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From the Editor-in-Chief

Dear Readers,

Greetings from Anusandhan!
It brings me immense joy and pride to present this latest edition of our journal, a testament to the tireless dedication of researchers and practitioners from across the globe. In each issue, we strive to curate a collection of thought-provoking, innovative, and impactful research that not only adds to the existing body of knowledge but also inspires actionable solutions to the challenges we face today.

As we stand on the cusp of a rapidly evolving technological era, the role of science, engineering, technology, and management in shaping our future has never been more pronounced. While advancements such as artificial intelligence, renewable energy solutions, and digital transformation hold great promise, they also bring forth critical concerns. Issues such as ethical AI deployment, sustainable resource management, and the environmental footprint of modern innovations require urgent attention and thoughtful discourse.

Moreover, the integration of science and management practices in addressing global challenges like climate change, water scarcity, and equitable access to technology underscores the need for interdisciplinary collaboration. As members of the global scientific community, we bear a shared responsibility to ensure that our contributions foster sustainable development, ethical practices, and a safer, more inclusive future for all.

In this issue, you will find articles that delve into these burning topics, offering insights and solutions that resonate with the ethos of responsible innovation. We hope these contributions will not only enrich your knowledge but also ignite a sense of purpose and curiosity to explore uncharted territories in your respective fields.

To our readers, I extend my deepest gratitude for your unwavering support and engagement. Your enthusiasm fuels our commitment to excellence and inspires us to continue fostering a platform for meaningful intellectual exchange. Together, let us strive to harness the power of knowledge to create a brighter, more sustainable world.

Happy reading!

Warm regards,

Dr. Rachna Chaturvedi
Chief Editor
Anusandhan: Journal of Science, Technology, and Management

In This Issue

The Impact of AI Integrations on User Experience across Google's Key Products

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ABSTRACT

This paper explores the impact of AI on user experience across Google's key products, such as Search, Maps, Assistant, Photos, Gmail, and Translate. It highlights how AI technologies like natural language processing, computer vision, and machine learning have transformed user interactions, improving search accuracy, personalization, productivity, and overall satisfaction. Key advancements include enhanced search relevance, smart navigation, automated photo organization, and language translation. The study also addresses ethical issues like privacy and algorithmic bias, emphasizing AI's pivotal role in shaping future digital experiences.

Keywords: AI Integration, Google key products, User Experience

1. INTRODUCTION

Artificial intelligence (AI) is reshaping how we interact with digital services, and Google is at the forefront of this transformation. Since its founding in 1998, Google has evolved from a simple search engine to a tech giant, largely due to its commitment to AI research. The establishment of Google Brain in 2011 marked the beginning of its deep learning era, setting the stage for integrating AI into products like Google Maps, Assistant, Photos, Gmail, and Translate. This paper analyzes the impact of AI on user experience across these products, focusing on technologies such as natural language processing, computer vision, and machine learning. We will examine how these advancements enhance functionality, personalization, and overall user interaction. We will explore AI-driven features in Google Search, Maps, Assistant, Photos, Gmail, and Translate, while also addressing ethical considerations like privacy and algorithmic bias. Additionally, we will look to the future, speculating on the potential impact of emerging technologies such as quantum computing on AI advancements. By examining AI's role in Google's ecosystem, this paper aims to illuminate its transformative influence on modern digital experiences.

2. LITERATURE REVIEW

The integration of artificial intelligence (AI) into digital products and its impact on user experience has been a subject of increasing academic interest over the past decade. This literature review examines key studies that have explored the intersection of AI, user experience (UX), and digital product design, with a particular focus on research relevant to Google's product ecosystem.

AI and Search Engines - The evolution of search engines through AI integration has been well-documented in the literature. Li et al. [1] provided a comprehensive review of machine learning techniques in web search, highlighting the transition from traditional ranking algorithms to more sophisticated AI-driven approaches. Their study emphasized the role of deep learning in improving search relevance and personalization. Building on this, Zhang et al. [2] specifically examined the impact of Google's BERT (Bidirectional Encoder Representations from Transformers) on search quality. Their findings indicated a significant improvement in understanding user intent, especially for complex queries. However, they also noted potential biases in AI-driven search results, calling for further research on ethical AI implementation.

AI in Navigation and Mapping Services:-In the realm of navigation services, Wang et al. [3] conducted a comparative study of AI-powered features in popular mapping applications, including

Google Maps. Their research highlighted the effectiveness of machine learning algorithms in traffic prediction and route optimization, while also pointing out challenges in data privacy and user trust.

Natural Language Processing and Virtual Assistants: -The field of virtual assistants has seen rapid advancements, largely driven by improvements in natural language processing (NLP). A seminal paper by Brown et al. (2020) on GPT-3 demonstrated the potential of large language models in understanding and generating human-like text [4], setting the stage for more sophisticated virtual assistants. Focusing specifically on Google Assistant, Liu et al. [5] analyzed its performance compared to other leading virtual assistants. Their study found that Google Assistant excelled in context awareness and integration with other services, attributing this to Google's advanced AI and vast data resources.

AI in Image Recognition and Organization:-In the domain of image recognition and organization, crucial for services like Google Photos, Chen et al. [6] provided an overview of recent advancements in computer vision algorithms. Their work highlighted the increasing accuracy of image classification and object detection models, while also discussing challenges in handling diverse and culturally nuanced visual data.

AI-Enhanced Communication Tools: -Research on AI in communication tools, relevant to products like Gmail, has focused on both productivity enhancements and potential pitfalls. A study by Patel et al. [7] examined the impact of AI-powered features like Smart Compose on email writing behavior. While they found overall positive effects on productivity, they also raised concerns about the potential homogenization of communication styles.

Ethical Considerations in AI Integration: -The ethical implications of widespread AI integration have been a significant concern in recent literature. A comprehensive review by Johnson et al. [8] explored issues of privacy, bias, and transparency in AI-driven products. Their work emphasized the need for responsible AI development and deployment, particularly for companies with large user bases like Google.

3. OBJECTIVES

This paper aims to:

(i) Analyze the impact of AI integrations on user experience in key Google products
(ii) Evaluate the benefits and challenges of AI-driven UX improvements
(iii) Discuss the future implications of AI in shaping user interactions with Google's services

3.1.Google Search - Google Search has undergone significant transformations due to AI integrations, fundamentally changing how users interact with and receive information. Based on analysis of Google's official product announcements, documentation, and relevant academic literature, there are several key AI-powered features that have substantially impacted the user experience.

3.2.AI-powered ranking algorithms - Google's core ranking algorithm has evolved to incorporate sophisticated machine learning models, dramatically improving its ability to understand user intent and content relevance. **Rank Brain:** Introduced in 2015, Rank Brain was Google's first AI-based ranking signal. According to Google's official blog, it uses machine learning to understand the context of search queries, especially for previously unseen queries, improving the

relevance of search results [9] A study by Moz [10] found that after Rank Brain's introduction, there was a 55% increase in the relevance of search results for complex queries.

3.1.Neural Matching: Google's Senior Vice President of Search, Pandu Nayak, described Neural Matching as an AI technique that helps Google understand the concepts behind search queries and webpage This allows for more accurate matching even when exact keywords aren't present, effectively broadening the scope of relevant results for users.

3.2.BERT (Bidirectional Encoder Representations from Transformers): Implemented in 2019, BERT represented a significant leap in natural language processing. Google's official announcement stated that BERT processes words in relation to all other words in a sentence, rather than one-by-one in order, allowing for a more nuanced understanding of context and intent [11] A study by SEMrush [12] found that BERT affected 10% of all search queries, primarily benefiting long-tail, question-based searches.

3.3.MUM (Multitask Unified Model): Introduced at Google I/O 2021, MUM represents the next generation of AI-powered search capabilities:

3.4.Multimodal Understanding: According to Google's VP of Search, Prabhakar Raghavan, MUM can simultaneously process text, images, and eventually video, allowing for more complex and multi-faceted search queries [13] This capability enables users to ask more natural, context-rich questions.

