a fundamental tool from a very young age. This will influence their learning, problem-solving, and creative processes.

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Personalization and Customization Expectations: Having grown up with highly personalized digital experiences, Gen Beta will likely demand similar levels of customization and control in their physical environments, including lighting. **Sustainability and Ethical Awareness:** Building on the growing awareness of environmental and social issues among previous generations, Gen Beta may exhibit a strong inclination towards sustainable and ethically sourced products and services. **Focus on Experiences:** Beyond ownership, Gen Beta may prioritize experiences and the value derived from products and services, influencing their consumption patterns.

Fluid Identities and Community: Growing up in a globally connected world with diverse online communities, Gen Beta may exhibit more fluid identities and a strong sense of belonging to various digital and physical groups.

3. THE LIGHTING LANDSCAPE FOR GEN BETA: BEYOND ILLUMINATION

For Gen Beta, lighting will transcend its traditional function of simply providing light. It will become an integral part of a dynamic, responsive, and personalized environment. Key expectations for lighting systems serving Gen Beta will include:

Predictive and Proactive: Lighting systems will anticipate Gen Beta's needs based on contextual cues (time of day, weather, activity) and personal data (calendar, biometric sensors, smart home interactions).
Adaptive and Responsive: Lighting will adjust in real-time to changes in the environment and the user's state, seamlessly transitioning between different lighting scenes and intensities.
Intuitive and Effortless Control: Manual control interfaces will be minimized, with natural language processing, gesture control, or even brain-computer interfaces becoming the primary modes of interaction.
Holistic Well-being Integration: Lighting will be integrated with other smart home systems to optimize sleep cycles, enhance focus, and promote relaxation through dynamic colour temperatures and intensity variations.
Energy Efficiency and Sustainability: Gen Beta will demand highly energy-efficient lighting solutions with minimal environmental impact throughout their lifecycle.
Demand for Intelligent and Responsive Lighting: Gen Beta will expect lighting systems that are not only energy-efficient but also intelligent, responsive to their needs, and seamlessly integrated with other smart devices. This includes features like adaptive brightness, colour tuning based on time of day or mood, and integration with AI assistants.
Personalized Lighting Experiences: Moving beyond pre-set scenes, Gen Beta will likely demand highly personalized lighting experiences that can be easily customized through intuitive interfaces, potentially leveraging augmented or virtual reality.
Focus on Wellness and Basophilic Design: Understanding the impact of light on mood, sleep, and overall well-being, Gen Beta may drive demand for lighting solutions that promote health and incorporate principles of basophilic design.
Subscription and Service-Based Models: Instead of purchasing individual fixtures, Gen Beta may prefer subscription or service-based models for lighting, allowing for easier upgrades, maintenance, and access to advanced features.

Sustainability and Circular Economy: Gen Beta's potential emphasis on sustainability will push the lighting industry towards more energy-efficient technologies, longer-lasting products, and circular economy principles for manufacturing and disposal.
Integration with Immersive Technologies: As augmented and virtual reality become more prevalent, Gen Beta will likely expect lighting systems that can interact with and enhance these immersive experiences.

4. MODELING GEN BETA'S INFLUENCE ON LIGHTING ADOPTION

To quantify the potential impact of Gen Beta on the adoption of advanced lighting technologies, we can utilize mathematical functions. Let's consider a simplified model for the adoption rate of a new, intelligent lighting technology within a population.
Let **N(t)** be the number of individuals who have adopted the technology at time **t**. We can model the adoption rate using a logistic growth function, which is often used to describe the spread of innovations

$$\frac{d}{dt}N = kN(t)(1-\frac{N(t)}{L})$$

Where:

- **dN / dt** is the rate of adoption.
- **k** is the adoption rate coefficient, representing how quickly the technology spreads through the population.
- **N(t)** is the current number of adopters.
- **L** is the carrying capacity, representing the maximum potential number of adopters in the population.

The solution to this differential equation is:

$$N(t) = \frac{L}{1+Ae^{-kt}}$$

Where **A** is a constant determined by the initial number of adopters N_0 at time **t=0:**

$$A=\frac{L-N_0}{N_0}$$

Now, let's introduce the influence of Gen Beta. We can hypothesize that Gen Beta's inherent digital fluency and expectation of advanced technology will influence the adoption rate coefficient **k** As Gen Beta enters the consumer market, they will likely accelerate the adoption of intelligent lighting. We can model the adoption rate coefficient **k** as a function of the proportion of Gen Beta in the population. Let **G(t)** be the proportion of the population that belongs to Gen Beta at time **t.** We can assume that k increases as **G(t)** increases. A simple linear relationship could be:

$$k(t)=k_0+\alpha G(t)$$

Where:
k_0 is the baseline adoption rate coefficient without the significant influence of Gen Beta.
α is a coefficient representing the impact of Gen Beta's proportion on the adoption rate. A higher α indicates a stronger influence.
The proportion of Gen Beta in the population **G(t)** will itself be a function of time. As Gen Beta is born and enters the relevant consumer age groups, their proportion will increase. We can model this increase using a sigmoid function or a simple linear ramp function over a specific period. For

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simplicity, let's assume a linear increase in the proportion of Gen Beta from time t_{start} (when Gen Beta begins to enter the consumer market) to t_{end} (when Gen Beta reaches a significant proportion):

G (t) is defined piecewise as follows:

$G(t) = 0$ for $t < t_{start}$

$G(t) = (t - t_{start}) / (t_{end} - t_{start})$

For $t_{start} \le t \le t_{end}$

$G(t) = 1$ for $t > t_{end}$

Substituting the time-dependent adoption rate coefficient **k(t)** into the logistic growth model, we get a more complex differential equation:

$$\frac{d}{dt} N = (k_0 + aG(t))N(t)(1 - \frac{N(t)}{L})$$

This differential equation is more challenging to solve analytically, but it can be solved numerically. The key take away from this model is that as the proportion of Gen Beta **G(t)** increases, the adoption rate coefficient **k(t)** also increases, leading to a faster uptake of intelligent lighting technologies compared to a scenario without Gen Beta's influence.

5. MATHEMATICAL DERIVATION OF THE IMPACT:

To illustrate the impact, let's compare two scenarios:

Scenario 1: No Gen Beta Influence (Constant k): The adoption follows the standard logistic curve with a constant $\mathbf{k_0}$.

$$N_1 t = \frac{L}{1 + A_1 e^{-k_0 t}}$$

Scenario 2: Gen Beta Influence (Time-Dependent k): The adoption follows the model with

$$k(t)=k_0+\alpha G(t)$$

The difference in the number of adopters between the two scenarios at any given time t represents the accelerated adoption due to Gen Beta:

$$\Delta N(t)=N_2(t)-N_1(t)$$

Where $\mathbf{N_2(t)}$ is the solution to the differential equation with the time-dependent **k(t).**

While a full analytical solution for $\mathbf{N_2(t)}$ is complex, we can observe the impact on the rate of adoption. The instantaneous rate of adoption in Scenario 2 is:

$$\frac{dN_2}{dt} = (k_0 + \alpha G(t))N_2(t)(1 - \frac{N_2(t)}{L})$$

Comparing this to the rate in Scenario 1:

$$\frac{dN_1}{dt} = k_0 N_1(t)(1 - \frac{N_1(t)}{L}).$$

Assuming at a given time **t**, $\mathbf{N_2(t) \approx N_1(t)}$ (early in the adoption cycle where the difference is not yet significant), the difference in the rate of adoption is approximately:

$$\frac{dN_2}{dt} - \frac{dN_1}{dt} \approx (k_0 + aG(t))N(t)(1 - \frac{N(t)}{L}) - k_0 N(t)(1 - \frac{N(t)}{L})$$

This shows that the difference in the rate of adoption is directly proportional to the influence of Gen Beta **α**, the proportion of Gen Beta in the population **G(t),** and the current number of adopters **N(t)** (weighted by the remaining potential for adoption). As **G(t)** increases, the rate of adoption accelerates.

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6. IMPLICATIONS FOR THE LIGHTING INDUSTRY

The anticipated characteristics and influence of Gen Beta present both challenges and opportunities for the lighting industry:

Shift in Product Development: Companies need to prioritize the development of intelligent, connected, and highly customizable lighting solutions.

Focus on User Experience: Intuitive interfaces, seamless integration with smart home ecosystems, and personalized control will be crucial.

Embrace of Service Models: Exploring subscription or service-based models can cater to Gen Beta's potential preference for access over ownership.

Sustainability as a Core Value: Incorporating sustainable materials, energy-efficient technologies, and circular economy principles will be essential for attracting Gen Beta consumers.

Collaboration with Tech Companies: Partnerships with AI developers, software providers, and smart home platform creators will be vital for delivering the integrated experiences Gen Beta will expect.

Educational Initiatives: Educating consumers about the benefits of advanced lighting technologies and their impact on well-being will be important for driving adoption.

7. LIMITATIONS AND FUTURE RESEARCH

This paper provides a preliminary analysis based on anticipated trends. The actual characteristics and impact of Gen Beta may differ. Future research should focus on: Refining the definition and characteristics of Gen Beta as the cohort emerges. Conducting empirical studies to understand the preferences and behaviours of early Gen Beta individuals. Developing more sophisticated mathematical models to capture the complex interactions between generational shifts, technological adoption, and market dynamics. Analysing the socio-economic factors that may influence Gen Beta's access to and adoption of advanced technologies.

8. CONCLUSION

While Gen Alpha is currently in the spotlight, the imminent arrival of Generational Beta is set to reshape various industries, particularly those heavily reliant on technology and user experience. The lighting industry, in its transition towards intelligence and connectivity, is particularly susceptible to Gen Beta's influence. Their hyper-digital fluency, expectation of AI as a native tool, and demand for personalization will drive the adoption of advanced lighting technologies at an accelerated pace, as illustrated by our mathematical model. Companies that proactively understand and cater to the needs and preferences of Gen Beta will be best positioned to thrive in the future lighting landscape. Circulate over, Gen Alpha; Gen Beta is taking on the lighting now, and the industry must be prepared for their transformative impact.

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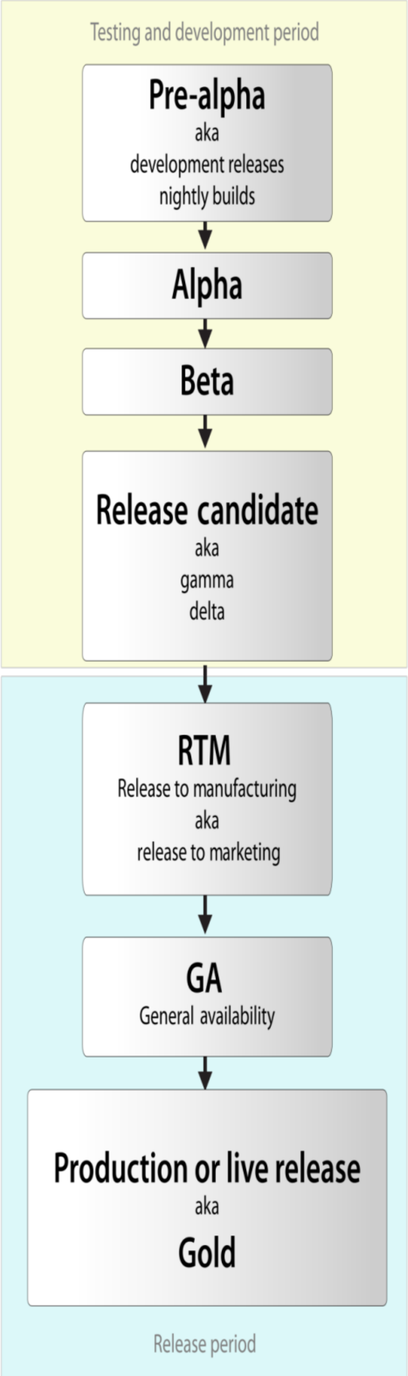
APPENDIX FIGURE



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Empowering the Gen Alpha with Innovations in Online Schooling & Proctoring: International Youngsters Competencies Day

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ABSTRACT

In the context of the rapidly evolving educational landscape, Empowering Generation Alpha through innovations in online schooling and proctoring is paramount for fostering essential competencies required in the 21st century. This paper explores how technological advancements in digital education platforms support the unique learning needs of Generation Alpha—those born from 2010 onward. As global challenges and disruptions have prompted a shift towards online learning, strategies that enhance engagement, accessibility, and integrity in assessments have become crucial. On International Youngsters Competencies Day, we emphasize the importance of developing critical thinking, digital literacy, and collaborative skills in young learners. Innovations such as adaptive learning technologies and artificial intelligence facilitate personalized education paths, catering to diverse learning preferences and paces. Moreover, advancements in online proctoring ensure the reliability and security of assessments, fostering a culture of academic integrity and trust. This paper discusses case studies from various international contexts, highlighting successful implementations of online schooling innovations that empower students to thrive in a digitally connected world. By integrating gamification and interactive tools into curriculum design, educators can create immersive learning experiences that motivate and inspire. Furthermore, the role of community and parental engagement in supporting online learning environments is critically analyzed. In conclusion, empowering Generation Alpha through innovative online schooling and proctoring practices not only equips them with necessary competencies but also prepares them for a future characterized by rapid technological change and global interconnectedness. This research underscores the need for continuous investment in educational technologies and pedagogies that nurture the potential of our youngest learners.

***Keywords**: Generation Alpha, online schooling, innovations, proctoring, competencies, digital education, academic integrity, adaptive learning.*

1. INTRODUCTION

As the most digitally immersed generation, Gen Alpha is poised to face unique challenges and opportunities in the educational landscape. Online schooling, further accelerated by the COVID-19 pandemic, has emerged as an adapTable educational model that meets the requirements of contemporary learners. However, ensuring effective learning outcomes in an online environment necessitates innovation, particularly in assessment methods like online proctoring. This paper evaluates how innovative approaches in online education and proctoring can empower Gen Alpha and enhance their competencies as global citizens.

This research paper examines the innovative approaches to online schooling and proctoring aimed at empowering Generation Alpha (Gen Alpha) with the skills and competencies required in an increasingly digital world. Defined as those born from 2010 onwards, Gen Alpha represents the first generation to grow up entirely in the 21st century, which has been characterized by rapid technological advancements. This study explores the educational methodologies employed to meet their unique needs, reviews existing literature, proposes a robust research methodology for detailed analysis, and outlines future research directions.

2. LITERATURE REVIEW

2.1. Understanding Gen Alpha

Generation Alpha is characterized by its familiarity with technology from an early age and has been observed to possess different learning preferences compared to previous generations. Research indicates a strong inclination towards interactive and engaging educational content that utilizes gamification and multimedia.

2.2. Online Schooling Trends

The transition to online schooling has revealed various pedagogical strategies and technological tools designed to enhance student engagement and learning outcomes. Studies underscore a shift towards blended learning environments that combine synchronous and asynchronous teaching methods, allowing flexibility and accessibility.

Key Innovations:

Gamification: Incorporating game-like elements to motivate students.