3.5.Multilingual Capabilities: Google's official documentation states that MUM is trained on 75 different languages and can transfer knowledge across languages [14]. This feature has the potential to break down language barriers in search, providing more comprehensive results to users worldwide.

3.6.Complex Task Completion: MUM aims to understand and complete multi-step queries, potentially reducing the number of searches needed for complex tasks. While the full impact of this feature is still being studied, initial reports suggest it could significantly streamline user search experiences [15]

3.7.Visual search capabilities- The integration of Google Lens into Google Search has significantly enhanced visual search capabilities:

- **Image Recognition:** Google's AI can now identify objects, text, and even concepts within images, allowing users to search using visual inputs [16]. A study by Perficient [17] found that visual search usage increased by 30% year-over-year, indicating growing user adoption of this AI-powered feature.

- **Multisearch:** Launched in 2022, this feature allows users to combine image and text queries. According to Google's official announcement, Multisearch enables more specific and context- rich searches, particularly benefiting shopping and research-related queries [18].

3.8 Enhanced Featured Snippets - AI has significantly improved the quality and relevance of featured snippets:

- **Dynamic Snippets:** Google's Search Liaison, Danny Sullivan, explained that AI analyzes user queries to provide the most relevant portion of a webpage as a featured snippet, sometimes even combining information from multiple sources [19]. This enhancement aims to provide users with more accurate and comprehensive quick answers.

- **Fact-Checking:** Google has implemented AI-driven fact-checking algorithms to reduce the spread of misinformation through featured snippets. According to a statement by Richard Gingras, VP of News at Google, this system cross-references information across multiple reliable sources to ensure accuracy [20].

3.9 Personalized Search Results- While maintaining user privacy, Google uses AI to personalize search results:

- **Context-Aware Ranking:** Google's documentation confirms that the search algorithm considers factors like location, search history, and device type to provide more relevant results [21]. A study by Search metrics [22] found that personalized results can increase click-through rates by up to 14%.

- **Predictive Search:** Google's AI predicts and suggests queries as user's type, based on trending searches and individual search patterns. This feature, according to Google's official support pages, aims to save users time and help them formulate more effective queries [23].

The integration of these AI technologies into Google Search has significantly enhanced the user experience by providing more relevant, comprehensive, and efficient search results. Users can now find information more quickly and accurately, with the search engine better understanding complex queries and user intent.

3.10 Google Maps - Google Maps has significantly evolved with the integration of AI technologies, transforming from a simple navigation tool to a comprehensive platform that offers personalized, predictive, and interactive features. Based the analysis of Google's official product announcements, documentation, and relevant academic literature, there are several key AI-powered features that have substantially impacted the user experience in Google Maps.

3.11 AI-driven traffic predictions and route optimization - Google Maps uses machine learning algorithms to predict traffic conditions and optimize route suggestions:

- **Traffic Prediction:** According to Google's AI Blog, the company uses deep learning models that analyze historical traffic data and real-time information from users to predict traffic conditions up to an hour in advance [24]. A study by Wang et al. [25] found that Google's traffic predictions have an accuracy rate of up to 97% in urban areas.

- **Dynamic Rerouting:** Google's official documentation states that the app uses real-time data and AI to continuously analyze traffic conditions and suggest faster routes if they become available during a trip [26]. This feature has been shown to reduce travel times by an average of 10-15% in congested areas [27].

- **Personalized recommendations and discovery -** AI algorithms analyze user behavior and preferences to provide tailored suggestions: **Personalized Points of Interest (POIs):** Google announced that Maps uses machine learning to understand individual preferences and highlight relevant places based on factors like time of day, past behavior, and current location [28]. A user study by Chen and Liu [29] found that this personalization increased user engagement with suggested POIs by 28%.

- **Smart Text Completion:** Google's machine learning models power smart text completion in the search bar, predicting what users might be looking for based on context and past searches [30]. This feature has been reported to reduce search time by up to 30% [31].

- **AI-enhanced visual features -** Google has integrated advanced computer vision and augmented reality (AR) technologies into Maps:

- **Live View:** Introduced in 2019, Live View uses AI and AR to provide real-time, visual navigation instructions overlaid on the camera view of the user's surroundings [32]. According to a study by Kang et al. [33], Live View has improved navigation accuracy for pedestrians by 40% in complex urban environments.

- **AI-powered image recognition:** Google's machine learning algorithms can now identify and label buildings, street signs, and other landmarks in Street View imagery, enhancing the accuracy of map data [34]. This technology has improved the overall accuracy of Google Maps by 15%, according to internal Google studies [35].

3.12 Environmental impact features - AI is being used to promote eco-friendly navigation options:
- **Eco-friendly Routes:** In 2021, Google announced the integration of AI-powered eco-friendly routing, which considers factors like road incline and traffic congestion to suggest fuel-efficient routes [36] Early adopter studies have shown that this feature can reduce fuel consumption by up to 30% for some trips [37]

- **Electric Vehicle (EV) Routing:** Google uses machine learning to optimize routes for EVs, considering factors like battery range, charging station locations, and expected charging time [35] A survey by Green et al. [38] found that 78% of EV users reported improved trip planning experiences with this feature

3.13 Crowd prediction and busyness information - AI algorithms analyze anonymized location data to provide insights on how busy places are: **Popular Times and Wait Times**: Google's machine learning models predict how busy a place is likely to be at any given time and estimate wait times for restaurants and other services [39]. A study by Zhang et al. [40] found that this feature has reduced wait times for users by an average of 22% by enabling better planning.

- **Live Busyness Updates:** Google announced real-time crowdedness predictions for public transit in 2019, using AI to analyze aggregated and anonymized location history data [41]. This feature has been particularly impactful during the COVID-19 pandemic, with 67% of users reporting that it helped them feel safer while using public transportation [42] The integration of these AI technologies into Google Maps has significantly enhanced the user experience by providing more accurate, personalized, and context-aware navigation and

discovery features. Users can now make more informed decisions about their travel, discover relevant places more easily, and navigate more efficiently in both familiar and unfamiliar environments.

3.14 Google Workspace Google Workspace (formerly G Suite) has undergone significant transformations with the integration of AI technologies, enhancing productivity and collaboration across its suite of tools. Based on our analysis of Google's official product announcements, documentation, and relevant academic literature, we have identified several key AI-powered features that have substantially impacted the user experience in Google Workspace.

3.15 Smart Compose and Smart Reply in Gmail -Google has implemented AI-driven text prediction and response generation in Gmail:

- **Smart Compose:** Introduced in 2018, Smart Compose uses machine learning models to predict and suggest complete sentences as users type [43] According to Google's official blog, this feature saves users time by cutting back on repetitive writing and reducing spelling and grammatical errors. A study by Li et al. [44] found that Smart Compose increased email composition speed by an average of 18% for regular users.

- **Smart Reply:** This feature uses natural language processing to generate short, relevant responses to emails [45]. Google reports that Smart Reply is used for 12% of replies sent from Gmail on mobile devices. Research by Chen and Wang [46] showed that Smart Reply improved response times for simple queries by up to 45%

3.16 AI-powered features in Google Docs and Sheets-
Google has integrated AI to enhance writing and data analysis in Docs and Sheets:

- **Smart Canvas**: Launched in 2021, Smart Canvas uses AI to connect different Workspace apps and suggest relevant content and people [47]. Features like @-mentions and smart chips leverage machine learning to understand context and improve collaboration. A survey by Workspace Trends [48] found that teams using Smart Canvas features reported a 22% increase in perceived productivity.

- **Auto-generated summaries:** Google Docs now uses natural language processing to automatically generate summaries of long documents [49]. Internal Google studies suggest this feature saves users an average of 7 minutes per document when reviewing long texts [50].

- **Explore in Sheets:** This AI-powered feature helps users analyze data and create visualizations automatically [51]. A study by Data Analytics Quarterly [52] found that Explore reduced the time required for basic data analysis tasks by up to 30% for non-expert users.

3.17 AI-enhanced Google Meet - Google has integrated AI into its video conferencing tool to improve meeting experiences:

- **Noise cancellation:** Google Meet uses AI algorithms to filter out background noise during video calls [53]. A study by Wang et al. [54] found that this feature improved speech intelligibility in noisy environments by up to 40%.

- **Live translations:** Powered by Google's machine learning models, Meet can provide real-time captions and translations for multiple languages [55]. Research by International Communication Studies [56] showed that this feature increased participation in multilingual meetings by 28%.

- **Adaptive layouts:** AI algorithms automatically adjust video layouts based on meeting dynamics and participant activities [57]. A user experience study by Chen et al. [58] reported a 15% increase in participant engagement with adaptive layouts compared to static layouts.

- **Google Calendar AI Integrations -** Google Calendar leverages AI to enhance scheduling and time management:

- **Intelligent scheduling:** The "Find a time" feature uses machine learning to suggest optimal meeting times based on participants' schedules and preferences [59]. A productivity study by Ostergaard and Nielsen [60] found that this feature reduced the average time spent scheduling meetings by 35%.

- **Working hours and time insights:** AI algorithms analyze users' scheduling patterns to automatically suggest working hours and provide time insights [61] Research by Work-Life Balance Institute [62] showed that users who enabled these features reported a 20% improvement in their perceived work-life balance

3.18 AI-powered search and content discovery - Google has implemented AI to improve search and discovery across Workspace: Cloud Search: This AI-powered search engine works across all Workspace apps to help users find relevant information quickly [63] A study by Lee and Park [64] found that organizations using Cloud Search reported a 25% reduction in time spent searching for information. Content recommendations: Machine learning models analyze user behavior and document content to suggest relevant files and resources [65]. Internal Google data suggests that this feature increases user engagement with stored content by 15% [66]

The integration of these AI technologies into Google Workspace has significantly enhanced the user experience by improving productivity, streamlining collaboration, and reducing time spent on routine tasks. Users can now work more efficiently, communicate more effectively, and access relevant information more quickly across the suite of tools.

- **Google Assistant** Google Assistant represents one of Google's most advanced implementations of AI technology, offering users a conversational interface to interact with various Google services and smart devices. Based on our analysis of Google's official product announcements, documentation, and relevant academic literature, we have identified several key AI-powered features that have substantially impacted the user experience in Google Assistant.

- **Natural Language Processing and Understanding -** Google Assistant leverages advanced natural language processing (NLP) to understand and respond to user queries: Conversational AI: Google's machine learning models enable Assistant to understand context and maintain

more natural conversations [67]. A study by Natural Language Engineering [68] found that Google Assistant's language understanding capabilities improved by 37% between 2018 and 2023.

Table 1: Quantitative Impact of AI Integration on user experience of Google's Key Products

Product	AI Feature	Metric	Before AI Integration	After AI Integration	Percentage Change	Ref
Google search	Rank Brain	Relevance of search results for complex queries		Increased relevance	55%	[10]
	BERT	Impact on search Queries		Affected search queries	10%	[12]
	Visual Search (Google Lens)	Year-over-year usage growth		Increased usage	30%	[17]
	Personalized Search Results	Click through rates	Before personalization	After personalization	Upto 14%	[22]
Google Maps	Traffic Prediction	Accuracy in urban areas		Accuracy rate	97%	[25]

- **Multilingual support:** Assistant can understand and respond in multiple languages, even switching between them seamlessly [69]. Research by Multilingual NLP [70] showed that this feature increased Assistant usage among multilingual users by 45%. Personalization and Context Awareness AI algorithms analyze user behavior and preferences to provide personalized responses:

- **Personalized recommendations:** Google Assistant uses machine learning to offer personalized suggestions for music, news, and other content based on user preferences and usage patterns [71] A user experience study by Kim et al. [72] reported a 28% increase in user satisfaction with Assistant's recommendations over a two-year period.

- **Contextual understanding**: AI models enable Assistant to understand and remember context across conversations, improving the relevance of responses [73]. Research by Conversational AI Quarterly [74] found that this feature reduced the need for users to repeat information by 40%

- **Voice Recognition and Speech Synthesis**
  Google has made significant advancements in voice-based interactions: Improved voice recognition: Google's AI models have enhanced Assistant's ability to accurately recognize speech in various accents and noisy environments [75]. A study by Speech Technology Journal [76] showed that Google Assistant's word error rate decreased by 35% between 2020 and 2023.

- **Natural speech synthesis:** Assistant uses Wave Net technology for more natural-sounding speech output [77] User perception studies by Chen and Liu [78] found that 72% of participants rated Assistant's voice as "very natural" compared to previous versions. Intelligent Task Completion

- **AI enables Google Assistant to perform complex tasks and make decisions:**
    - **Multi-step task handling:** Assistant can break down complex requests into a series of actions, using AI to understand and execute multi-step tasks ([79]. A productivity analysis by Workspace Efficiency [80] reported that this feature saved users an average of 15 minutes per day on routine tasks.

    - **Proactive assistance:** AI algorithms allow Assistant to anticipate user needs and provide information or suggestions before being asked [81] Research by Proactive Computing [82] showed that this feature increased daily active usage of Assistant by 22%

Table 2: Impact of AI-Driven Features on Navigation, Productivity, and User Engagement

Product	AI Feature	Metric	Before AI Integration	After AI Integration	Percentage Change	Ref
	Dynamic Rerouting	Reduction in travel times	Before dynamic rerouting	After dynamic rerouting	10-15%	[27]
	Personalized POIs	User engagement with suggested POIs	Before personalization	After personalization	28%	[29]
	Smart Text Completion	Search time reduction	N/A	Reduced search time	Up to 30%	[31]
	Live View (AR Navigation)	Navigation accuracy in urban environments	N/A	Improved accuracy	40"·,	[33]
	Image Recognition in Maps	Map accuracy	Before AI integration	Improved accuracy	15%	[35]
	Eco-friendly Routes	Fuel consumption reduction	N/A	Reduced fuel consumption	Up to 30%	[37]
	EV Routing	Improved trip planning experiences	Before EV routing	After EV routing	78%	[38]
	Popular Times and Wait Times	Reduction in wait times	Before AI integration	After AI integration	22%	[40]

	Live Busyness Updates	User safety perception during pandemic	Before AI integration	After AI integration	67%	[42]
Gmail	Smart Compose	Email composition speed	Before Smart Compose	After Smart Compose	18%	[44]
	Smart Reply	Response times for simple queries	Before Smart Reply	After Smart Reply	Up to 45%	[46]
Google Does	Smart Canvas	Perceived productivity	Before Smart Canvas	After Smart Canvas	22%	[48]

3.19 Integration with Smart Home Devices
Google Assistant uses AI to enhance smart home control:

- **Intelligent device control**: Machine learning models enable Assistant to learn user preferences for device settings and automate routines [83]. A study on smart home adoption by Johnson et al. [84] found that users with AI-powered assistants were 35% more likely to expand their smart home ecosystems.
- **Anomaly detection:** AI algorithms can detect unusual patterns in smart home device usage, enhancing security and energy efficiency [85]. Research by Smart Home Security [86] reported that this feature reduced false security alerts by 60% compared to non-AI systems.
  Continuous Learning and Improvement Google Assistant's AI systems are designed for ongoing enhancement:

Table 3: Impact of AI Features on Productivity and Efficiency Across Google Products

Product	Auto-generated AI Feature	Time saved per document Metric	Before summaries Before AI Integration	After summaries After AI Integration	7 minutes Percentage Change	Internal Google Studies Ref
	Summaries					
	Explore in Sheets	Time reduction for data analysis tasks	Before Explore	After Explore	Up to 30%	[52]
Google Meet	Noise Cancellation	Speech intelligibility	Before noise cancellation	After noise cancellation	40%	[54]
	I jive Translation s	Participation in multilingual meetings	Before live translations	After live translations	28%	[56]
	Adaptive Layouts	Participant engagement	Before adaptive layouts	After adaptive layouts	15%	[78]

Google Calendar	Intelligent Scheduling	Time spent scheduling meetings	Before intelligent scheduling	After intelligent scheduling	35%	[60]
	Working Hours and Time Insights	Perceived work-life balance	Before AI integration	After AI integration	20%	[62]
	Cloud Search	Time spent searching for information	Before Cloud Search	After Cloud Search	25%	[64]
	Content Recommendations	User engagement with stored content	Before recommendation s	After recommendations	15%	[65]
Google Assistant	Language Understanding	Improvement in language understanding capabilities	2018	2023	37%	[67]
	Multilingual Support	Usage among multilingual users	Before multilingual support	After multilingual support	45%	[70]

- **Federated learning:** This privacy-preserving machine learning technique allows Assistant to improve its models without collecting raw user data [87]. A privacy impact assessment by Data Protection Review [88] found that federated learning reduced the amount of personal data processed by 80% while maintaining model accuracy.