Augmented and Virtual Reality: Providing immersive learning experiences.

Adaptive Learning Technologies: Personalizing the educational content to meet individual learning needs.

2.3. Proctoring Innovations

The necessity for online assessments has led to innovations in proctoring technology to ensure academic integrity. Research highlights various types of online proctoring solutions, including:

Live Proctoring: Real-time monitoring by proctors.

Automated Proctoring: AI-driven systems analyzing student behaviour.

Record and Review: Capturing assessment sessions for later review.

2.4. International Competencies

As the world becomes increasingly interconnected, it is essential for Gen Alpha to develop competencies that prepare them for global citizenship. These include critical thinking, digital literacy, intercultural communication, and collaboration skills.

3. RESEARCH METHODOLOGY

This research adopts a mixed-methods approach, combining qualitative and quantitative data collection techniques to assess innovations in online schooling and proctoring.

3.1. Research Design

Quantitative Surveys: Online surveys distributed to parents, educators, and students to gauge their experience and satisfaction with online schooling and proctoring.

Qualitative Interviews: In-depth interviews with educators and technologists to gather insights into the effectiveness of various online teaching methods and assessment strategies.

3.2. Sample Selection

Participants include a diverse range of international students aged 10-13, parents of Gen Alpha children, educators from various settings (traditional schools, online schools), and technology providers specializing in online education.

3.3. Data Analysis

Quantitative Data: Statistical analysis using software like SPSS to identify trends and correlations.

Qualitative Data: Thematic analysis of interview transcripts to unearth common themes and insights.

4. FUTURE SCOPE

The future of education for Gen Alpha lies in continuous innovation and adaptation. Further research could explore the following areas:

Longitudinal Studies: Investigating the long-term impact of online education and proctoring on student competencies.

Equity in Education: Examining the disparities in access to technology and its effects on learning outcomes among international students.

Integration of Emerging Technologies: Assessing the role of artificial intelligence, machine learning, and block chain in creating more secure and effective online learning environments.

5. MATHEMATICAL FUNCTION: ANALYZING ENGAGEMENT LEVELS

To quantify the effectiveness of various online schooling methods, we can introduce a mathematical model that predicts student engagement levels based on various parameters.

Engagement Function

Let E represent the engagement level, from 0 (no engagement) to 1 (full engagement). We can define E as a function of:

Content Quality (Q): The richness of the educational material (scale of 1-10).

Interactivity (I): Level of student interaction (scale of 1-10).

Peer Collaboration (C): Opportunities for collaborative learning (scale of 1-10).

The engagement function may be represented as

$$\mathbf{E\ (Q,\ I,\ C)} = \frac{\boldsymbol{Q+I+C}}{\mathbf{30}}$$

This function averages the scores across three dimensions, setting the maximum possible engagement level at 1. As we conduct surveys and collect data, we can utilize this function to quantify and compare engagement levels across different educational settings and proctoring environments.

6. CONCLUSION

In conclusion, empowering Gen Alpha with innovations in online schooling and proctoring is crucial for their educational and personal development. By leveraging technology effectively, we can enhance their competencies and prepare them for future challenges. The proposed research methodology and mathematical models presented in this paper lay a foundation for further exploration into this important topic.

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Implementing the Modified PSO Algorithm to Train the ANFIS Structure

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ABSTRACT

An advanced method for maximizing the energy output of solar photovoltaic systems is the PSO-ANFIS MPPT. The Adaptive Neuro-Fuzzy Inference System (ANFIS) and Particle Swarm Optimization (PSO) are used to proactively track the solar panels' Maximum Power Point (MPPT). PSO effectively modifies the ANFIS smart control system's settings to accommodate shifting panel characteristics and ambient circumstances. Under quickly shifting meteorological circumstances, like as temperature and irradiance, it offers accurate, reliable, and quick reaction PV tracking. In order to find the best answer, this algorithm imitates the social nature of fish or birds. It can be difficult to effectively adjust the ANFIS structure's parameters using conventional gradient-based techniques, but the altered PSO algorithm assists. It assists in modifying the settings to determine the solar panels' Maximum Power Point (MPP). In this study, a novel method for training the fuzzy inference system (ANFIS) based on adaptive networks is presented. The gradient base approach or least squares (LS) based approach was the focus of earlier studies.With certain modifications, we use particle swarm optimization (PSO), one of the swarm intelligence branches, for conditioning all of the ANFIS structure's attributes in this work.Natural evolutions are the source of these changes. Ultimately, the technique is used to identify nonlinear dynamical systems, and when compared to basic PSO, the results are rather good. Under quickly changing weather circumstances, traditional MPPT approaches such as Incremental Conductance (IC) and Perturb and Observe (P&O) have limits in terms of tracking speed and efficiency. These systems can function more effectively and lessen their dependency on traditional energy sources by improving the energy output from solar panels.It aids in optimizing solar panel energy harvesting, which is crucial for supplying electricity to distant homes, schools, or small companies.By adjusting to variations in load and environmental circumstances, it guarantees a steady and effective energy supply. In order to improve performance, hybrid intelligence algorithms like the Adaptive Neuro-Fuzzy Inference System (ANFIS) and Particle Swarm Optimization (PSO) are employed.

Keywords: TSK System, Fuzzy Systems, ANFIS, Swarm Intelligent, Identification, Neuro-Fuzzy, Particle Swarm Optimization.

1. INTRODUCTION

Some issues, including predicting chaotic systems and adapting to complex plants, are complicated and dynamic, necessitating the use of advanced techniques and technologies in order to create an intelligent system. It is dependable to use fuzzy systems as estimators, identifiers, and predictors for this purpose [1,2].When fuzzy logic and neural network architecture were combined, neuro-fuzzy systems were created. These systems retain the interpretability of fuzzy systems while benefiting from feedforward output calculation and neural network backpropagation learning capabilities [3]. The TSK [4,5] is thought to be appropriate for complex applications because it is a fuzzy system with distinct functions in consequence [6].It has been demonstrated that a TSK system might roughly represent each plant with a practical set of rules [7].The neuro-fuzzy system known as ANFIS is a popular variant of the TSK systems [8].ANFIS employs a straightforward method of implicit scaling due to its distinct consequent functions. This adaptive network has been used in a variety of systems and exhibits strong performance and capabilities in system identification, prediction, and control. Because the ANFIS can be understood as neighbourhood linearization modelling and traditional linear approaches for estimation of state and control are immediately applicable, it has the advantage of good adaptability [9].The ANFIS is made up of fuzzy systems and neural networks. ANFIS parameter training and updating is one of the primary issues. Most training techniques rely on gradients, which can be quite challenging to calculate at each step. Additionally, using chain rules may result in local minima. Our aim is to suggest a technique that can update all parameters more quickly and easily than the gradient method. finding the optimal learning rate is exceedingly challenging with the gradient method, as parameter convergence is very sluggish and dependent on initial parameter values. However, the learning rate is not required for this new approach, which is known as PSO [10]. The remainder of the document is structured as follows: We go over ANFIS in Section II. The PSO approach is covered in Section III. Section IV provides a summary of the suggested approach and how it was used for nonlinear identification. Lastly, our findings are presented in Section V.

2. ANFIS ALGORITHM

Based on fuzzy logic inference and neural network design, the adaptive neuro-fuzzy interference system technology is regarded as a hybrid approach. When creating fuzzy expert systems, the neuro-fuzzy technique is crucial. Regardless, achieving the minimal performance requires careful consideration of the quantity, kind, regulations, and specifications of the fuzzy system Membership Function. The process of reaching the minimal performance involves trial and error. This statement highlights the significance of the settings in fuzzy systems.

One of the adaptive systems' Sugeno networks, ANFIS, aids in training and education. In order to reduce the need for an expert user, this framework harnesses expert knowledge to make models more methodical. To gain a deeper comprehension of the ANFIS architecture, let us examine the fuzzy system below, which is a first-order Sugeno model with two rules and two inputs. Fig. 5 depicts the corresponding ANFIS architecture of a first-order Sugeno fuzzy model with two rules. Each node in a particular layer of the five-layer

architecture performs a similar function. fuzzy IF-THEN rule set, where the results are combinations of the inputs in a linear fashion.
Rule 1:
If (x is A1) and (y is B1) then (f1 = p1x + q1 + r1) (1)
Rule 2:
If (x is A2) and (y is B2) then (f2 = p2x + q2 + r2) (2)

Layer 1: In this layer, each node is adaptive and represents a fuzzy membership function. The output of each node is the degree of membership of the input to the fuzzy membership function it represents. Expressions that may be used to get those results are:

$$O_{1,i} = \mu_{Ai}(x) \quad i=1,2 \qquad (3)$$

$$O_{1,i} = \mu_{Bi}(x) \; i=3,4 \qquad (4)$$

In fuzzy logic, Ai and Bi represent fuzzy sets, typically defined by membership functions (MFs). These sets are often represented in parametric form, which means they're defined by a set of parameters. For example, in the case of trapezoidal-shaped MFs, these parameters define the shape of the trapezoid. $O_{1,I}$ Represents the output of a node in the i-th layer of a neural network or a similar computational model.

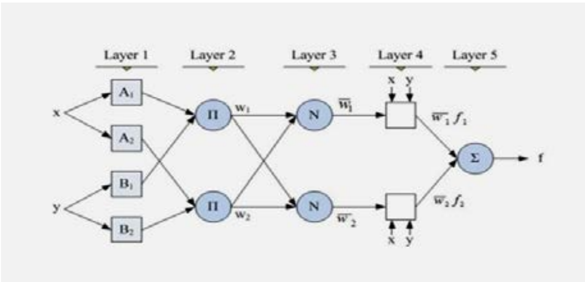


Figure.1.Structure of an ANFIS that is comparable to a Sugeno fuzzy model of first order with two inputs and two rules

Layer 2: This type of layer is often referred to as an affine transformation or fully connected layer in neural networks. In such a layer, each node takes in the inputs, multiplies them by a set of fixed weights (parameters), and then passes the result through an activation function. If there's no activation function, then it's just a linear transformation. The notation Π might be used to represent these fixed weights or multipliers. Expression (5) displays the outputs from this node.

$$O_{2,i} = W_I = \mu_{Ai}(x)\mu_{Bi}(y) \; i=1,2 \qquad (5)$$

Layer 3: The nodes in this layer are referred to as fixed nodes and have a 'N' next to them to indicate that they handle the normalization of the preceding layer's score strength. By guaranteeing that the input to the next layer is within a suiTable range, this normalization procedure improves the training process's stability and convergence. This node's output is provided in (13).

$$O_{3,i} = \overline{W} = \frac{w_i}{w_1+w_2} \; ; \; i=1,2 \qquad (6)$$

Layer 4: layer of fuzzy logic using adapTable nodes adaptive nodes in fuzzy logic modify their parameters in response to input data. Fuzzy logic procedures are usually used to combine inputs to determine the output of each node. Each node's output is determined by multiplying a the first-order polynomial function with the normalized score strength. This means the output of each node can be represented as:

$$O_{4,i} = \overline{W}_i f_I = \overline{W}_i(p_i x + q_i y + r_i) \quad i=1,2 \qquad (7)$$

Layer 5: There is only one node in this layer, denoted by an S, which stands for simple summary.

$$O_{4,i} = \textstyle\sum_i \overline{W}_i f_I = \frac{\sum_i W_i f_i}{\sum_i W_I} \; ; \; i=1,2 \qquad (8)$$

2.1. Learning Algorithms

The subsequent to the development of ANFIS approach, a number of methods have been proposed for learning rules and for obtaining an optimal set of rules. For example, Mascioli et al [11] have proposed to merge Min-Max and ANFIS model to obtain neuro-fuzzy network and determine optimal set of fuzzy rules. Jang and Mizutani [12] have presented application of Lavenberg-Marquardt method, which is essentially a nonlinear least-squares technique, for learning in ANFIS network. In another paper, Jang [13] has presented a scheme for input selection and [14] used Kohonen's map to training. Jang [15] is introduced four methods to update the parameters of ANFIS structure, as listed below according to their computation complexities: 1. Gradient decent only: all parameters are updated by the gradient descent. 2. Gradient decent only and one pass of LSE: the LSE is applied only once at the very beginning to get the initial values of the consequent parameters and then the gradient decent takes over to update all parameters. 3. Gradient decent only and LSE: this is the hybrid learning. 4. Sequential LSE: using extended Kalman filter to update all parameters. These methods update antecedent parameters by using GD or Kalman filtering. These methods have high complexity. In this paper we introduced a method which has less complexity and fast convergence.

3. PARTICLE SWARM OPTIMIZATION (PSO) ALGORITHMS

One type of population-based search method is particle swarm optimization (PSO), which simulates the social behaviour of birds in a flock [16]. According to the fitness information gathered from the environment, they all update the population of persons by using various operators. This allows the population to be predicted to travel toward better regions for solutions. Each individual is a point in the D-dimensional search space, and in the PSO, each individual flies in the search space with a velocity that is dynamically changed based on its own flight experience [17]. Three main algorithms make up the PSO in general. The individual best is the first. In this form, each person just evaluates their own stance against its best one. The algorithms of this type do not employ information from other particles. The world's best rendition is the second one [18]. Particles travel according to social knowledge, which includes the location of the best particle in the swarm. Each particle also applies its past experience to choose its best solution to date. The algorithms in this kind are shown as:

1. Initialize the swarm,$p_{(t)}$, of particles such that the position$\underset{X_i}{\rightarrow}$ *(t)*of each particle $P_i \in P(t)$ is random within the hyperspace, with t = 0.
2. Evaluated the performance F of each particle, using its current position$\underset{X_i}{\rightarrow}$ *(t).*
3. Compare the performance of each individual to its best performance thus far: if then:if
$F(\underset{X_i}{\rightarrow}(t)) < pbest$, then:

$$Pbest_i = F(\underset{X_i}{\rightarrow}(t)) \qquad (9)$$

$$\underset{X}{\rightarrow} pbest_i = \underset{X_i}{\rightarrow}(t) \qquad (10)$$

4. Compare the performance of each individual to global best particle: if *F* ($\vec{X_i}$ *(t)) <gbest then:*

gbest = F ($\vec{X_i}$ *(t))* (11)

$\vec{X}_{gbest}$ = $\vec{X_i}$ (t) (12)

5. Change the velocity vector for each:

$\vec{V_i}$(t)=$\vec{V_i}$(t-1) + ρ_1 ($\vec{X}_{pbest}$ - $\vec{X_i}$ *(t))* + ρ_2 ($\vec{X}_{gbest}$ - $\vec{X_i}$ *(t))* (13)

Where ρ_1 and ρ_2 are random variables. The second term above is reffered to as the cognitive component, while the last term is the social component.