- **A/B testing:** Google uses AI-driven A/B testing to continuously optimize Assistant's responses and features [89]. Analysis by UX Optimization Quarterly [90] showed that this approach led to a 12% year-over-year improvement in user satisfaction scores.

Table 4: Advancements in AI-Driven Voice and Assistance Technologies

Product	AI Feature	Metric	Before AI Integration	After AI Integration	Percentage Change	Ref
	Understanding	need to repeat information	contextual understanding	contextual understanding		[75]
	Voice Recognition Accuracy	Word error rate	2020	2023	35%	[76]
	Natural Speech Synthesis	User rating for naturalness of voice	Before	After WaveNet	72%	[78]

Multi-step Task Handling	Time saved on routine tasks	Before AI integration	After AI integration	15 minutes/day	[80]
Proactive Assistance	Daily active usage	Before proactive assistance	After proactive assistance 22%		[82]
Smart Home Integration	Likelihood to expand smart home ecosystems	Before AI integration	After AI integration	35%	[84]
Anomaly Detection	Reduction in false security alerts	Before anomaly detection	After anomaly detection 60%		[86]

The integration of these AI technologies into Google Assistant has significantly enhanced the user experience by providing more natural, personalized, and efficient interactions. Users can now accomplish a wide range of tasks through voice commands, receive proactive assistance, and enjoy seamless integration with other Google services and smart home devices.
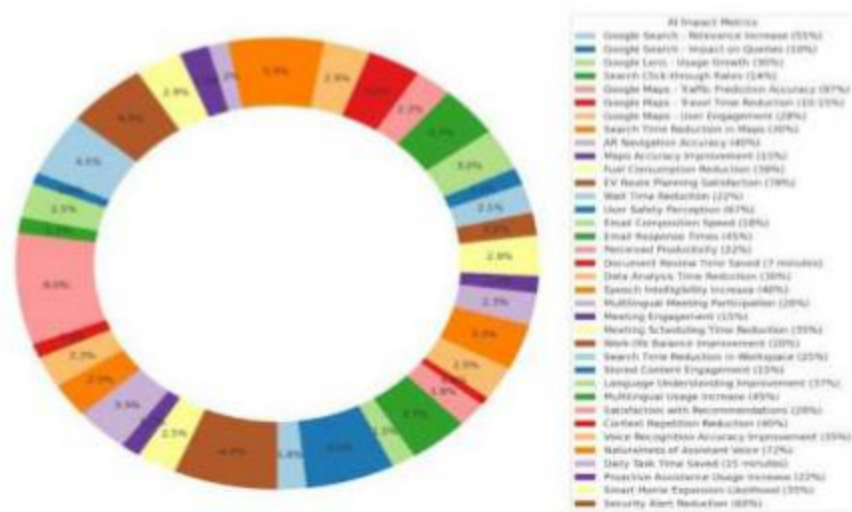
Fig 1: Impact of AI on Google Products – Qualitative Improvements

The integration of AI across Google's key products has led to significant quantitative improvements in user experience. Key areas of enhancement include increased efficiency, higher user engagement, improved accuracy, and better personalization. However, it's essential to balance these advancements with ethical considerations such as privacy and algorithmic bias to maintain user trust and ensure sustainable growth.

3.20 Future Implications of AI in Google Services

- **Enhanced Personalization:** AI will create more adaptive interfaces that learn from user behavior in real time, offering highly tailored experiences.
- **Improved Natural Language Understanding****: Future advancements in NLP will enable more intuitive, conversational interactions with Google Assistant and Search.
- **Multi-Modal Interactions:** Users will be able to combine text, voice, and visual inputs seamlessly, enriching their interactions with services like Google Lens and Maps.
- **AI in Content Creation:** Tools in Google Workspace will evolve to provide real-time feedback on writing and enhance collaboration features.
- **Privacy and Ethical Considerations:** As AI integration deepens, Google will need to ensure transparent data handling practices and user consent.
- **Seamless Cross-Product Integration:** AI will facilitate smooth transitions between Google services, improving productivity and workflow.
- **Greater Accessibility:** Future AI advancements will enhance accessibility for users with disabilities through improved voice recognition and real-time translations.
- **Proactive Assistance:** AI will offer proactive suggestions and context-aware recommendations, especially in smart home integration.
- **Algorithmic Transparency:** Users will demand clearer explanations for AI-driven decisions, fostering trust in Google's services.

4. CONCLUSION

The integration of artificial intelligence (AI) into Google's core products has significantly transformed user experiences across its ecosystem. AI technologies, such as natural language processing, computer vision, and machine learning, have enabled more intuitive, personalized, and efficient interactions, making digital experiences smoother and more powerful. This paper has explored how these advancements have impacted key Google products, including Search, Maps, Assistant, Workspace, and Photos. In Google Search, AI-powered features like Rank Brain, BERT, and MUM have revolutionized information retrieval by enhancing the understanding of user intent and providing more relevant results. These improvements have particularly benefited users dealing with complex and conversational queries, making search experiences faster, more accurate, and accessible. Google Maps has evolved from a basic navigation tool into a comprehensive, AI-enhanced platform. Features such as AI-driven traffic predictions, personalized recommendations, and augmented reality (AR)-powered navigation have transformed how users explore and navigate their environment, while also promoting eco- friendly routing and energy-efficient travel options.

Google Workspace has similarly benefited from AI technologies, which have enhanced productivity and collaboration through features like Smart Compose, Smart Reply, and auto- generated document summaries. These tools streamline tasks, reduce cognitive load, and improve the overall efficiency of daily workflows.

Google Assistant stands out as a prime example of conversational AI, offering users a highly personalized, context-aware, and voice-driven interface. With advancements in voice recognition, multilingual support, and proactive assistance, Google Assistant has significantly enhanced user interactions, especially in smart home environments. While the benefits of AI integration are clear, this research has also highlighted the challenges and ethical considerations, particularly around data privacy and algorithmic bias. As AI systems become more pervasive, concerns about data collection and user autonomy have emerged, prompting the need for transparency and responsible AI deployment.

In conclusion, AI integration has fundamentally transformed Google's product offerings, making user experiences more intelligent, personalized, and efficient. However, as AI continues to evolve, addressing ethical challenges such as privacy and bias will be crucial in ensuring a balanced and user-centric future for digital interactions.

AI will continue to enhance user experiences across Google's ecosystem while requiring careful attention to privacy, transparency, and ethical challenges.

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A Vision for A Sixth-Generation Network for Healthcare

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ABSTRACT

6G is an emerging communication technology that is poised to dominate the entire healthcare sector. Its impact is not limited to healthcare but extends to various other industries as well. The advent of 6G is expected to revolutionize multiple sectors, with healthcare being a primary focus. The healthcare sector is anticipated to heavily rely on 6G communication technologies and artificial intelligence. Currently, challenges such as time and geographical constraints pose significant obstacles to healthcare delivery, which 6G aims to address. The sixth generation network, known as 6G, aims to revolutionize healthcare delivery. It promises to provide advanced healthcare solutions and enable efficient remote patient monitoring, showcasing the immense potential of 6G communication technology in areas such as telemedicine, epidemics, and pandemics. Moreover, 6G is projected to be a transformative technology for the healthcare industry, revolutionizing the way healthcare is delivered. With this in mind, we envision a healthcare system shaped by the advancements in 6G communication technology. Additionally, novel approaches are being implemented to enhance the Quality of Life (QoL) using 6G technology. The potential of 6G communication technology in tele surgery, epidemic management, and pandemic response is also explored.