6. Move each particle to a new position:

$\overrightarrow{X_i}$(t) = $\overrightarrow{X_i}$(t-1) + $\overrightarrow{V_i}$(t) (14)

t = t+1

7. Go to step 2, and repeat until convergence.

The random variables ρ_1 and ρ_2 are defined as $\rho_1 = r_1 C_1$ and $\rho_2 = r_2 C_2$, With $r_1, r_2 \sim$ U(0,1), and $C_1\ and C_2$ are positive acceleration constant. Kennedy hes studied the effects of the random variable ρ_1 and ρ_2 on the particle's trajectories. He asserted that $C_1 + C_2 \le 4$ guarantee the stability of PSO.

3.1. Modified PSO Algorithm

This method replaces the population's worst particle with a new one. Determining the worst particle and creating new particles for the existing population are crucial [19]. During generation, the particle with the worst local best value is chosen. After selecting two particles at random from the population, we create two new particles using the crossover operator. After that, choose the best particle among the two freshly created particles, and then swap out the poorer particle for the chosen one. On the other side, we alter it by combining the GA operator with the PSO algorithm. Compared to a basic algorithm, this tweak makes convergence faster [16].

3.2. Learning By PSO

In this section, the way PSO employed for updating the ANFIS parameters is explained. The ANFIS has two types of parameters which need training, the antecedent part parameters and the conclusion part parameters. The membership functions are assumed Gaussian as in equation (5), and their parameters are$\{a_i,\ b_i,\ c_i\ \}$, wherea_i is the variance of membership functions and $c_i$is the center of MFs. Also $b_i$is a trainable parameter. The parameters of conclusion part are trained and here are represented with $\{p_i,\ q_i,\ r_i\}$.

3.3. How to Apply PSO for Training ANFIS parameters

There are 3 sets of trainable parameters in antecedent part $\{a_i,\ b_i,\ c_i\ \}$, each of these parameters has N genes. Where, N represents the number of MFs. The conclusion parts parameters ($\{p_i,\ q_i,\ r_i\}$) also are trained during optimization algorithm. Each chromosome in conclusion part has, *(I + 1)×R* genes that R is equal to Number of rules and I denotes dimension of data inputs. For example, each chromosome in conclusion part in fig (1) has 6 genes. The fitness is defined as mean square error (MSE).

Parameters are initialized randomly in first step and then are being updated using PSO algorithms. In each iteration, one of the parameters sets are being updated. i.e. in first iteration for example a_is is updated then in second iteration are updated $b_i$and then after updating all parameters again the first parameter update is considered and so on.

3.4. Nonlinear Function Modelling

Example 1: Identification of a nonlinear dynamic system. In this example, the nonlinear plant with multiple time-delays is described as [18].

$y_{p^{(k+1)}} =$ f $(y_{p^{(k)}},\ y_{p^{(k-1)}},\ y_{p^{(k-2)}},\ u(k),$ u(k-1)(12)

Where

f (x_1 , x_2 , x_3 , x_4 , x_5) = $\frac{x_1 x_2 x_4 x_5 (x_3 - 1) + x_4}{1 + x_1^2 + x_2^2}$ (13)

Here, the current output of the plant depends on three previous outputs and two previous inputs. Testing input signal used is as the following:

$$u(k) = \begin{cases} sin\left(\frac{\pi k}{25}\right) \quad 0 < k < 250 \\ 1.0 \quad 250 \le k < 500 \\ -1.0 \quad 500 \le k < 750 \\ 0.3\, sin\left(\frac{\pi k}{25}\right) + 0.1\, sin\left(\frac{\pi k}{25}\right) + \\ 0.6\, sin\left(\frac{\pi k}{25}\right). \quad 750 \le k < 1000 \end{cases} \quad (14)$$

Fig.2 (a) shows results using the ANFIS and PSO for identification (solid line: actual system output, the dotted line: the ANFIS and PSO result). Fig.2 (b) Present the MSEs of modified algorithm and Fig.2 (c) Present the MSEs of basic algorithm. The parameters for training the ANFIS with this PSO algorithm listed in Table I.

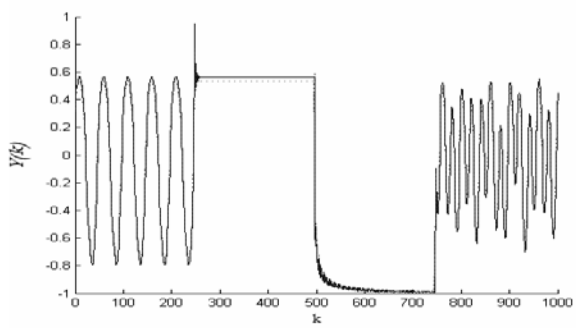
Example 2: Identification of nonlinear systems. We consider here the problem of identifying a nonlinear system which was considered in [18]. A brief description is as follows. The system model is

$y_{(k+1)} =$ f $(y_k, y_{(k-1)}) + u(k)$ (15)

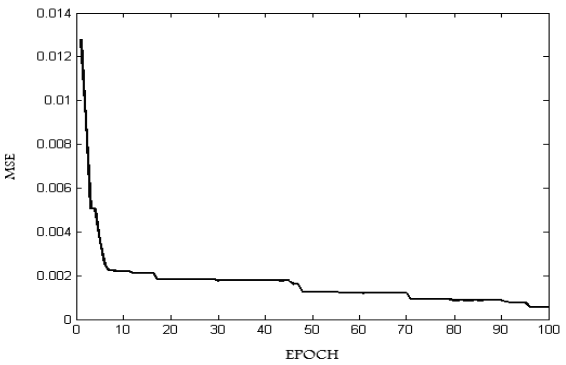
f (x_1 , x_2) = $\frac{x_1 x_2 (x_1 + 2.5)}{1 + x_1^2 + x_2^2}$(16)

Fig.3 (a) shows results using the ANFIS and PSO for identification (solid line: actual system output, the dotted line: the ANFIS and PSO result). Fig.3 (b) Present the MSEs of this algorithm and Fig.3 (c) Present the MSEs of basic algorithm. The parameters for training the ANFIS neural network with this PSO algorithm listed in Table II.

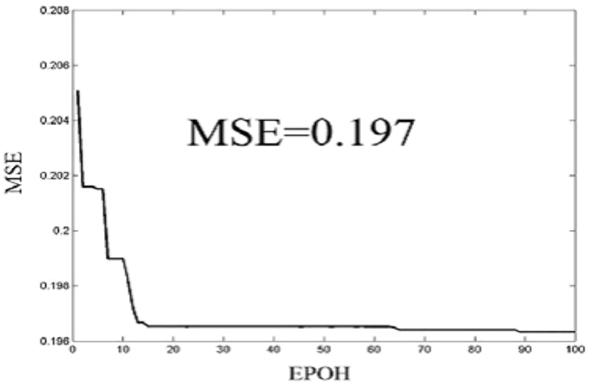
Table.1.Parameters For Exampel I	
NO of input	5
NOOfDatafor train	1000
NOMFsforeachinput	2
NOof particlefor each population	15
Epoch foreachpopulation	100



a

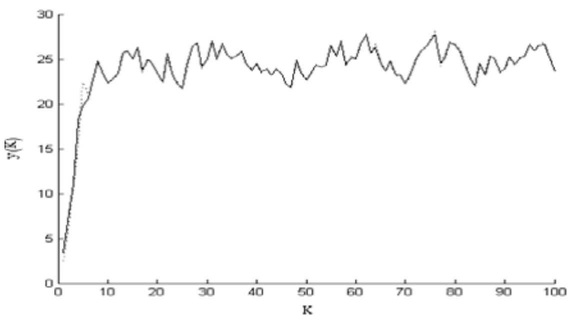


b

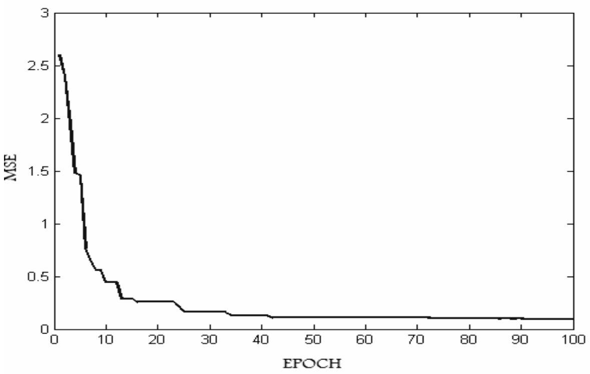


C

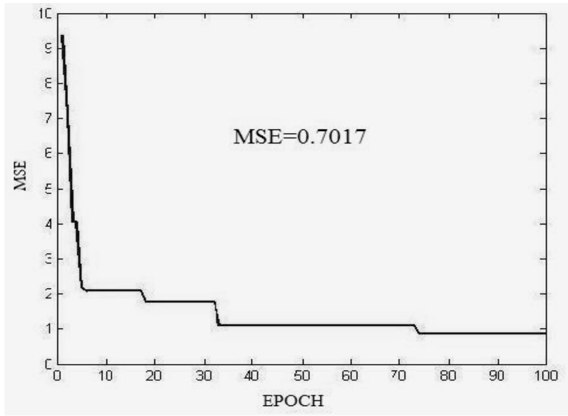
Figure.2.Using PSO for training parameters in ANFIS structure for example1. Simulation results for nonlinear system identification. (a) (dashed line), and actual system output (solid line). (b) MSEs for modified algorithm.(c) MSEs for basic algorithm.



a



b



c

Figure.3.Using PSO for training parameters in ANFIS structure for example2. Simulation results for nonlinear system identification. (a) (Dashed line), and actual system output (solid line).(b)MSEs for modified algorithm.(c)MSEs for basic algorithm.

TABLE.2.PARAMETERS FOR EXAMPE II	
NO of input	3
NOOfDatafor train	100
NOMFsforeachinput	2
NOof particlefor each population	10
Epoch foreachpopulation	100

4. CONCLUSION

We presented a novel approach to ANFIS structure parameter training in this research. In our new approach, we updated the parameters using PSO. There are some changes between the standard PSO and the one we utilized. The simulation results demonstrated that the new method outperforms basic PSO for complicated nonlinear systems. Compared to existing training algorithms like GD and LS, the complexity of this new method is lower since it does not rely on derivation, which is a particularly challenging calculation for training antecedent component parameters. But, based on the number of calculations needed for each technique, PSO needs fewer calculations to reach the same error objective as Backpropagation [19]. Additionally, this new method solves the local minimum problem in the GD algorithm for training. By using the suggested PSO method to identify nonlinear models, its efficacy was demonstrated.

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Utilizing G Machine Learning In Production: Possibilities, Obstacles, and Model Applications

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ABSTRACT

Emerging trends such as autonomous driving, natural language processing, service robotics, and Industry 4.0 predominantly rely on the significant advancements achieved in machine learning (ML). The proliferation of data, combined with readily available processing power and user-friendly software tools, has paved the way for applying these algorithms across a broad spectrum of industrial domains. Thus, the goal of this paper is to integrate various ML application scenarios, taking into account industry-specific views about electronics manufacturing, electric motors, transmission components, and medical devices, as well as process-oriented views about DIN 8580 manufacturing process groups, VDI 2860 handling operations, and cross-process strategies.

Keywords: Machine learning, VDI 8580, VDI 2860

1. INTRODUCTION

The digitalization of production holds the promise of boosting domestic productivity and unlocking new business models. Industry 4.0 is revolutionary not only because it digitizes products and manufacturing processes but also because it offers real-time technological system connectivity potential[1]. This enables the collection of data that can be analyzed and assessed using machine learning (ML) technique, with the goal of enhancing quality, reducing lead times, cutting costs, and improving flexibility. With the continuous advancement of computing power and storage capacity, whether through edge devices or cloud platforms, increasingly sophisticated algorithms can be deployed [2]. However the immense scope of ML may be, equally diverse, are the potential application scenarios within production. Especially for small and medium-sized enterprises, there is a noTable absence of a systematic guideline for identifying and implementing economically feasible ML use cases, as well as industry-specific best practices. Hence, the purpose of this work is to present a well-organized summary of representative ML use cases across various processes and subsectors of the manufacturing industry. Following an introduction to relevant concepts, fundamental potentials, and primary challenges of ML, the third section outlines several ML applications from a process-oriented perspective, encompassing different manufacturing processes, handling operations, and cross-process strategies. Expanding on this, the fourth section presents exemplary applications from specific sub-sectors such as electronics or electric motor production.

2. KEY FUNDAMENTALS, OPPORTUNITIES, AND DIFFICULTIES

2.1. A Brief Summary Of ML Techniques

Machine Learning (ML) is a facet of artificial intelligence (AI) that empowers computers to learn autonomously, without explicit programming [3]. Rather than constructing models of technical systems using physical laws, ML algorithms discern correlations from data, such as process and quality data. Broadly, ML encompasses supervised, unsupervised, and reinforcement learning. In supervised learning, ML models are trained on datasets containing pairs of inputs and outputs, known as features and labels. The goal is to identify patterns within the training data, enabling tasks like predicting product quality based on production data. Unsupervised learning involves the computer learning from data without predefined output. Instead, the algorithm learns patterns, such as typical sensor data from a machine, to detect anomalies in the future [4]. Reinforcement learning, the third ML paradigm, entails an "agent" making decisions in an environment to maximize cumulative rewards [5].

Various algorithms can be employed depending on the type of learning involved. Commonly utilized are artificial neural networks (ANN), which encompass convolutional neural networks (CNN). Other algorithms include support vector machines (SVM), decision trees, random forests, and k-nearest neighbours. The concept of deep learning denotes ML methods that utilize multiple data transformation steps to efficiently extract information from extensive datasets [6]. Particularly in robotics, ML-driven object recognition and motion planning have recently made significant strides [11]. The scheduling of job shops, fault diagnostics, and energy management are other noteworthy application areas [8,9]. But a thorough classification of real-world ML application scenarios has not yet been created, and that is not the goal of this brief review study.

2.2. ML's Fundamental Possibilities In Production

ML has a wide range of possible uses in production, despite its power. Machine learning algorithms are able to evaluate the state of machinery or tools and anticipate when maintenance or tool replacements are most appropriate [7, 8]. Machine learning (ML)-based models have the ability to replace random sample checks in quality management by tracking or predicting product quality based on process data [8,9]. It is envisaged that ML integration into process control will concurrently lower reject rates, sTable output quality, and improve flexibility to changing conditions [7, 10].

2.3. Approaches To Implementing ML In Production

Like Industry 4.0 use cases, the potential of ML can arise from either technological advancement (opportunity-push) or the existing demand for optimization (problem-pull) [12]. Given that the application of ML techniques is only viable when the identified production issue or optimization opportunity is suited for them, selecting the appropriate use cases is pertinent. Methods such as value stream mapping, Ishikawa diagrams, process capability analysis, or expert consultations can aid in pinpointing relevant cases. Subsequently, the chosen use cases must be specified and evaluated for their cost-effectiveness. In ML projects, the availability and quality of data significantly impact this evaluation, as additional data storage, sensors, and processing capabilities necessitate further investment. This assessment can be used to prioritize and choose the most relevant use cases; a portfolio matrix may be used in this process [12].

The most often used approach for project execution is the six-phase iterative CRISP-DM cycle, which comes from the field of data mining [6]. In the initial business understanding phase, the project's problem and objectives are analyzed, comprehended, and defined, leading to the creation of a project plan. In the data understanding step that follows, accessible data is analyzed to obtain preliminary insights on machine learning goals and data quality considerations. Following this, the data preparation phase encompasses tasks such as picking, organizing, constructing, transforming, integrating, and formatting the accessible data. During the modeling and evaluation stages, the project objectives are the primary focus for the training and assessment of these algorithms. In the modelling and evaluation phases, these algorithms are trained and assessed with a focus on the specified project objectives. Upon successful implementation, the project is documented, and the model is put into use in a real-life environment [6, 13].

2.4. Significant Obstacles To Implementing ML In Production

As previously stated, availability and quality of data are crucial preconditions for making successful use of machine learning [7]. This includes information from a variety of sources, including stations, work centers, field and control equipment, goods, the company itself, suppliers, and even customers, according to RAMI 4.0 [14]. Integrating data from both old and new plants remains a major difficulty, despite efforts to standardize communication through the adoption of the I4.0 asset administration shell in OPC UA [14,15]. Regretfully, it's frequently difficult to predict ahead of time which data will ultimately be required to train a model accurately enough [7].

Up to 70% of an ML project's effort is usually spent on data preparation. Since machine learning algorithms only learn from the data that they are fed, it is imperative to make sure that legitimate data is assigned correctly at every stage of the process [7]. When selecting an algorithm, factors such as its robustness—how it responds to unexpected scenarios—and interpretability are significant considerations [11,13].

Although CRISP-DM provides a basic framework for ML initiatives, there are yet no explicit guidelines or methods available. Combining CRISP-DM with Six Sigma's structured methods and instruments is a certain approach [16, 17]. Furthermore, there is a lack of explicit techniques for locating pertinent use cases that include characteristics unique to a given industry. Therefore, as this article suggests, a structured use case presentation provides a good starting point for aligning with one's own production issues.

3. EXAMPLE APPLICATIONS AT THE PROCESS LEVEL

Production systems, regardless of industry, usually comprise handling operations specified in VDI 2860 [19] and a variety of manufacturing processes in accordance with DIN 8580 [18] (Fig. 1).Subsequently, exemplary ML use cases within the corresponding subcategories, along with cross-process applications, will be provided to offer a general understanding of ML potentials.

3.1. Primary Shaping

As per DIN 8580 [18], primary shaping is the process of generating cohesion in order to build a solid body out of shapeless material. In literature, ML-based methods have begun to emerge for specific processes like casting. For instance, Saleem et al. [20] utilize ML to enable intelligent process control in foundries by evaluating process data and identifying correlations. Furthermore, Rössle and Kübler [21] introduce a machine learning method that uses process data from high-resolution sensors to forecast die-casting quality in real-time. Although it is difficult to precisely classify additive manufacturing under the primary classes of DIN 8580, the majority of additive processes are associated with primary processing [22]. Based on the microstructure of the powder feedstock, ML can help characterize it [23]. Furthermore, ML can be used to monitor the layer formation process by examining image or acoustic emission data [24, 25].

3.2. Forming

Forming is the process of using plastic deformation to change a solid body's shape while maintaining its mass and cohesiveness [18]. Similar to primary shaping, there are existing ML approaches in this domain. In [26], a new method is introduced for categorizing forming processes into multiple failure classes using ML, demonstrating promising predictions of necking onset. Furthermore, ML is used by Dib et al. [27] to forecast flaws in metal forming procedures. Another application of machine learning is anomaly detection in press-hardening [28].

3.3. Cutting

As per DIN 8580 [18], cutting describes operations that alter a shape by weakening the cohesiveness of the material. In this context, machining is a key subgroup that includes cutting operations in which layers of material are mechanically removed in the form of chips from a work-piece by means of cutting tools [18].

The method of creating new programs from unsuiTable ones is known as genetic programming. This is comparable to subjecting the population of programs to the natural genetic process. Selection, crossover, and mutation are techniques used in natural genetic processes that are also applicable in genetic programming. As outlined in [29], a range of ML applications has already been integrated into machining operations, encompassing diagnostics and prognostics of machine tools, parameter optimization, and product quality prediction. For example, Al-Zubaidi et al. [30] offer an overview of applying Artificial Neural Networks (ANN) in milling processes, emphasis on predicting surface roughness, cutting force, tool life, and wear. Martínez et al. In Martínez et al.'s [31] method, a supervised learning model for automated quality assessment of metallic surfaces based on ANN is used to visually analyze machined metal parts. Furthermore, in addition to analyzing online process data such as vibrations and cutting forces [32], image data of the actual tool enables a direct assessment of its current condition [33]. Garcia-Ordas et al. [33] utilize Support Vector Machines (SVM) in conjunction with texture descriptors to classify each cutting edge image as either worn or serviceable. Additionally, Pimenov et al. [34] propose an ML-based approach for real-time prediction of surface roughness by analyzing main drive power using models like regression trees and random forest. Moreover, abnormal process states such as chattering are detected using unsupervised learning and the non-negative matrix factorization method for dimensionality reduction [35]. It is recommended to use a modular system design for an Industry 4.0-compliant data-driven monitoring system [36]. Lastly, [36] shows how to estimate operating conditions based on structure-borne sound without requiring a permanent interface to the control of the machining centre. This establishes a general method that is especially useful in industrial Brownfield circumstances. ML is used in soldering for final solder joint inspection as well as for the analysis, prediction, and optimization of soldering quality [41]. Althoefer et al. [42] offer an automated monitoring and failure classification approach utilizing Artificial Neural Networks (ANN) in relation to self-tapping threaded fastenings. The force-displacement curve offers the best data foundation for press-fit processes in terms of forecasting product lifespan and wear [43]. ANN is used in [44] to evaluate the quality of adhesive-bonded connections. ML can be used, for example, to anticipate bolt force for bolt flange connections [45].

3.4. Joining

As defined in DIN 8580 [18], joining involves bringing together two or more work-pieces of geometrically defined form or combining such work-pieces with amorphous material. Numerous machine learning techniques are currently available in this field, starting with welding. Using support vector regression, Petković [37] offers a supervised learning method for quality prediction in welding operations. ML algorithms are used in [38] to classify welds according to arc sound signals. On the other hand, Khumaidi et al. [39] introduce a visual inspection system based on Convolutional Neural Networks (CNN) for welding defect classification. Furthermore, Günther et al. [40] provide a deep neural network and reinforcement learning based self-improving laser welding system.

3.5. Coating And Altering The Characteristics Of Materials

The last two major categories given in DIN 8580 [18] are coating and material property modification. Painting and coating are two examples of techniques that apply a securely adhering layer of shapeless material to a work-piece's surface; tempering, on the other hand, is a process that modifies the qualities of the material itself. For instance, in thermal spraying, an ML-based vision system may evaluate test spray pattern images to determine how well the plasma gun nozzle is aligned [46]. With regard to heat treatment, Oh and Ki [47] introduce a deep learning model intended to forecast the tool steel's hardness distribution after laser heat treatment.

3.6. Handling

VDI 2860 defines handling as the awareness, defined alteration, or temporary maintenance of a certain 3D arrangement of geometric bodies inside a reference coordinate system [19]. Handling is a component of material flow. It covers a wide range of areas, including insertion, localization, assessment, object manipulation, and support tasks like environmental evaluation. To date, numerous ML applications focus on autonomously planning and optimizing trajectories for articulated robot arms, as well as processing sensor data, such as 6 Degrees of Freedom (6DoF) pose estimation.

For example, Hodaň et al. [48] compare learning-based, template matching, and point-pair feature-based approaches in a benchmark study of 6 Degrees of Freedom (6DoF) object pose estimation. They find that learning-based systems have the shortest processing times, despite potential limits in precise posture detection. In a related context, Blank et al. [49] introduce a pipeline that combines Convolutional Neural Networks (CNN) with template matching methods for 6DoF pose estimation, particularly suited for texture-less industrial components. With segmentation, the CNN greatly lowers false positive pose estimates in this method. Furthermore, Bobka et al. [50] use online estimates of assembly offsets using a deep feed forward network to improve precision in a robotic handling task that may subsequently be adjusted. Mahler et al. [51] show that by training a CNN to acquire ambidextrous grasping from synthetic data utilizing several gripper types, it is possible to manage objects that are unknown and arbitrarily positioned. These examples show how machine learning (ML) can be used to solve important handling problems, especially in robotics.

3.7. Cross-process methods

In addition to the challenges posed by unsTable individual manufacturing and handling steps, the unknown inter- and intra-relationships within multistage production sequences present risks in complex production systems. As a result, utilizing machine learning approaches, extensive data analysis ideas are developed to identify previously unknown cause-effect linkages between product states and production processes [52]. Cross-process production influences on product quality can be identified by comparing data from upstream production with downstream product inspections. Building on this, Eger et al. [53] suggest a method for mitigating online defect propagation and prevention that aims to decrease scrap and inspection work. Furthermore, Wuest et al. [52] support the use of a supervised machine learning (ML)-based feature ranking technique to find and rank pertinent state features, clarifying the links between and within processes.

4. SIGNIFICANT ADVANCEMENTS AT THE INDUSTRY LEVEL

The subsequent examples demonstrate the versatility of employing various ML approaches from a process standpoint across diverse industries, either independently or in appropriate conjunction.

4.1. Production In The Electronics Industry

Within electronics production, Surface Mount Technology (SMT) is extensively employed, demanding exceptionally high yields and consistent processes. SMT assembly typically involves three key processing stages: solder paste printing, component placement, and soldering. Following each of these steps, additional inspection systems can verify process stability and detect faulty components [54]. Given the substantial automation and data accessibility in this domain, ML finds diverse applications [55]. Khader et al.'s work [56], for example, focuses on applying reinforcement learning to online stencil printing parameter control. Wang et al. [57] address the important influence of stencil cleaning on printed circuit board quality by using machine learning to identify the ideal cleaning cycle. Liukkonen et al. [59] use self-organizing maps to assess data from the wave soldering process, while May et al. [58] use Artificial Neural Networks (ANN) to simulate component placement faults. Convolutional Neural Networks (CNN) can then be used in optical inspection to classify solder joint images [60].

4.2. Electric motor production

Facing increasing demands spurred by electric mobility, the collection and intelligent analysis of process data hold significant promise for the future of electric motor production [12]. In the realm of magnet assembly, there are approaches for ML-based selective assembly sequences aimed at compensating for individual magnet tolerances [61]. ML can also be used to monitor machining steps, like twisting a motor shaft or fine-tuning a cast motor housing, as was indicated in section 3.3 [36]. Furthermore, there are alleged possibilities in insulating and winding technologies [12]. The majority of ML techniques used in the manufacture of electric motors currently focus on contacting processes [10]. An Artificial Neural Network (ANN) for hot crimping can forecast the quality of the resulting connections as well as electrode wear [62]. Images of the connection's burn-up or the machine's acoustic emissions can be used to predict the quality of the connection in ultrasonic crimping [61, 63]. Similarly, it is possible to estimate electrical resistance and detect welding errors when laser welding hairpins [64, 65]. ML can be used in the final motor quality inspection to detect defects based on vibration signals [66].

4.3. Production Of Automotive Transmission Components

Numerous erratic disturbance factors have an impact on production systems in large-scale automotive supplier production, which leads to defects. A transmission control unit manufacturer's manufacturing data, for example, includes a variety of process and quality parameters. To identify the most important factors from a large number of variables, it is desirable to reduce dimensionality in the event of a dramatic increase in defect percentage during the end-of-line test. To effectively identify multivariate failure correlations, [67] combines supervised learning techniques like decision trees with unsupervised techniques like cluster analysis. An alternative method, described in [68], makes use of a hybrid learning-based model to quickly identify abnormal patterns and the underlying causes of quality problems.

4.4. Production Of Medical Devices

X-ray tube assemblies are subject to stringent quality requirements due to their crucial role in numerous medical applications. However, the key component responsible for radiation generation, the X-ray tube, can only undergo comprehensive testing once assembled. Consequently, errors detected during final inspection may stem from a combination of variations in various upstream processes. To analyze the cause-and-effect relationship on product quality, it is insufficient to examine individual parameters in isolation. As a result, ML is used to examine quality-critical factors throughout processes [69]. Predicting the lifespan of X-ray tubes is another use for machine learning (ML), as they, like light bulbs, experience wear and tear [70]. Machine learning (ML) makes predictions for each particular product by comparing records of process data with operational data collected from field use [69].

4.5. Conclusion And Prospects

The excellent applications show that machine learning (ML) has a lot of potential for real-world applications. However, industries find it difficult to apply machine learning (ML) to their own production difficulties due to the lack of industry-specific rules and the unstructured representation of prospective use cases. As a result, this article provides a methodical summary of numerous machine learning application cases from the perspectives of industry sectors and processes. The process perspective mainly includes cross-process methodologies, handling procedures in accordance with VDI 2860, and the manufacturing process groups described in DIN 8580. It outlines exemplary machine learning use cases at the industry level in the manufacturing of electronics, electric motors, automobile transmission components, and medical equipment. The organized overview offers a good starting point for discovering possible use cases from an opportunity-driven perspective, even though it is not comprehensive. However, the majority of the techniques mentioned above are still in the research stage and are not yet prepared for general use or practical application. Therefore, it is imperative to promote additional research on machine learning applications while also providing the required data. As usual, taking action now is essential to avoid falling behind later.

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Advancements in Computer Network Security: A Comprehensive Study on Firewall Technology

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ABSTRACT

In the midst of rapid network development, heightened concerns surround cyber security. With a focus on enhancing the security of computer networks, the spotlight is on firewall technology as one of the most potent solutions. This article delves into the nuanced analysis of firewall technology development, aiming to provide insights and inspiration for the evolving landscape of network security

Key Words: Firewall, Artificial Intrllrgence, WAN, LAN

1. BASIC CONCEPT OF FIREWALL

The firewall, a fundamental component in the realm of computer network security, serves as a robust defence mechanism. Positioned strategically between the secure intranet and the comparatively less secure extranet, it functions as a gatekeeper controlling connectivity. Comprising both software and hardware elements, the firewall ensures that all traffic between these networks traverses through it. The secure intranet is recognized as a protected network, while the extranet is deemed less secure. Acting as a crucial service provider, the firewall guarantees the security of network information. Its role extends beyond mere connectivity; it serves as a sentinel, implementing security policy controls such as permission, rejection, and monitoring. Through these controls, the firewall manages the release and interception of information flow in and out of the network.

The firewall operates as an analyser, scrutinizing the information flow to discern potential threats. As a separator, it filters and categorizes the analysed information flow. Additionally, it functions as a limiter, constraining the flow of unsafe information and denying access to the intranet. Simultaneously, it authorizes the passage of secure information into the intranet, effectively safeguarding network security and ensuring the integrity of the intranet. Originating from the concept of building partitions designed to impede the spread of fire, the term "firewall" has evolved to encapsulate the protective nature of this network security measure. Physically, firewalls can vary in implementation, often consisting of a combination of hardware devices such as routers and hosts, complemented by software components. In essence, a firewall is a dedicated protective device, employed to safeguard the integrity of network data, resources, and users, thereby fortifying the overall security of the network [1].