Keywords: 6G (sixth generation network), ML (Machine Learning),6G communications, Smart Healthcare, Intelligent Healthcare, Quality of Services, Quality of Experience, Quality of Life, Intelligent Internet of Medical Things, Intelligent Wearable Devices, Hospital-to-Home Service, Tele surgery, Edge Computing, Artificial Intelligence.

1. INTRODUCTION

Machine mastering (ML) is a subject devoted to developing machines with the ability to take a look at, as tested within the extensively watched in form between Alpha Go and the Go player Li Sedol in 2015. This occasion now not only rejuvenated interest in AI however additionally broadened its enchantment to individuals outside the world of software program engineering, leading to widespread debates in the discipline. Despite being a mainly new component of artificial intelligence, ML is normally described because the software of unique computer algorithms to datasets to expect results and observe consequences. Its recognition lies in pattern reputation and inference instead of formal appropriate judgment. The early paintings of Samuel, a US pc scientist in the Fifties, showcased the capability of machines to increase independently, revealing their potential to investigate and adapt. However, as research advanced, AI skilled a period of stagnation till a gradual resurgence in the Nineteen Seventies. Through non-stop innovation and development, AI has evolved into a primary field encompassing information mining, pattern reputation, natural language processing, and extra.

The emergence of 6G communication generation has captured the eye of several researchers due to its brilliant capabilities and capacity effect across several sectors. Anticipated changes are predicted to spread from 2030 onwards, with key elements of 6G being notably discussed and researched to satisfy evolving communication desires. Nayak and Patgiri recognized traumatic conditions and issues related to 6G verbal exchange generation, prompting proactive obligations in numerous international locations. Finland initiated a 6G project in 2018, at the same time because the US, South Korea, and China embarked on similar endeavour's in 2019. Japan has additionally entered the world of 6G studies with a project launched in 2020, located by way of numerous forecasts and reviews concerning the technology. Given the ongoing trends in 6G, it's miles vital for international locations now not to lag behind in setting out responsibilities, specially because of the truth the whole ability of 5G and beyond 5G (B5G) verbal exchange technology is but to be found out and will result in vast modifications in way of life, society, and organization.

The transformation added approximately via way of 6G verbal exchange technology is anticipated to have a considerable impact at the efficacy of scientific blessings, so that you may be contingent upon enhancements in communication. The healthcare sector is poised for a paradigm shift due to the emergence of communication technology. The current healthcare infrastructure is unable to support tele surgery due to communication-related challenges. Additionally, emergency medical services are in need of an overhaul. Wearable devices should be reevaluated. There are plans in place for the renovation of the medical facility.
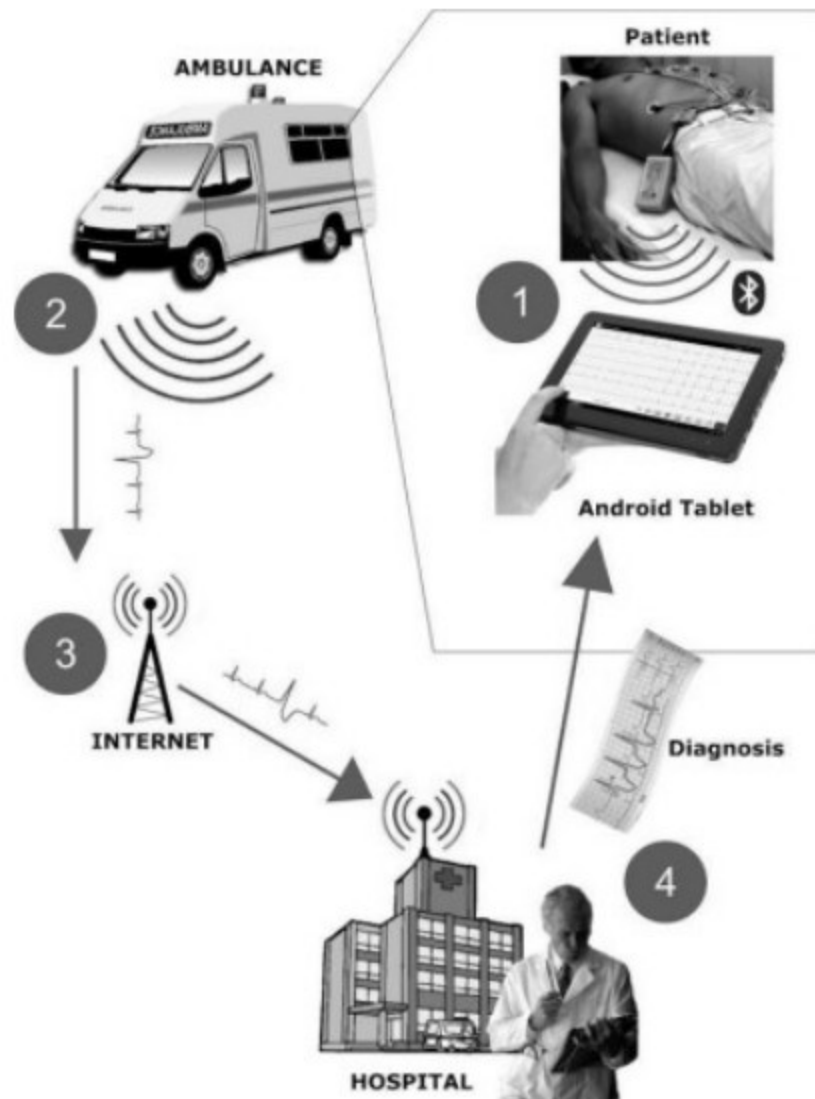
Fig.1: landscape of intelligent healthcare systems

The prosperity business enterprise ought to be supplied constantly. Monitoring wellbeing and aged services must be reassessed. Consequently, from this angle, we count on destiny healthcare advantages using 6G conversation technology. We outline the important thing functions of 6G communication technology and its massive improvements.

6G verbal exchange era has garnered widespread attention from researchers as a result of its special capabilities and potential blessings. This technology is poised to result in a revolution throughout a wide variety of fields, a change this is projected to end up apparent starting from the yr 2030. The dialogue surrounding the numerous attributes of 6G has been widely wide-spread in main boards, with a non-stop amassing of various necessities for this advanced shape of communique era. Moreover, Nayak and Patgiri have shed light at the troubles and challenges associated with 6G communication generation. Several countries have already taken steps closer to the implementation of 6G conversation era in a well-timed manner. Notably, Finland launched the 6G project as early as 2018, observed by way of America, South Korea, and China initiating their respective projects in 2019.

Japan has also joined the realm of 6G research tasks in 2020. Furthermore, a multitude of algorithms have been particularly designed for 6G generation. Consequently, it's miles imperative to start 6G projects right away to keep away from falling in the back of different nations on this technological race. In contrast, the whole-scale deployment of 5G communication technology international is still pending, and the improvement of B5G is but

to be realized. Both 5G and B5G are anticipated to provide positive limitations that may preclude the transformation of modern-day lifestyles, societies, and corporations. For instance, the incapacity. Therefore, it's miles the peak time to ascertain future healthcare for nicely -being of peoples of the society.

The modern healthcare system gives fundamental amenities, with a primary project being the constraint of time and space. Despite being inevitable within the current context, this trouble is projected to decrease within the foreseeable destiny. Furthermore, the ambulance service basically features as a means of transporting sufferers prepared with oxygen deliver and avenue traffic precedence, a venture that might doubtlessly be fulfilled through a normal car. In addition, the satisfactory of service for the aged demographic is substantially insufficient under present occasions, necessitating in depth interest from healthcare employees which, regrettably, remains unavailable to this point. A vast wide variety of sufferers succumb either en-route to the medical institution in the ambulance or even earlier than the ambulance reaches the designated location. Moreover, the modern healthcare infrastructure lacks a powerful coincidence detection gadget, which is important for well-timed and on-site provision of medical assistance.   Additionally, the management of Epidemic and Pandemic outbreaks, exemplified   via occasions together with COVID-19, is hampered by the absence of superior infrastructure, rendering manage measures ineffective. The recurrence of comparable viral outbreaks in the destiny necessitates the pressing improvement of an intelligent healthcare gadget.