2. WORKING PRINCIPLE AND CHARACTERISTICS OF FIREWALL

The working principle of a firewall is rooted in pre-defined configurations and rules that govern its operation. Firewalls serve as vigilant gatekeepers, monitoring all data flows passing through them. The fundamental objective is to permit only authorized data to traverse the network, maintaining a secure environment. Key characteristics and principles of firewalls include:

Pre-defined configurations and Rules: Firewalls operate based on pre-established configurations and rules that dictate their behaviour. These rules are set by administrators to define the criteria for allowing or blocking data packets.
Data flow monitoring: A firewall actively monitors all data flows entering and leaving the network. It scrutinizes each packet of information to ensure compliance with the specified rules and configurations
Authorization of Data: Only authorized data, as per the configured rules, is permitted to pass through the firewall. This selective filtering ensures that potentially harmful or unauthorized data is prevented from entering the network.
Logging and record keeping: Firewalls maintain detailed logs of relevant information, including connection sources, communication displays provided by servers, and any attempts to breach security. These logs serve as valuable resources for administrators in monitoring and analyzing network activity.
Administrator monitoring and Tracking: Firewalls provide tools and interfaces for administrators to monitor and track network activity. This facilitates real-time awareness of the network's status and enables quick responses to potential security threats.

In summary, firewalls act as a proactive security measure by adhering to predefined rules, monitoring data flows, and permitting only authorized traffic. Their logging capabilities enhance the ability to analyse network events and identify potential security breaches, allowing administrators to maintain a secure and well-monitored network environment [2].

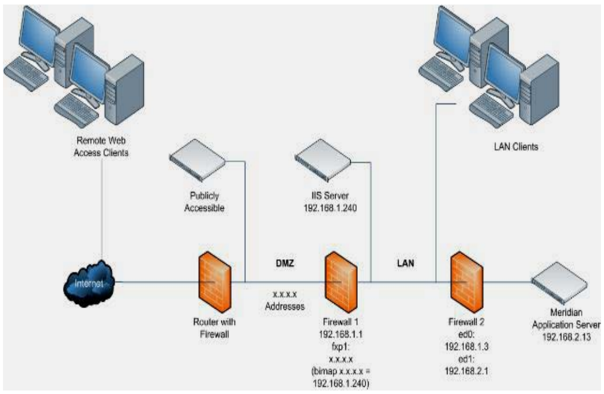

Figure.1.Firewall

3. MAIN FUNCTION OF FIREWALL

The firewall plays a crucial role in network security, offering several key functions to safeguard the integrity and confidentiality of information. Here are the main functions of a firewall:

Dynamic Packet Filtering: Firewalls employ dynamic packet filtering technology, analyzing individual data packets based on pre-defined rules. This allows for real-time decision-making on whether to permit or deny the passage of packets.
State detection technology: Utilizing state detection technology, firewalls keep track of the state and context of active connections. This enhances the firewall's ability to make informed decisions about the legitimacy of data traffic.
Packet interception and Application layer information extraction: Firewalls are capable of intercepting packets as they traverse through the network. They extract information from the application layer, allowing for a more detailed analysis of the data. This information is crucial in making decisions about whether to allow or deny the data based on security considerations.
Dynamic network security control: Firewalls enable dynamic management of information flows through their ports. By assessing the security of the information, firewalls can dynamically decide whether to allow or refuse the data, contributing to a dynamic and secure network environment.
Control of unsafe services: Firewalls effectively control insecure services by setting up policies for data entry and exit between trusted and entrusted domains. This allows administrators to deny access to unsafe services outside the intranet, enhancing overall network security.
Rule planning and flexibility: Administrators can define rule plans that dictate the behavior of the firewall. These rules can automatically start and close based on specified start up and shutdown policies. This not only enhances intranet security but also provides flexibility in adapting to changing network requirements.

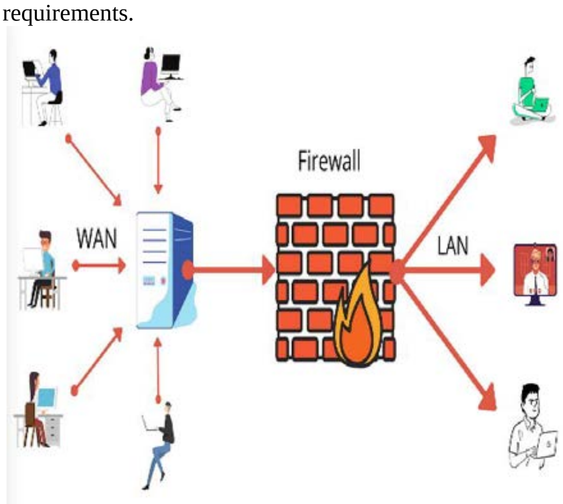

Figure.2.Function of Firewall

4. MEANS OF FIREWALL TECHNOLOGY

4.1. Composite Technology

Composite technology in the context of firewall usage refers to the integration of multiple security measures and technologies to provide a more comprehensive and robust defense against various threats. Composite technology aims to enhance the stability, reliability, and security of protective measures provided by firewalls. By combining various security components, it creates a more resilient defense system against malicious activities.

The use of composite technology helps in reducing malpractice related to firewall configuration and management. The integration of diverse security measures minimizes vulnerabilities and potential misconfigurations that could be exploited. Over time, the composite ability of firewall technology has matured, indicating that the integration of different security features has become more sophisticated and effective in countering a wide range of cyber threats. Composite technology embodies the characteristics of diversity, bringing together various elements such as anti-virus software, firewalls, and alarm systems. This comprehensive approach addresses multiple aspects of security, creating a more holistic defense mechanism.

As technology in the realm of the Internet advances, the composite ability of firewall technology continues to improve. This reflects the adaptation and integration of new and advanced security features to counter evolving cyber threats. Installing firewalls, especially those utilizing composite technology, can yield good results for both individual and enterprise users. It ensures the safety of computer and internet usage by providing robust monitoring and protection against malicious attacks. Composite technology allows for the implementation of multiple layers of different defense mechanisms. This multi-faceted approach ensures a more thorough and effective defense against a variety of cyber threats. Composite technology provides multiple encryption and protection mechanisms. Normal access requires passing through multiple ports, enhancing the overall security posture and achieving the desired level of protection. Firewall composite technology actively hides the internal situation of the computer network. This helps prevent malicious access by hackers or viruses, reducing the chances of unauthorized visits and improving overall protection.

4.2. Use access policies

Firewalls are used to segment the use of the Internet into intranet and extranet, planning distinct usage paths. This segmentation aims to achieve secure data transmission, access, and interaction by implementing different access policies for each. Firewall technology is utilized before entering the system to gain a preliminary understanding of other systems and circumstances. This proactive approach ensures smooth operations and enhances safety factors by preventing exceptions.

Computer networks and access policies employ various forms of protection, aligning with the security requirements. The optimization of firewall adjustments is carried out to improve the overall security of computer network protection. Access policies, based on security requirements, are optimized through firewall adjustments. Detailed records of all access policy activities are maintained, serving as an execution order to enhance the efficiency of computer network security protection. Intrusion detection is highlighted as a crucial function in computer internet usage. The dynamic detection system is mentioned as a means to improve the stability of the computer protection system, addressing potential hidden security issues.

Combining firewall and computer antivirus software enhances the monitoring capabilities of computers. Diversified methods are employed to investigate potential hidden security issues in all directions. Users are encouraged to use firewall software not only for passive detection but also for active intrusion detection on a regular basis. This proactive approach helps reduce the probability of security incidents and improves overall user security. The text mentions the categorization of hackers into non-destructive and destructive attacks. Non-destructive attacks aim to disrupt system operations using denial-of-service attacks, while destructive attacks involve intrusions for stealing confidential information or destroying target system data. The use of access policies, active intrusion detection, and diverse security measures collectively aim to reduce the chance of being visited by malicious entities, thereby improving the overall level of protection against various cyber threats. Here are few common attacks:

1.1.1. Denial Attack

Denial-of-Service (DoS) attacks are malicious attempts to disrupt the normal functioning of a computer network, system, or service, making it temporarily or indefinitely unavailable to users. The description provided focuses on a type of DoS attack that exploits vulnerabilities in the Windows operating system or TCP/IP protocol.

Deception Attack: The basic principle and process of an IP deception attack, a type of deception attack used in TCP/IP environments. an IP deception attack involves exploiting trust relationships within a network by incapacitating a trusted host, engaging in IP spoofing to deceive the target host, and establishing a connection to introduce a backdoor for unauthorized operations. This technique is sophisticated and aims to operate stealthily within TCP/IP environments.

Scam Attack: scanners play a critical role in the reconnaissance phase of cyber-attacks, allowing hackers to gather essential information about potential vulnerabilities and entry points in a target host or network. The information collected can be used to plan and execute subsequent stages of an attack while minimizing the risk of detection.

Backdoor Program: Programmers may introduce back doors into program modules. A back door is a hidden entry point or functionality within a program that allows unauthorized access or control. The text highlights the potential risks associated with the unintentional persistence of back doors in program modules, emphasizing the need for thorough security practices to prevent unauthorized access and mitigate potential attacks.

5. CONCLUSION

The research conducted has contributed to an enhanced understanding of computer network firewall technology. It underscores the responsibility of technicians to engage in continuous practical exploration, diligently summarizing scientific advancements in firewall technology. The objective is to perpetually elevate the standard of computer network security. By combining the insights gained from this research, it is anticipated that this knowledge can serve as a valuable reference for fellow technical professionals. The commitment to ongoing improvement and vigilance in the realm of firewall technology is crucial for fortifying our defense against emerging cyber security challenges.

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Utilizing the Fundamentals of Artificial Intelligence in Mechanical Engineering

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ABSTRACT

Artificial Intelligence (AI) is being utilized to make a variety of engineering challenges and techniques smarter as the world becomes more intelligent in every aspect. As several AI techniques are being tested in a range of mechanical engineering applications, such as failure detection to maximize the usage of AI. It's becoming crucial to investigate and comprehend their applicability and performance in areas like problem/fault detection, autonomous cars, manufacturing, smart buildings, etc. In order to determine which AI technique is more appropriate for the applications, this paper will examine the use of artificial neural networks, genetic algorithms, deep learning, fuzzy logic, hybrid techniques, and case-based reasoning in a few mechanical engineering applications**.**

Key words: Artificial Intellegence(AI), Artificial Neural Natwork,Deep learning.

1. INTRODUCTION

In almost every sector, artificial intelligence (AI) is growing its acceptance. Everything is becoming intelligent including wristwatches, watches, jewellery, TVs, and more. It has not only simplified our work but also created a new area of study, effort, and advancement. Artificial Intelligence encompasses a vast array of subdivisions and programs that enable us to carry out our tasks more efficiently than we could ever before, if we were human. AI includes machine learning as a fundamental component. This is how the machine acquires its intelligence. A software program is said to acquire experience "E" from a task "T" and a measure of performance "P", to put it in a more if, its performance on task T increases which is measured in terms of performance "P" with E of experience. Let's take a look at an actual person as an example to better comprehend this. Let's take the example of a kid who is learning about related arrays of tasks "T". Performance P will be lower if that kid consumes more time in learning the subject. Let's assume that he has completed five or more related arrays of tasks "T" and has earned experience E.He will need much less time if he returns to review the fundamentals of arrays of tasks "T" which means performance "P" has enhanced. Three main subcategories of machine learning might be distinguished:

1.1. Learning Under Supervision (SL)

Sample inputs and outputs, or a predefined set of processes, are used to teach the program to do a certain job. It presents the outcome based on the provided training examples when given a fresh set of data. Let's look at a straightforward example. If I teach a computer how to conduct addition using a certain set of training illustrations, the machine will execute addition when I provide it with two fresh numbers. However, division and multiplication cannot be done with this type of software; only addition can be done with it.

1.2. Learning without supervision (UL)

A collection of data is simply handed to the application. The program's job is to identify connections and patterns among the provided data collection. Let's say that the computer has been fed equity exchange statistics for the last month. It now forecasts and computes what will be the final value of the equity exchange for for the forthcoming day or week. The accuracy "P" of your equity exchange "T" increases in forecasting as we increase the amount of data "E" we feed [1].

1.3. Learning by Reinforcement (RL)

A reward must be obtained while we make decisions in learning approach. Consider a labyrinth, where a baby rabbit must pass through particular hurdles in order to get to its youngsters. To simplify the work, RL techniques are used here [2].

2. ARTIFICIAL NEURAL NETWORK

An artificial intelligence's primary goal is to emulate human capabilities and accomplish numerous tasks more effectively. In order to create an artificial intelligence using machine learning and algorithms which closely resembles human intellect. An Artificial Neural Network (ANN) is built once the studying component of an AI has been built. Let's first examine how a neural network in humans functions in order to better comprehend this. Figure 1 illustrates this.

As mentioned in figure above, a neuron, which is also known as a nerve cell? Nerve cell is a type of cell that receives signals from sensory receptors and sends the necessary action/output to the appropriate physical body element. For instance, when we place our palm on a warm skillet, the sensory receptors transfer the sensation of heat through nerve cells to the brain, which then transmits the response, that is, rapidly removing your hand. The body of the cell is called the soma, or cell body. The dendrites assist the neuron in receiving information or signals from other nerve cells and transmitting them to the soma. The required action is then sent by the body through the axon. Thus, the axon functions as a transmitter and the dendrites as receivers.

At the conclusion, the axon splits into strands/fibres and sub strands/fibres.Synapses are located at the ends of these strands/fibres. The synapses/functional unit connects two neurons—the axon of one nerve cell and dendrite of other nerve cell. As soon as the soma's impulse reaches these brain chemicals/neurotransmitters, these are specific molecules which reached to terminals. The way these brain chemicals/neurotransmitters diffuse via the synaptic gap determines whether they promote or inhibit the electrical impulse-emitting propensity of the receiving neuron. Transferred electrical impulses primarily determine the quality of the signals that are passed. Here's when remembrance becomes important. Now that we have thoroughly examined actual nerve cells, let's use a model to examine an artificial neural network. The neural network is treated like a linear cutoff barrier in the McCulloch-Pitts neural model. This is mostly used to divide the inputs into two types. Thus, in computer science, as we say, the output is binary, that is, either 0 or 1 [3].

2.1. ANN`s Applications

Self-driving vehicles and fault identification employ these ANNs. Some of the most recent developments in the methodology for fault detection in many mechanical engineering domains include fault detection in gas shielded power plants [6], flaw detection in cracked beams [4], and online fan blade damage detection [5]. An artificial neural network (ANN) may be employed in self-driving vehicles in a similar manner as a human being's neural network. As an illustration, let's imagine we are operating a vehicle. Abruptly, we spot an animal across the path of traffic. We must now engage the brakes. That is the synapse that will be sent to the brain through the axons and dendrites, as was previously shown. In the sameway, we may train an AI to avoid obstacles by building a comparable configuration[7].

Furthermore, we may design a function that alters the vehicle's speed based on the sheer amount of traffic. Moreover, neural networks may be utilized to optimize the tool path for mechanical processes like welding [8] additionally impediment identification [9].

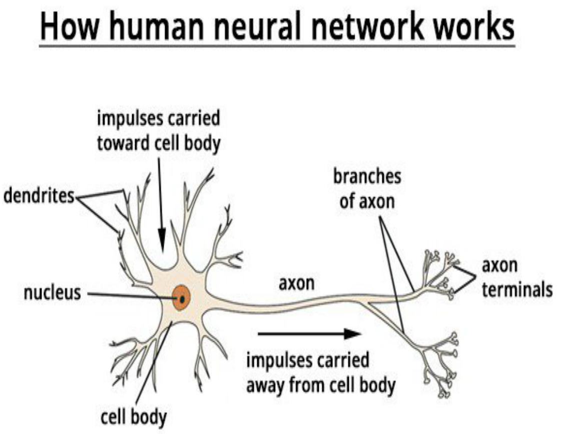

Figure.1.Human nerve cell [3]

3. GENETIC PROGRAMMING AND ALGORITHMS

The following is the main distinction between an algorithm based on genetics and a neural network: A neural network may be used to represent an adapTable function that has demonstrated outstanding performance across a range of applications, whereas a genetic algorithm is a technique for randomized algorithmic optimization. In other words, it provides the setting that gives optimum response to a specific function. The genetic algorithm begins with a number of parameters that are selected at random and keeps the set of parameters that minimizes loss.

The method of creating new programs from unsuiTable ones is known as genetic programming. This is comparable to subjecting the population of programs to the natural genetic process. Selection, crossover, and mutation are techniques used in natural genetic processes that are also applicable in genetic programming.

3.1. Genetic Algorithm Applications

GP may be applied to defect detection in the same way as artificial neural networks (ANN) [10, 11]. It is possible to mix and employ both ANN and GP [12,13]. Neural networks are based on genetic algorithms, which may be used in various applications. in fields with ANNs to increase their efficacy.

4. DEEP LEARNING

The approach primarily utilizes extensive machine learning methods which combine both supervised and unsupervised learning. Deep learning, sometimes referred to as hierarchy learning,that is primarily employed in applications that needed pattern recognition. It functions on the non-linear computing logic. Using this technique, the current iteration's output is supplied as the next iteration's input. Neural network are the fundamental building blocks of learning systems, whether they are controlled, uncontrolled, or reinforcement-based. Neural networks that function as seen in Figure 2 are known as convolution neural networks.

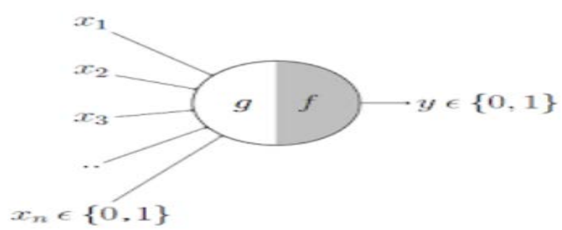

Figure.2.A brief operation of an ANN [17]

4.1. Deep Learning Applications

In the field of mechanical engineering, deep learning/computing has several uses, including defect identification in tire of wheel [18], mechanical characteristics prediction [19], environmentally friendly manufacturing [20]. picture analysis in automobiles [21]. Deep learning takes specific stages and is most useful in situations when image processing is needed, such as night detection.

5. FUZZY SET THEORY AND SOFT COMPUTING

This is just a small portion of the vast field of soft computing. The term "soft computing" refers to the application of different techniques and algorithms to solve issues in the real world that are laborious to solve theoretically. This method's primary goal is to replicate how the human brain functions so that decisions may be generated more precisely and accurately. The three fundamental components of soft computing are genetic algorithms, fuzzy sets, and neural networks. We've already covered the reasoning behind genetic algorithms and neural networks. Three main phases are involved with fuzzy logic:

5.1. Learning

In this stage, information is sent into the computer so that it can make decisions.

5.2. Making decisions

In fuzzy logic, judgments are formed primarily through this procedure, which is based on conditional assertions known as fuzzy statements.

5.3. Defuzzification

It is the act of creating an output by layering several rules on top of one another.Other soft computing techniques, such as Bayesian networks, evolutionary computation, ant colony algorithms, and probabilistic reasoning, are also used in addition to fuzzy logic [22, 23].

5.4. Soft Computing Applications

Various machines employ techniques for flaw identification, including adaptive computation, fuzzy logic, and rough set theory. Rough set theory may be utilized in different data recovery/image recovery techniques [26, 27]. Fuzzy logic is used to identify faults in bearings and reluctance motors [24, 25]. Soft computing is mostly used in settings where choice-making is done and in retrieving data.

6. HYBRID METHODOLOGIES

Hybrid approaches combine two of the neural, fuzzy, and genetic algorithmic approaches as discussed previously. They are mostly used to enhance the algorithm's functionality. The popularity of the various combinations of intelligence approaches employed in the industry today is seen in Figure 3.

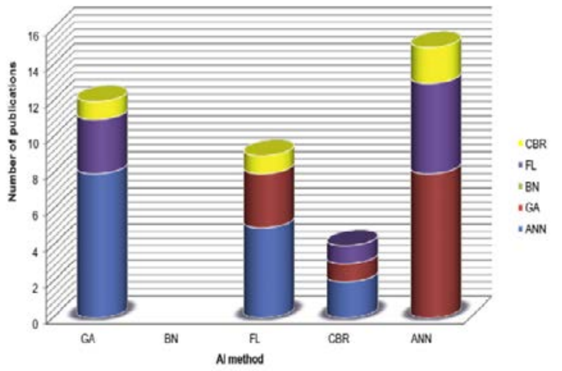

Figure.3.Combinations of the intelligence methods used and their popularity [28]

6.1. Hybrid Technique`s Applications

Applications such as measuring vibration [29] and cracking spotting [30] employ neuro-fuzzy algorithms. Vibration monitoring is primarily based on a typical fuzzy system, the fuzzy rules of which are simplified using neural network assistance. Two well-known data sets—Fisher's Iris data set and Westland's vibration data set—are utilized for evaluating how well the system is performing. On a helicopter, an accelerometer is a device that is attached in several places. It's a tool for measuring inertial forces, or acceleration forces. The two datasets and classifiers—two distinct classifiers for Westland's data set and neurofuzzy for Fisher's—are then used to execute the test.

In essence, a classification algorithm is a discrete-valued function that is used to give certain data points (particular pieces of information) a class label. Thus, the outcomes demonstrated the superior efficacy and efficiency of the neuro-fuzzy classification algorithm. The two primary factors involved in fracture identification are the dimension and severity of the crack. The technique described above makes use of hybrid neural networks to pinpoint the precise site of the fracture by utilizing the eigen frequencies values. Nearly every application incorporating neural networks, evolutionary algorithms, and soft computing approaches can benefit from hybrid methodologies. Their primary improvements are in the algorithms' accuracy and performance.

7. CASE-BASED REASONING (CBR)

It is an approach of fixing novel problems through an examination at how earlier issues were resolved peviously. CBR is an effective technique in practically every domain. It is employed in the design, identification of defects, and diagnosis processes in engineering. It is simply comprehensible and useful because it is based on solutions that currently exist.

7.1. Usage of CBR

It is employed in the field of design engineering to enhance design of die in die-casting [30], assembly lines strategy in shipbuilding [31], and VR-based system for machining fixture [32]. It is employed in industrial printers [21], gas turbines [34], and injection molding machines [33] for the purpose of defect diagnostics.

8. CONCLUSION:

The conclusion provides an overview of artificial intelligence methods in mechanical engineering, including fault detection, autonomous vehicles, and image processing. Hybrid techniques combine multiple AI methods for versatility but are complex and time-consuming to code. Artificial Neural Networks (ANN) excel in problem-solving and machine learning due to their flexible learning approach. Genetic Programming (GP) is ideal for industrial quality control and computer-automated design. Fuzzy logic is widely used in control systems, power engineering, and robotics for its simplicity and adaptability to uncertainty. Deep Learning algorithms, employed in self-driving cars, don't require explicit programming. Soft Computing techniques aid in data recovery and decision-making processes. Case-based Reasoning generates new solutions based on existing ones, useful in various applications like design and fault diagnosis.

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Producing and Assembling an Automated Scarecrow

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ABSTRACT

For the purpose of to protect the plants in the areas, a scarecrow is used to frighten the birds and other wildlife. In order to protect his harvest from birds and other wildlife, a farmer placed a scarecrow in the center of the field. It has been observed that the scarecrow remains motionless when birds enter the grassy area. This scarecrow will be redesigned as part of our project so that, when birds enter the field, it will detect their presence using a PIR sensor, move its hand upwards and downwards using a flapping mechanism, and sound a speaker to alert people when the birds fly overhead. The flapping mechanism's function is to transform the motor's circular motion into a reciprocating fluttering of the hands. The connecting rods force the hand up and down as the crank moves. It will assist in frightening the birds, causing them to flee the field and making the farm's plants safe. It is also applicable to landscapes.

Keywords: speaker, linear motion, PIR sensor, and flapping mechanism.

1. INTRODUCTION

Farmers typically employ scarecrows to protect their crops from damage from field birds and other wildlife. By frightening off birds and other animals, scarecrows assist farmers in protecting their harvests. In the town, scarecrows are constructed from recycled clothing and wood and given a spooky appearance to frighten away birds and wildlife from the farmers' crops. Additionally, scarecrows are utilized in airfields and yards. In the dark of night, a scarecrow is ineffective at keeping agriculture safe. Therefore, employing Automatic Scarecrow is an alternative to utilizing Normal Scarecrow. Another name for an automatic scarecrow is a **smart scarecrow**. A normal scarecrow is less effective than an automatic or smart scarecrow. An automatic scarecrow shields crops from animals and birds at all times. It works well both during the day and at night. It operates on auto play. The alarming gadget, movable arms, and detectors are all features of the automatic scarecrow. It has been observed that the scarecrow remains motionless when birds enter the area. In our project, we're going to change this scarecrow so that when birds enter the field, it will use a passive infrared sensor to detect their approach, a flapping mechanism to move its hand upwards and downwards, and a speaker to announce when the birds arrive. The flapping mechanism's goal is converting the motor's rotary action into the linear motion of flapping arms. The connecting rods force the hand to move upward and downward as the crank runs. It will aid in frightening the birds, causing them to flee the field and making the crops grown there protected. It is also applicable to landscapes.

2. METHODOLOGY

Our project methodology is broken down into four sections:

- Mechanism Details
- Designing Systems
- Protocol
- Elements

2.1. Specifics of the Mechanism

The scarecrow's arms are moved up and down in our project using a flapping mechanism. Below are the specifics of the flapping mechanism:

2.1.1. Mechanism of flapping

The purpose of the flapping mechanism is to translate the motor's rotary action into the linear motion of the flapping arms. As the crank revolves, the palm is pushed upward and downward by the connecting rods. The crank, connecting rod, flapping arm, support framework, nut, and bolts make up the flapping mechanism. When the crank spins, the connecting rod and flapping rod are pulled up and down by the connecting rod. The crank is a joint with one end of a connecting rod, and the second end of the connecting rod is a joint with a flapping bar.

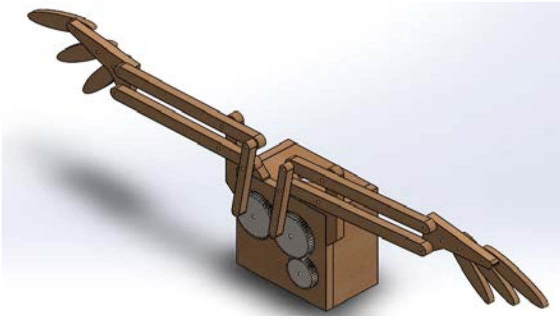

Figure.1.Flapping mechanism

2.2. Designing circuits

Circuit is made up of the following parts: Connecting wires for an Arduino UNO motor driver, the PIR sensor, the speaker, and solar panel.

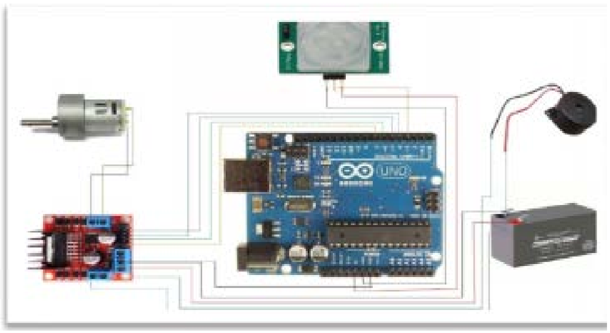

Figure.2.Circuit Diagram

2.3. Workflow

The programme code for the Arduino Uno is shown below.

```
int PIR = 3;
int BUZL = 4;
int BUZR = 5;
int MOT_L = 6;
int MOT_R = 7;

void setup() {
  Serial.begin(9600);

  pinMode(PIR,  INPUT);
  pinMode(BUZL, OUTPUT);
  pinMode(BUZR, OUTPUT);
  pinMode(MOT_L, OUTPUT);
  pinMode(MOT_R, OUTPUT);

}
void loop()
 {

  int a = digitalRead(PIR);
  Serial.println(a);
if(a == 1)
{
 digitalWrite(BUZL,HIGH);
 digitalWrite(BUZR,LOW);
 digitalWrite(MOT_L,HIGH);
 digitalWrite(MOT_R,LOW);
 }

 else{
 digitalWrite(BUZL,LOW);
 digitalWrite(BUZR,LOW);
 digitalWrite(MOT_L,LOW);
 digitalWrite(MOT_R,LOW);
 }
 delay(10);


}
```

2.4. protocols

Many different parts are used in the construction of our Automatic Scarecrow project. We have divided up the components of our project into two categories: mechanical components and electrical and electronic components. **Mechanical components include:**Metal pipe; Wood; Screws and nuts and bolts.

Figure.3.Metal pipe

Components those are electrical and electronic: Solar anels and connecting wires, An Arduino UNO; A motor and motor driver; A PIR sensor and speaker

2.5. Parts those are mechanical:

2.5.1. Metal pipe:

The Scarecrow's framework is made of mild steel square hollow section pipe. They provide the scarecrow's construction strength.

Figure No. 4: Wood

2.5.2. Wood:

To construct the workings of the mechanism for our project (a flapping mechanism), we used plywood and solid wood. The mechanism is supported by solid wood, and the connecting rod, crank, and flapping hands are made of plywood.

2.5.3. Screws and nuts:

Screws and nuts and bolts are used to temporarily attach the flapping mechanism, which allows the scarecrow hands to be readily flapped both upward and downward. Screws are used to join the components into the structure and mechanism. Screws are used to permanently link the machinery and the supporting structure.