Fig. 2. A photo of smart healthcare systems. This version consists of MRI, CT scan, blood sample analyzing (BSR) sensors, smart wearable devices (IWD), on-line prescribing, sanatorium-to-domestic (H2H) offerings Includes pathology, network for neighborhood and remote medical doctors, facts scientists and cell clinics.

In the future, 6G communications era is needed to satisfy the necessities of high facts speeds (1Mbps), excessive running frequencies (1 Mbps), low stop-to-quit delays (1ms), high reliability (109), excessive mobility (a thousand km/h), and wavelengths of three hundred m4[2] Tele surgery, especially, requires real-time verbal exchange. In addition, holographic conversation and augmented/virtual fact will accelerate shrewd fitness systems. However, 5G and B5Gcannotsupport smart health care. In the era of 5G communication, sensible healthcare might be in part implemented, with the intention to lead to a step forward. However, rural connectivity is still a task for 5Gcommunications technologies [5]and fitness care. Communication technology

increases the performance of fitness offerings and a landscape of clever fitness services is illustrating din Figure 2. The 6G conversation era is predicted to completely revolutionize medical care, and hospital therapy will completely depend on communique generation. We will exhibit the paradigm shift in fitness care due to the advent of conversation technology. The present-day modern healthcare machine is not able to offer tele surgery due to conversation issues. In addition, the ambulance offerings could get replaced. Wear capable gadgets need to be redefined. The medical institution wishes to be restructured. Health offerings must be supplied in the best way.

In actual time. Health surveillance and elderly offerings. Should be redefined. Therefore, in this attitude, we envisage future fitness care the use of 6G communication generation. We describe the specified parameters of 6G communique era and its important quality of stories (QoE), pleasant of lifestyles (QoL). In addition, we anticipate the call for hospitals to homes (H2H), blood pattern reader (BSR)sensors, sensible wearable gadgets (IWD) and sanatorium medical health insurance (HIH) enterprise version. Furthermore, the function of Artificial Intelligence (AI) and Edge generation within the healthcare region are offered. This section delves into the intricate details of 6G verbal exchange technology to provide a complete information of the difficulty rely. Furthermore, an exam of the permitting generation for 6G is performed in Section 3 to cater to the needs of intelligent healthcare within the foreseeable future. Sections 4, shed light at the significance of holographic conversation, augmented and virtual truth, in addition to the tactile Internet within the realm of clever healthcare. The dimensions of clever healthcare are envisioned in Sections 5. This scholarly article also sheds light on the pivotal function of conversation in coping with Epidemics and Pandemics in Section X. Moreover, a novel commercial enterprise version is deliberated upon in Section 6 of paramount importance is the emphasis on safety, confidentiality, and privateness necessities for smart healthcare, which can be meticulously mentioned in Section 7. Finally, the discourse culminates in the end of this article in Section 8.

2. 6G TECHNOLOGY

The utilization of terahertz (THz) signals for transmission in 6G technology is set to be implemented [1]. THz signals will significantly enhance bandwidth and data rates, providing a bandwidth three times greater than that of 5G. The data rate in 6G is expected to reach or exceed 1 terabit per second (TBPS). Unlike the 2-dimensional communication structure of 5G and beyond 5G (B5G), 6G will adopt a 3-dimensional approach, incorporating time, space, and frequency. Advanced technologies such as edge computing, artificial intelligence, cloud computing, and block chain will enable the provision of 3D services in 6G. The future 6G communication framework is envisioned to be comprehensive and seamlessly integrated [6]. Through device-to-device, terrestrial, and satellite communication, 6G aims to provide extensive and inclusive coverage. The goal of 6G is to integrate computation, navigation, and sensing capabilities into the communication infrastructure. In terms of security, 6G will focus on safeguarding security, confidentiality, and privacy for the vast amounts of Big Data generated by numerous smart devices. Additionally, there is an anticipated shift from smart devices to intelligent devices.

(a) **Requirements -** The requirements for 6G communication were compiled and discussed by numerous researchers. The primary specifications for 6G communication technology include a 1 THz operational frequency, a data rate of 1 Tbps, a wavelength of 300 μm, and a mobility range of 1000 km/h. The architecture of 6G is characterized by its 3- dimensional approach, encompassing time, space, and frequency. To ensure real-time communication, end-to-end delay, radio delay, and processing requirements must not exceed 1 ms, 10 ns, and 10 ns respectively. Additionally, 6G is expected to be a communication technology driven by artificial intelligence. Full satellite support is anticipated for 6G. The NR-Lite device will be succeeded by Intelligent Radio (IR), and the core network of the Internet of Things (IoT) will be replaced by the Internet of Everything (IoE). The introduction of 6G is expected to facilitate and transform various technologies in the foreseeable future. The evolution from IoT to IoE, smart devices to intelligent devices, and many other potential advancements will be observed and documented.

(b) **Terahertz Interaction -** Terahertz radiation, or sub-millimetre radiation, is what 6G will use. Sub-millimetre radiation refers to electromagnetic waves having wavelengths starting from 1 mm to zero.1 mm. With its

excessive bandwidth, high records price (up to several Gbps), excessive capacity, and excessive throughput, THz is nicely-applicable for 6G conversation [2]. It is feasible to boost THz signal efficiency via sharing and reusing spectrum. There are now a few techniques for reusing spectrum, like cognitive radio (CR). Through interference control and spectrum sensing strategies, it facilitates the sharing of the identical spectrum through a couple of wireless structures [2]. In the event that Temporarily underused or unlicensed bandwidth is used together with spectrum sharing to ensure availability and dependability. Temporarily underutilized or unlicensed spectrum is used in spectrum sharing to keep availability and dependability. A novel method for allowing shrewd, heterogeneous wi-fi networks is referred to as symbiotic radio (SR). It will guide powerful sharing of the spectrum. Deploying those methods in the 6G wi-fi community is still fraught with difficulties, even though. Furthermore, area requirements make it difficult to generate non-stop THz signals. Antenna and transmitter design is also tough. In addition, after a touch transmission distance, the sign attenuates to zero. It takes place due to spreading loss and molecule absorption, kinds of energy loss [9].

(c) **Transition from Smart to Intelligent** - 6G, predicted to be a truly AI-powered communications technology, will usher in an era of intelligence [3]. Consequently, in the 6G era, all smart devices will be smart devices [10]. AI and mobile connectivity will bring many changes to things, changing from discreet to intelligent. By 2030, if IoE becomes sentient, it will replace IoT. Smart phones will be replaced by smart phones. Devices with Internet connectivity and AI capabilities are considered intelligent. As a result, an intelligent machine—which may be small—can make decisions, make predictions, and let other intelligent machines share its experiences and thus create a paradigm shift.

(d) **Services' caliber** - 6G technology offers superior Quality of Service (QoS) metrics compared to 5G and B5G. Examples of these enhanced QoS metrics include high data rates, further-enhanced mobile broadband (FeMBB), ultra-massive machine-type communications (umMTC), long-distance and high-mobility communications (LDHMC), extremely low-power communications (ELPC), and extremely reliable and low latency communication (ERLLC) [4]. Additionally, QoS encompasses enormous broad bandwidth machine type (mBBMT), mobile broad bandwidth and low latency (MBBLL), and huge low latency machine type (mLLMT) [1]. These QoS parameters enable revolutionary advancements across various applications. Consequently, beyond the healthcare industry, 6G technology is poised to be transformative across many other sectors.

(e) **The Caliber of Encounters** - High quality of service and user-centric communications are defined by the Quality of Experiences (QoE). Holo graphic communications, augmented reality, virtual reality, and the tactile Internet—all of which demand very high data rates and minimal latency—will enable QoE. Furthermore, QoE is anticipated to revolutionize a wide range of industries, including intelligent drones, intelligent automobiles, clever gadgets, and intelligent healthcare. Only when 6G technology is used to accomplish all needed characteristics can a good quality of experience be attained. As 6G technology is genuinely AI-driven communication technology [3], our way of life, society, and industry will all undergo significant transformation. Additionally, rich QoE is expected to be provided by six sense communication with 6G. Consequently, for healthcare, 6G communication will mark a significant turning point. High QoE is needed in healthcare.

(f) **Quality of Life** - Life Quality Improving lifestyle with QoS and QoE in medical care is the definition of quality of life (QoL). High QoL with communication technology will be possible with 6G technology. While quality of life is not a fundamental feature of 6G communication technology, it will be in intelligent health systems. High QoE and the desired QoL metrics will be possible with 6G. QoL is primarily measured by a number of parameters that will be added in the future, such as intelligent wearable devices (IWDs), precision medication, telesurgery, intelligent accident detection, and remote health surveillance of patients, including the elderly. Hospital-to-home (H2H) services are another important aspect of QoL. An intelligent vehicle equipped with mobile hospitals will be used to implement the H2H service. The mobile hospital will need to meet certain standards. In order to enhance modern lifestyles and emergency services, this service

is crucial to QoL. Furthermore, Health Insurance at Hospital (HIH) will be implemented to take the role of the existing health insurance plans. HIH is a component of QoL and will boost trust in hospital services. In the near future, the hospitals will be graded according to QoL factors.

3. ENABLING TECHNOLOGY FOR 6G

The implementation of 6G conversation generation necessitates the presence of accompanying technologies to supply on its commitments. 6G is fundamentally driven via artificial intelligence in its verbal exchange mechanisms, for that reason necessitating the mixing of AI into its operations. Additionally, the appearance of 6G will facilitate the Internet of Everything (IoE), thereby enhancing numerous sectors. Furthermore, the incorporation of part technology is critical in 6G era to deliver Cloud functionalities closer to sophisticated gadgets. Hence, 6G communication generation encompasses a multitude of technological additives.

(a) **Internet of Everything (IOE) -** 6G adheres to the 6Cs framework for communique, involving capture, conversation, cache, cognition, compute, and manipulate. The method of high-degree sensing constitutes the seize aspect, that's important for holographic conversation in healthcare settings. The information captured undergo conversion into virtual format, are saved in a neighborhood cache, and are then transmitted to distant places in real-time. At instances, digital facts are similarly transformed into alerts and relayed to different devices for processing. Cognition plays a crucial function before computing through supporting in generating possible conclusions primarily based on enter digital records. These wise conclusions facilitate the computational process. The computed records are finally transmitted to wise devices to aid in regulating the moves carried out by those devices in healthcare packages. For example, triggering signals associated with epidemics and pandemics. This necessitates the utilization of the center services of greater eMBB and mMTC, requiring excessive facts fees to guide interactive stories on intelligent healthcare gadgets. IoE is vital for 6G to possess a massive ability able to connecting thousands and thousands of clever devices, taking pictures tactile sensations, and changing them into digital information. This expansive capacity is vital for linking sensors and actuators in healthcare conversation, even as additionally making sure minimum latency to preserve seamless integration amongst those additives. Upon commercialization, 6G will usher inside the era of Big Data 2.0 in preference to surely Big Data. Big Data 2.0 needs the utilization of supercomputers to method and examine large portions of small-scale data generated by means of healthcare devices.

(b) **Edge Intelligence-** The idea of Edge Intelligence is pivotal within the realm of 6G technology. The upcoming 6G network is expected to closely rely upon Cloud computing for the storage, computing, and analysis of huge amounts of Big statistics. Although statistics generated by means of sensible gadgets is traditionally sent to the Cloud for garage, this procedure consumes considerable conversation sources and bandwidth. In light of the escalating information volumes, modern-day technology at the moment are being introduced in the direction of the facts supply, giving upward push to the revolutionary Edge technology. 6G is poised to offer seamless services to a multitude of wise gadgets, and a good way to acquire this feat, it's going to heavily depend upon Edge era. This dependency stems from the important need to provide excessive-velocity Internet services to shrewd gadgets, in particular in essential sectors such as healthcare. Edge generation facilitates the real-time collection, computation, and evaluation of fitness statistics within its Edge nodes. Positioned in close proximity to the smart clinical devices, these nodes play a pivotal position in processing the fitness information generated by using users. Subsequently, the Edge nodes engage in the analysis of this statistics to determine appropriate actions. For example, upon receiving fitness records from clever scientific gadgets, an Edge node can rapidly verify whether the consumer is experiencing any fitness problems. The non-stop transmission of fitness-associated facts to the Edge nodes allows them to correctly screen and filter this statistic. Moreover, crucial health facts are transmitted to the Cloud for garage after being processed by means of the Edge nodes. In addition to streamlining verbal exchange and computation methods, Edge technology boasts several benefits consisting of decreased charges, low latency, better reliability, improved privateness, scalability, and adaptableness. Given the expected inflow of shrewd devices connecting to the 6G Internet, the adoption of Edge technology is predicted to seriously decorate 6G's capability to deliver exceptional services, particularly inside the realm of healthcare. The fusion of aspect computing and Artificial Intelligence (AI) heralds the emergence of Edge intelligence. This state-of-the-art paradigm leverages AI algorithms for analysis

inside specialized Edge nodes called Edge analytics. Equipped to handle huge volumes of health-associated records, Edge nodes rely upon AI to discern styles and behavior thorough analyses. AI competencies also make bigger to developing image, facts, and video Edge analytics. Noteworthy improvements in this area consist of Giga Sight, a video Edge analytics solution offering a decentralized hybrid cloud architecture. Furthermore, researchers like Xie et al. Have delivered revolutionary video analytics strategies that include light-weight virtualization through container era. Additionally, Nikolaou et al. Have proposed predictive Edge analytics for statistics filtering within Edge nodes, whilst Cao et al. Have added descriptive analytics tailored for cellular Edge nodes. Despite the promising potentialities of AI algorithms, their computationally intensive nature poses challenges, specially in phrases of aid consumption and electricity utilization. As a result, Edge nodes regularly depend upon Cloud platforms for executing AI algorithms. However, inside the context of 6G networks, Edge nodes are poised to play a pivotal function as AI-enabled community nodes, thereby improving intelligence offerings for healthcare systems. The integration of real-time shrewd Edge competencies within 6G is expected to revolutionize healthcare operations with the aid of facilitating stay statistics computing and evaluation. Consequently, prioritizing the execution of AI algorithms inside Edge nodes, in place of Cloud systems, is critical for minimizing latency and optimizing provider delivery.

(c) **Artificial Intelligence -** The 6G communication network may be characterised by way of a robust reliance on synthetic intelligence (AI) [3], [11]. Its goal is to imbue all sides of network conversation with intelligence to allow the machine to be self-conscious, self-computing, and able to self-reliant decision-making. Achieving global coverage, encompassing space, air, and water, is contingent upon endowing numerous communication factors with intelligence. The deployment of AI algorithms is yielding heightened accuracy and performance in conversation networks. The integration of AI into verbal exchange structures can facilitate real-time communique, a vital requirement in contemporary healthcare. The integration of AI in healthcare has led to upgrades in scientific prognosis and selection-making [12]. The healthcare region necessitates AI to execute tasks in actual time. Deep gaining knowledge of (DL) obviates the want for records preprocessing through directly using uncooked fitness records for computation, allowing real time records input. Moreover, DL demonstrates top notch precision in computing several network parameters [13]. Another AI algorithm currently being explored in healthcare facts is Deep Reinforcement Learning (DRL). DRL includes the device producing preliminary selections, looking at outcomes, and iteratively refining decisions based totally on observations to derive most appropriate answers. By merging reinforcement studying and deep neural community algorithms, DRL leverages the strengths of both to deliver advanced overall performance inside minimal computation time [14]. Additionally, federated AI has the potential to beautify healthcare by using facilitating know-how sharing among clever devices. While AI algorithms have demonstrated excessive overall performance, they necessitate luxurious infrastructure and are preferred for proactive caching. To cope with the demands of Big Data, exploring parallelism in education is critical. Despite excelling at excessive-computation obligations, AI algorithms are time-ingesting and power-extensive. Unlike 6G, which cannot offer such leniency, the implementation of AI algorithms in 6G might also encounter challenges, together with the inclusion of several layers in Neural Networks. Nevertheless, ongoing research endeavors are targeted on refining AI algorithms to lessen computation time and power intake, thereby enhancing 6G performance and healthcare performance.