Figure.4.Screw and Nuts

2.6. .Electrical and electronic components:

2.6.1. Arduino UNO:

This microcontroller board is used to read monitor signals and operate speaker and motor drivers.

Figure.5.Ardiuno UNO

2.6.2. Motor, Motor Driver:

The flapping mechanism is driven by a motor (a DC Gear motor, 12 volts), and the motor driver regulates the motor directions.

Speaker with PIR Sensor

Animals and birds are identified by motion using a passive infrared (PIR) sensor. Alerts are used to create noise in order to frighten animals and birds.

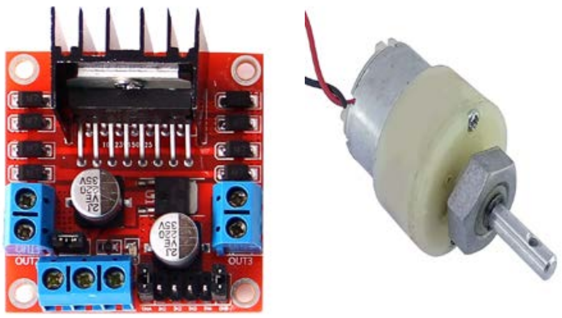

Figure.6.Motor, Motor driver

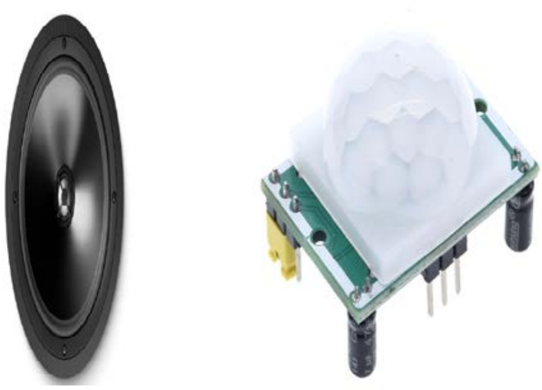

Figure .7.PIR Sensor, Speaker

2.6.3. Solar panels and Wire Connectors

The Arduino and motor driver are supplied with power by a battery with twelve volts of power. All of the electrical connections are made via connecting wires.

Figure.8.Solar panel, Wire connectors

3. ACTIVITY

Our project work has been split into two sections: the operation of the mechanism and the circuit. When the mechanism functions, the Scarecrow hand can move upward and downward using the Flapping mechanism. The connecting rod is attached to the rotating crank by a porTable joint that moves in both upward and downward directions. The connecting rod is then connected to the two arms. The mechanism is given support via a T-shaped joint.

When a bird or other creature senses movement in the circuit, its passive infrared sensor transmits an electrical signal to the Arduino UNO microcontroller, which is connected to a motor driver and panel. Additionally, Arduino transmits instructions to the motor driver, which then transmits instructions to the motor and speaker.

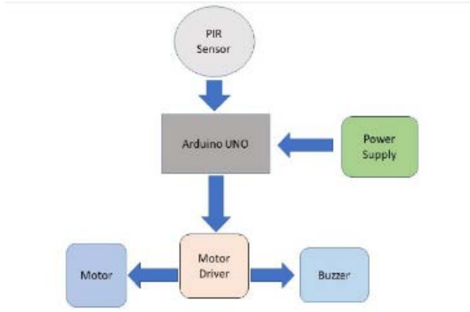

Figure.8.Arduino UNO

The automatic scarecrow model is displayed in the figure below.

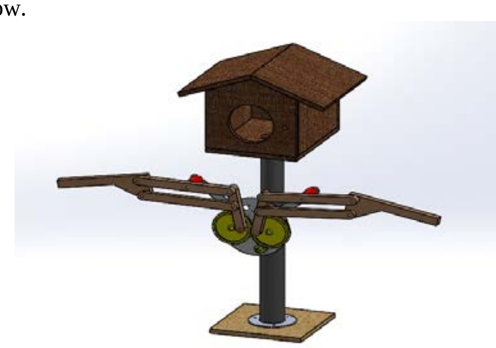

Figure.9.Project Picture

4. ESSENTIAL

It takes an automatic scarecrow to protect the crops from animals and birds. It works well both during the day and at night.It operates on autopilot.An automatic scarecrow shields crops from animals and birds at all times.In fields, scarecrows are used to protect plants and crops from birds and other wildlife. In landscaped areas, scarecrows are employed to preserve the blooms.In gardens, scarecrows are employed to preserve fruit.

5. SUMMARY AND FUTURE APPLICATIONS

The security that a scarecrow gives the crops at night is ineffective. Therefore, utilizing Automatic Scarecrow is an option in place of Regular Scarecrow. Another name for an automatic scarecrow is a smart scarecrow. Compared to a regular scarecrow, an automatic or smart scarecrow is more effective. An automatic scarecrow protects plants from animals and birds at all times. It works well both during the day and at night. It operates on autopilot. The automated scarecrow has movable arms, sensors, and an alert system.

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AI Technology's application in the manufacturing process, purchasing and supply management

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ABSTRACT

The increasing complexity and interconnectedness of modern manufacturing and purchasing and supply management (PSM) systems are driving technological advancements in these sectors. Recent progress in artificial intelligence (AI) and the vast amounts of generated manufacturing data, known as big data, enable the integration of advanced analytics tools into the supply chain, optimizing production processes. This paper focuses on the application of AI systems in manufacturing and PSM processes within factories, leading to concepts such as smart factories and smart manufacturing. These advancements are reshaping and digitizing production floors, traditionally reliant on human labor.

Keywords: Artificial intelligence; Intelligent systems; Smart factory; Smart manufacturing; Purchasing and supply management

1. INTRODUCTION

The objective of this study is to provide insight into the development of applied artificial intelligence (AI) technology in factory settings, focusing on its techno-economic aspects. The fourth industrial revolution serves as a key driver for advancements in applied AI, marking a significant progression from previous industrial eras. While the industrial revolution of the 1800s introduced water and steam-powered machinery to support labor efforts, Industry 3.0 saw the emergence of the first industrial robot by General Motors in 1961. With Industry 4.0, terms like machine learning and artificial intelligence have gained prominence, alongside the rebranding of older concepts as SMART factory, SMART manufacturing, SMART warehousing, SMART production, and SMART supply chain. These concepts are being enhanced through the application of artificial intelligence, machine learning, and deep learning, with the aim of making processes more intelligent. Cyber-Physical Systems (CPS) play a crucial role in this advancement, integrating computer-based algorithms with the physical world through powerful sensors, enabling real-time data access and processing. Data-based decision making, facilitated by big data, streamlines decision-making processes, particularly in Supply Chain Management planning. Artificial intelligence, including its subclasses, emerges as a pivotal success factor in these processes, aiding in optimal and dynamic product routing in supply chain management. While the integration of AI offers numerous benefits such as process optimization and cost reduction, it requires significant investment of resources and time to fully realize it's potential.

In the early stages of industrial robotics, their capabilities were limited due to being tailored for singular tasks. However, the industrial sector is now advancing towards what's termed as Industry 4.0, a concept initially introduce by Klaus Schwab, a German engineer and economist, in 2015. Industry 4.0 encompasses the utilization of data-sharing technology, integrating advancements such as the Internet of Things, cloud computing, and artificial intelligence.

Figure.1.Unimate- First industrial robot

One potential scenario involves a sensor detecting equipment malfunctions on the factory floor, with data instantly transmitted via cloud storage to flag the issue and initiate automatic repairs. This real-time monitoring and response system promises significant productivity enhancements throughout the manufacturing process, necessitating factory workers to adapt and upgrade their skills as automation and digitalization become more prevalent. This paper aims to contribute to industry development by providing an overview of current and upcoming AI innovations in manufacturing, assisting industry leaders in evaluating technology adoption. Additionally, it seeks to support the ongoing technical development of factory workers by highlighting technology trends and areas for skill enhancement. Leaders across various industries can also benefit from insights into the adaptability and potential investment value of emerging technologies for optimizing their supply chains. Furthermore, non-specialists in AI technology will find the paper valuable for gaining sufficient knowledge and facilitating their learning journey into AI advancements.This paper thus seeks to address the following research questions:

What is the application of artificial intelligence technology in the manufacturing process and the purchasing and supply management?

The paper begins by exploring the broader concept of change processes and their impact on the manufacturing industry due to technological advancements. It then delves into the historical evolution of computers within manufacturing, followed by a brief overview of the evolving role of human workers in the context of smart manufacturing. The discussion also addresses the shifting responsibilities of factory workers amidst these developments. Subsequently, the paper examines the practical applications of AI in manufacturing, highlighting how it facilitates process optimization through automation and its effects on purchasing and supply management. Finally, the paper concludes with insights into future prospects in this evolving landscape.

2. COMPUTER'S HISTORY IN THE MANUFACTURING PROCESS

In the quest for streamlining manufacturing, entrepreneurs pinpointed automation as the primary driver. Subsequently, the mechanization of these processes was facilitated by central computers and dedicated integrated circuits. This section offers background information to comprehend the evolution and impact of automation technology

2.1. Mechanization and rationalization

Until around fifty years ago, automation was largely interchangeable with mechanization. Manual labor was replaced by machinery and other technical tools, resulting in both advantages and disadvantages. The benefits included increased efficiency, but drawbacks such as high costs and machinery inflexibility were also evident. Notably, entire manufacturing lines often required reconstruction to accommodate new products, leading to a significant adoption of mechanization, particularly in industries with mass production like automotive manufacturing.

2.2. Birth of computers and integrated circuits

Herman Hollerith, a pivotal figure in the history of automation, significantly contributed to the development of the modern computer. His groundbreaking work revolutionized the American population census of 1890 by introducing a punch card system. This system, comprised of perforated cards and wire brushes, facilitated automated data processing, marking a departure from manual counting methods. When the brushes encountered holes in the cards, electric circuits closed, enabling data interpretation. Hollerith's innovation laid the foundation for the establishment of the IBM machine corporation.

The electric machine in the 1950s and the integrated circuit in the 1970s were two developments that brought a new change in industrial technology

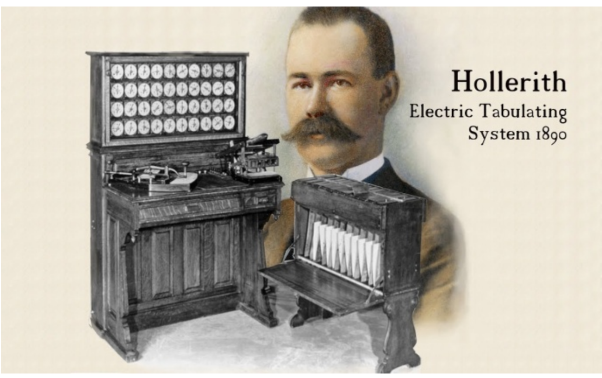

Figure.2.Herman Hollerith and his electric tabulating system

The section highlights the ongoing process of work and manufacturing radicalization through technology, which began in the past and shows no signs of halting. Applied AI is poised to significantly impact factory workers' lives, alter manufacturing processes, and reshape the overall structure of factory shop floors.

3. THE HUMAN FACTOR IN SMART MANUFACTURING

Warren G. Bennis, a renowned US organizational consultant, once envisioned the future factory with just two occupants: a human and a dog. According to Bennis, the human's duty would be to feed the dog, while the dog's responsibility would be to prevent the human from interacting with automated systems. This concept resonates with many industrialists and experts who foresee Industry 4.0 being driven by advanced AI tools, transforming manufacturing and distribution processes with a focus on human motivational factors. In this paradigm, humans are expected to assume supervisory roles and ensure product quality, while robots handle labor-intensive tasks either independently or in collaboration with humans. Achieving a harmonious balance between humans and robots remains a significant challenge. Consequently, considerable attention is being devoted to human-robot collaboration (HRC), with various institutions worldwide exploring innovative approaches. Researchers emphasize the importance of intuitive human-computer interfaces and effective task allocation between humans and robots for the success of HRC. Multimodal fusion systems, integrating technologies like speech and motion recognition, aim to strike the optimal balance between human intuition and robot precision.

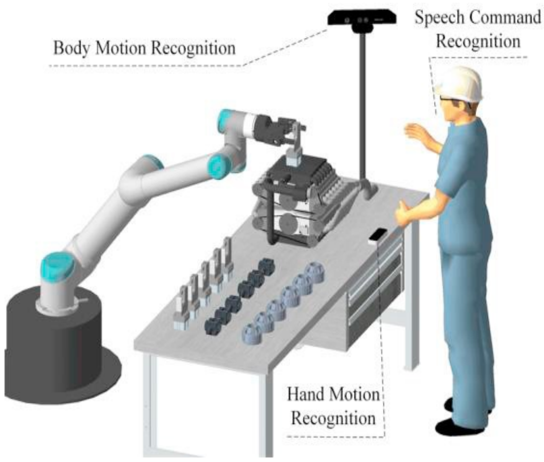

Figure.3. Multimodal human-robot collaboration enabled by speech command, hand motion and body motion recognition systems.

Despite the apparent diminishing role of humans in Industry 4.0, certain human skills remain essential. While new job prospects will emerge, human involvement, particularly in interpersonal interactions demanding psychological and emotional aptitude, remains crucial. Physical labor will largely transition to planning and managerial duties. Nonetheless, human presence remains vital for maintaining and innovating smart systems, necessitating the acquisition of new skill sets like data management and technical competencies linked to data. Moreover, fostering an open culture regarding ongoing AI projects is imperative.

4. ADVANCES OF APPLIED ARTIFICIAL INTELLIGENCE ASSOCIATED TO THE SMART MANUFACTURING CONCEPT

Combining data analytics with AI technology has the potential to enhance efficiency, product quality, and safety in the production process. Consequently, the manufacturing sector emerges as a primary driving force behind the advancement of applied AI technology. Within these sectors, four specific areas undergoing rapid digitization and optimization, significantly influenced by AI algorithms, are being examined.

4.1. Quality assurance inspections

Utilizing advanced imaging technology, companies like BMW and Canon have employed artificial intelligence solutions to identify inconsistencies and defects beyond human detection. Bosch integrated AI into their manufacturing, enhancing cycle time, defect detection, and quality inspection, leading to a 10% CO2 emission reduction and a 45% decrease in testing time, saving $1.3 million. The new AI systems ensure a 0% defect escape rate and less than 0.5% false alarm rate, contrasting with the 20-30% error rate with human inspectors due to optical illusions and imprecisions. Consistent quality from such systems boosts customer satisfaction while reducing production time and costs. Various machine learning approaches, like supervised learning, aid in quickly identifying defects, though challenges arise when unforeseen states occur. Clustering methods of unsupervised learning can handle such cases, finding patterns in data without predefined output, thereby facilitating effective subdivision.

4.2. Preventative maintenance

One significant advantage of preventive maintenance is its ability to forecast when a mechanical component might need replacement. By integrating historical data, machine learning generates an algorithm that identifies potential issues as they arise, enabling organizational experts to address them promptly and prevent delays or disruptions in development.

In preventive and predictive maintenance, statistical methods have been used for some time in making decisions. In areas with many variables, machine learning methods such as neural networks can be used for classification

Angius et al. (2016) demonstrated that the implementation of policies in such systems can be inadequate, potentially impacting the timely completion and delivery of customer orders. Hence, it is essential to assess not only the machine condition but also the effect of these system policies on the service level before their selection [20]. A visual representation of the workflow is depicted in figure 4.

4.3. Predictive forecasting

In today's dynamic economic landscape, maintaining competitiveness requires businesses to closely monitor even minor shifts in market trends. These shifts can signal significant future fluctuations in demand, potentially leading to serious production challenges upstream. AI algorithms can manage all aspects of purchasing and supply management systems, helping organizations prepare for demand changes that might disrupt production and delivery. Mahya et al. (2020) highlight that conventional supply chain management assumptions often overlook uncertainties in demand, costs, and capacity, leading to various risks such as consumer demand fluctuations, product distribution issues, and operational risks. By anticipating market changes, businesses can enhance resilience and allocate resources more effectively, adopting a proactive approach. Tarallo et al. (2019) emphasize the importance of detailed market prediction, especially for fast-moving consumer goods. AI-driven sales forecasting outperforms traditional statistical methods for perishable items, optimizing inventory, reducing stock-outs, improving supply chains, and boosting profitability.

Reinforcement learning algorithms excel in market predictions, particularly in domains like stock markets or cryptocurrency exchanges, where trading bots employing deep reinforcement learning have proven effective. Unlike other machine learning methods, reinforcement learning algorithms can yield promising outcomes with less data. This approach mirrors human learning behavior, focusing on discovering optimal strategies through trial and error. The learner, or agent, interacts with an environment, receiving rewards for actions taken. The agent's objective is to maximize these rewards, adapting to the market dynamics. In this context, a reinforcement learning approach involves a clear setup: the agent represents the trading bot, the environment signifies the market, and the rewards reflect the generated profit or loss.

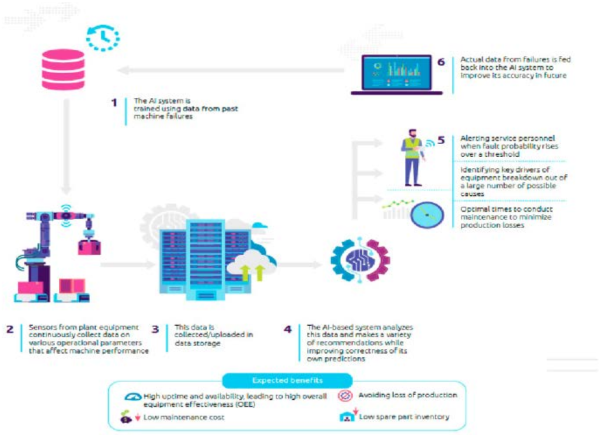

Figure.4.Usage of AI for intelligent maintenance in manufacturing

4.4. Real-time monitoring

Real-time monitoring stands out as a significant advantage of AI in manufacturing, offering precise insights into production inefficiencies and bottleneck causes. This capability enables swift identification of areas needing adjustment, leading to prompt issue resolution and resulting in savings in time and costs. Kumar et al. (2018) demonstrated the benefits, highlighting cloud manufacturing as a method for real-time monitoring that enhances resource efficiency by accurately assessing machine status. It minimizes system downtime through condition-based tracking using sensor data analysis. This data is then shared via machine-to-machine communication protocols and cloud service data retrieval methods. Furthermore, this approach benefits small and medium-sized enterprises (SMEs) within the network, fostering collaboration and facilitating cost-effective production services with short lead times.

4.5. Supply chain management

Machine learning (ML) systems and neural networks offer significant value in supply chain management. In this realm, techniques like linear regression can predict the bull-whip effect's impact. Decision trees and random forests aid in lead scoring for resource allocation by supply chain managers. Neural networks analyze customer-seller audio and video communications, aiding lead time planning and adjustment. ML optimizes decision-making in goods and services flow, yielding time and resource efficiencies. Statistical methods, extended by ML, enhance planning processes, especially for non-linear problems. Despite clear benefits, only 15% of companies apply ML in supply chain functions, possibly due to data scarcity or lack of awareness. These advancements affect purchasing, supply management, and personnel deployment, promising system enhancements.

4.6. Purchasing

The procurement divisions of corporations generate vast amounts of data, yet often fail to fully harness its potential due to resource constraints or limited understanding. Additionally, procurement landscapes are evolving, with markets becoming larger, more intricate, and highly competitive. This is where AI and ML become invaluable. Traditional decision-making methods can be enhanced through neural networks, such as the decision tree, a pivotal tool in supervised learning. Incorporating AI into procurement often involves automating and streamlining processes, akin to techniques used in supply chain management. Globalization has expanded market diversity, making it challenging for humans to navigate. Here, neural networks play a crucial role by categorizing offerings based on specific attributes, facilitating autonomous or simplified decision-making. Leveraging such methods can offer companies a significant edge over competitors.

5. CONCLUSION

The integration of artificial intelligence (AI) finds a natural fit in both the manufacturing sector and purchasing and supply management. Despite Industry 4.0 being in its early stages, significant advantages of AI are already evident. This technology aims to permanently revolutionize how we manufacture goods and handle materials, spanning from design and production floors to supply chain logistics and administration. Given this transformative potential, it's imperative to emphasize the inclusion of AI in the educational curriculum of technical fields. This ensures that future professionals are equipped to adapt to and leverage AI advancements in manufacturing, procurement, and supply chain management, thus fostering a forward-looking approach in education.

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एआई शिक्षा : अल्फा और बीटा पीढ़ी के बीच प्रतिस्पर्धा

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प्रस्तावना

वर्तमान युग में, प्रौद्योगिकी का विकास तेजी से हो रहा है, जिसमें आर्टिफिशियल इंटेलिजेंस (एआई) का योगदान विशेष रूप से महत्वपूर्ण है। अतीत में, शिक्षा प्रणाली में परिवर्तन की गति धीमी रही, लेकिन अब वैश्विक और स्थानीय दोनों स्तरों पर इसकी अधिक आवश्यकता महसूस की जा रही है। इस पेपर में हम अल्फा (2010 से बाद में जन्मे) और बीटा पीढ़ी (अधिकांशतः 2000 से 2010 के बीच जन्मे) के बीच एआई शिक्षा में प्रतिस्पर्धा का विश्लेषण करेंगे।

1. परिचय

विज्ञान और प्रौद्योगिकी के तेजी से विकास के साथ, आर्टिफिशियल इंटेलिजेंस (एआई) ने शिक्षा के क्षेत्र में एक नई परिभाषा स्थापित की है। विशेषकर, अल्फा पीढ़ी (जिनका जन्म 2010 के बाद हुआ) और बीटा पीढ़ी (जिनका जन्म 1995 से 2010 के बीच हुआ) के बीच एआई शिक्षा का प्रभाव और प्रतिस्पर्धा एक महत्वपूर्ण अध्ययन का विषय बन गया है। इस पेपर में हम इस प्रतिस्पर्धा के विभिन्न पहलुओं पर विचार करेंगे।

2. पीढ़ियों की पहचान

2.1 अल्फा पीढ़ी

अल्फा पीढ़ी वे बच्चे हैं जो 2010 और उसके बाद जन्मे हैं। ये बच्चे टेक्नोलॉजी के साथ जन्म के समय से ही रहते हैं और डिजिटल टूल्स और संसाधनों का इस्तेमाल करते हैं। उनके लिए इंटरनेट और स्मार्ट उपकरण आम हैं।

2.2 बीटा पीढ़ी

बीटा पीढ़ी में वो बच्चे शामिल हैं जिन्होंने 2000 से 2010 के बीच जन्म लिया है। इन बच्चों ने अपने जीवन के शुरुआती वर्षों में इंटरनेट और कंप्यूटर तकनीक का सामना किया है लेकिन उनका उपयोग अल्फा पीढ़ी की तुलना में कम था।

3. एआई और शिक्षा

3.1 एआई का अर्थ

एआई, या आर्टिफिशियल इंटेलिजेंस, मशीनों की एक शाखा है जो मानव समान बुद्धिमत्ता को विकसित करने का प्रयास करती है। यह तकनीक विशेष रूप से शिक्षा में नई संभावनाएं खोलती है।

3.2 शिक्षा में एआई का उपयोग

एआई का शिक्षण विधियों में उपयोग करना, व्यक्तिगत अध्ययन योजनाएं तैयार करने, छात्रों के प्रदर्शन की निगरानी करने, और शिक्षकों को समय–समय पर सुझाव देने में मदद कर सकता है।

3.3 एआई शिक्षा का महत्व

एआई शिक्षा में व्यक्तिगतकरण, दक्षता और पहुंच के कई लाभ हैं। इसके माध्यम से छात्र अपनी गति से सीख सकते हैं और शिक्षकों को भी छात्रों की प्रगति पर नजर रखने में सहायता मिलती है। युवा पीढ़ी अब एआई टूल्स का उपयोग करके अपनी शिक्षा को और अधिक इंटरैक्टिव और आकर्षक बना रही है।

4. अल्फा पीढ़ी और बीटा पीढ़ी के बीच प्रतिस्पर्धा

4.1 तकनीकी जागरूकता

बीटा पीढ़ी ने एआई और डिजिटल तकनीकों के शुरुआती चरणों को देखा है, जबकि अल्फा पीढ़ी उनके विकास के साथ बड़े हो रही है। इससे अल्फा पीढ़ी तकनीकी उपकरणों के प्रति अधिक सहज है।

4.2 शिक्षण शैलिया

बीटा पीढ़ी के शिक्षण पद्धतियाँ ज्यादातर पारंपरिक थीं, जबकि अल्फा पीढ़ी के लिए एआई आधारित शैक्षिक प्लेटफार्म अधिक सामान्य हो गए हैं।

4.3 दक्षता और गति

अल्फा पीढ़ी, एआई के माध्यम से सीखने की उच्चतम दक्षता और गति की अपेक्षा करती है। बेशक, बीटा पीढ़ी ने भी एआई का उपयोग किया है, लेकिन वे इसके प्रति उतनी सहज नहीं हैं।

4.4 नवाचार और रचनात्मकता

अल्फा पीढ़ी नवाचार और रचनात्मकता में अधिक सक्षम दिखती है, क्योंकि वे तकनीक के उपयोग से नई संभावनाओं को पहचान रही हैं।

5. चुनौतियाँ और समाधान

5.1 डेटा सुरक्षा

डेटा गोपनीयता एक गंभीर चिंता है। ज़रूरी है कि एआई सिस्टम के विकास में डेटा सुरक्षा के मानकों का पालन किया जाए।

5.2 शिक्षकों की भूमिका

तकनीक के बढ़ते उपयोग से शिक्षकों की पारंपरिक भूमिका बदल रही है। उन्हें नई तकनीक और एआई के साथ तालमेल बैठाने की आवश्यकता है।

5.3 तकनीकी असमानता

दोनों पीढ़ियों के बीच एक मुख्य चुनौती तकनीकी असमानता है। सभी बच्चों के पास नवीनतम तकनीकों की पहुँच नहीं होती, जो उनके लिए शैक्षिक अवसरों को प्रभावित कर सकती है।

5.4 मानसिक स्वास्थ्य

एआई शिक्षा का अत्यधिक उपयोग बच्चों के मानसिक स्वास्थ्य पर भी असर डाल सकता है। अधिक स्क्रीन समय और सामाजिक संपर्क में कमी से विकास में बाधाएँ उत्पन्न हो सकती हैं।

6. अल्फा और बीटा पीढ़ी के शिक्षण अनुभव

6.1 अल्फा पीढ़ी का शिक्षण अनुभव

अल्फा पीढ़ी को विशेष रूप से एआई तकनीक का लाभ मिलता है। ये बच्चे आधुनिक तकनीकों जैसे कि शैक्षिक ऐप्स, गेम्स, और इंटरैक्टिव टूल्स का उपयोग करते हैं।

6.2 बीटा पीढ़ी का शिक्षण अनुभव

बीटा पीढ़ी ने तकनीक को अपने जीवन में एक बदलाव के रूप में देखा है। यद्यपि इन बच्चों ने भी तकनीक का उपयोग किया है, लेकिन उनकी शैक्षिक पृष्ठभूमि पहले की पीढ़ियों की तुलना में अलग है।

7. प्रतिस्पर्धा की धारणा

7.1 अल्फा पीढ़ी की क्षमताएँ

अल्फा पीढ़ी में तेजी से सीखने की क्षमता होती है। उनका ध्यान आकर्षित करने के लिए शैक्षणिक सामग्री को अधिक आकर्षक और इंटरैक्टिव बनाना आवश्यक है।

7.2 बीटा पीढ़ी के अनुभव

बीटा पीढ़ी ने बेहतर ज्ञान और अनुभव प्राप्त किया है। वे प्रौद्योगिकी का कुशलता से उपयोग करने में सक्षम हैं, लेकिन अल्फा पीढ़ी के मुकाबले उनके सीखने की गति धीमी हो सकती है।

8. भविष्य की संभावनाएँ

8.1 अनुकूलनशील शिक्षा

भविष्य में, शिक्षा प्रणाली में लचीलापन और अनुकूलनशीलता की आवश्यकता होगी। अल्फा और बीटा पीढ़ी के लिए कस्टमाइज्ड शिक्षण विधियाँ विकसित करना आवश्यक है।

8.2 निरंतर विकास

शिक्षा में तकनीकी विकास जारी रहेगा, और इसमें एआई की भूमिका हमेशा महत्वपूर्ण रहेगी। शिक्षकों और शिक्षार्थियों को निरंतर विकसित होते रहना होगा।

9. निष्कर्ष

संक्षेप में, अल्फा और बीटा पीढ़ी के बीच एआई शिक्षा में प्रतिस्पर्धा के कई पहलू हैं। जबकि अल्फा पीढ़ी तकनीकी ज्ञान में आगे है, बीटा पीढ़ी के पास अनुभव और ज्ञान का भंडार है। दोनों पीढ़ियों के लिए एक समन्वित और संतुलित शैक्षिक प्रणाली की आवश्यकता है, जो तकनीकी और मानवीय दोनों पहलुओं पर ध्यान केंद्रित करती है।

अल्फा और बीटा पीढ़ी के बीच एआई शिक्षा के मुकाबले में स्पष्ट अंतर देखने को मिलता है। जबकि बीटा पीढ़ी ने प्रौद्योगिकी के आगमन को पहचाना है, अल्फा पीढ़ी के लिए यह जीवन का एक अभिन्न हिस्सा बन गया है। एआई शिक्षा की संभावनाएं असीमित हैं, लेकिन सफलता के लिए इसे प्रभावी रूप से समेकित करने की आवश्यकता है। दोनों पीढ़ी के बीच प्रतिस्पर्धा न केवल शिक्षा के क्षेत्र में विकास को प्रोत्साहित करेगी, बल्कि समाज के लिए भी नई अवसरों का निर्माण करेगी।

10. संदर्भ

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