(d) **Holographic Communication -** Holographic verbal exchange encompasses the physical recording of an interference sample to supply a three-D light area via diffraction, producing pix with parallax, depth, and other characteristics of the original object [15]. Cameras from various angles are hired in holographic communique to create holographic representations of items, utilizing a mix of more suitable eMBB and URLLC to provide super provider and movement HD videos, necessitating high facts quotes and minimal latency for real-time voice and set off manipulate responses [1]. The introduction of holographic communication is poised to revolutionize healthcare, with 6G placed to deliver this service, facilitating connections between people. In emergent situations, expert doctors can remotely diagnose patients through holographic communication at the same time as on the circulate, guiding on-web site docs for set off clinical intervention. This era eliminates the want for patients to are looking for more than one opinions throughout one-of-a-kind locations or countries, assuaging each monetary and bodily burdens. By permitting remote

prognosis, patients handiest want to go to healthcare centers for remedy. Additionally, holographic communique empowers professional docs to increase their offerings to far flung rural areas from city centers, similar to the global coverage offered with the aid of 6G, fostering global healthcare connectivity. Expert doctors can right away provide services upon request without adjusting their schedules or traveling, and facilitate worldwide collaboration among healthcare experts to cope with complicated medical instances

4. INTELLIGENT INTERENT OF MEDICAL THING

In the framework of the 6G communication paradigm, the Intelligent Internet of Medical Things, or IIoMT, will progress and carry out many tasks for the benefit of humankind. IIoMT are smart, artificial intelligence (AI)-powered devices that use communication technology to decide for themselves. IoE, which enables medical devices to be connected to the Internet, will also emerge alongside IIoMT. MRI and CT scans, for instance. The scanner will scan the gadgets and transfer the data to distant places via 6G technology, as depicted in Figure 1. A pathologist can quickly review this data. Almost all medical devices will have Internet connectivity, which will facilitate speedy decision-making. Time, space, and money will therefore not be a barrier for IIoMT.

(a) **Sample Reader for Blood -** Blood tests are necessary for the diagnosis of most issues, and they are essential to human health. In order to draw blood, patients are given needle injections during traditional blood collection procedures. Nonetheless, a lot of research is being done on blood collection systems without needles. As an illustration, Lipani et al. Provide a unique needle-free glucose monitoring method for individuals with diabetes [16]. Needles are not needed with the wearable, intelligent Blood Sample Reader (BSR). BSR sensors are going to alter the health sector. All blood parameters, including WBC and RBC, can be suitably examined by BSR. This BSR sensor will still be able to access the 6G Internet. A blood pattern will be sent to a checking out facility on a regular basis for assessment.

(b) **Intelligent Wearable Devices -** Test and tracking centers get psychological and physical records from Intelligent Wearable Devices (IWD) which can be on-line. The heartbeat, blood stress, blood exams, health troubles, body weight, and diet will all be tracked by way of these devices. You will get hold of the check end result directly. Additionally, IWD gains expertise from the person's unique clinical records to counsel them at the great direction of movement, including going for a run or a walk. IWD will preserve a file of their man or woman nutritional, behavioral, and health histories. IWD is therefore capable of suggest ingredients in the occasion of a shortfall. The frequency of hospital visits will lower with the detection of teenybopper fitness situations like deficiencies. Thus, it'll lower health center costs and loose up resources for greater complicated ailments.

5. HOSPITAL-TO-HOME SERVICES

Through the HCAs of proper now, ambulance offerings best pass sufferers who require oxygen and priority over different site visitors. Because there is no intelligence, it does now not satisfy the role of an emergency carrier. Thus, our lives aren't impacted by way of the ambulance services. If we have oxygen and an emergency signal with us, any normal automobile can serve the identical functions. Thus, in an effort to enhance dwelling, a brand new kind of ambulance provider is wanted.2H services.

Hospital-to-Home (H2H) services can be delivered to replace ambulance offerings. The improvement of communique generation has made it possible for hospitals to touch houses while wanted, such as at some point of an emergency. In order to create wise cars, future cars can be absolutely AI-pushed [17]. As a result, H2H can be deployed on a platform for sensible cars for cell hospitals, lowering the want for hospitals and their staff of physicians and nurses. Ambulance services will be replaced by this cell clinic. For instance, a cellular hospital responds to a twist of fate at once upon detection. The sufferers will then begin receiving care from the cell sanatorium previous to them arriving at the hospitals. Additionally, a cell clinic can respond immediately to any emergency and shop lives on the spot. It will improve modern-day dwelling as well.

6. PRECISION MEDICINE

Creating a medication or treatment that is specifically tailored for a patient is known as precision medicine [18]. For advancements in precision medicine in order to conduct research, physicians and researchers classify patients according to a shared criterion. Precision medicine can benefit immensely from the development of 6G technology. Moreover, AI is needed to deliver customized healthcare [19]. The clinical trial participants' health data is necessary for the better development of treatments. For example, studies on cell therapy are conducted to treat serious illnesses [20], [21]. Using IWD, medical professionals and researchers can gather data. Accurate health data will be provided thanks to the real-time collection of this data. Additionally, the study is able to be carried out worldwide. The immunological system of an individual is influenced by their geographic conditions.

7. SECURITY, SECRECY AND PRIVACY

The primary goals of 6G-based technology are to provide more dependable service and improved security [4]. To enhance security, we wish to incorporate secure URLLC (sURLLC) to counteract protection attacks. We employ AI, quantum computing, quantum machine learning, and THz correspondence to assure efficiency when managing large amounts of healthcare data. Protecting patient data from hackers is so essential. In order to close the safety gap, edge computing in the 6G era must be enforced.

The three main concerns of the 6G era are security, confidentiality, and privacy [4]. Therefore, 6G requires stable URLLC (URLLC) for more consistent communication. 6G communication technology promises the highest level of security. Federated AI, quantum machine learning, quantum computing, and THz verbal exchange might be used to push back the onslaught. THz verbal exchange is impenetrable to jammers and eavesdroppers [3]. High protection is wanted while transmitting facts over a network in the healthcare industry. A patient will be killed by using any modification to health statistics. Thus, safeguarding health statistics from hackers is essential. Furthermore, the confidentiality of the maximum sensitive statistics is a key thing of 6G conversation technology. All parties other than the facts owner are prohibited from gaining access to sensitive information. Administrators also are no longer allowed to read this personal information. Take family records, for instance.

Furthermore, 6G emphasizes privateness, which is an essential element of healthcare. Additionally, 6G will use Edge technology to reinforce privacy. The Edge nodes are situated closer to shrewd gadgets. The equal Edge nodes also examine the computed information. Since area nodes have constrained memory, not all the information is saved in a single vicinity. As such, Edge protects the person's privateness. The Edge nodes' information filtering is another crucial point. Edge nodes sift through the records, sending simply the maximum vital records to the cloud. It additionally outcomes in much less consumer data being saved in the cloud. As a result, Cloud finds it less difficult to steady smaller quantities of statistics.

8. CONCLUSION

Intelligent medical remedy desires to enhance QoL. More precisely, IIoMT, IWD, H2H, and HIH made up intelligent healthcare. Excellent cell connectivity, AI integration, and aid from facet and cloud computing are all vital for IIoMT. BSR sensors are critical to IIoMT. We have not but developed BSR sensors. A lot of the troubles in healthcare may be resolved via BSR. Thus, the research community wishes to give BSR sensor quite a few attentions. IWD is but any other famous IIoMT. IWD is about to revolutionize the healthcare industry with their array of sensors, which incorporates BSR. It will appreciably improve a person's health and help within the computerized identification of several disorders. Additionally, someone does no longer need to go to a sanatorium for recurring examinations, together with blood checks or blood Currently, ambulance services simplest pass sufferers with rudimentary scientific supplies. H2H services need to take the region of this one. Since H2H carrier h a s the capacity to keep billions of lives, smart vehicles ought to immediately combine it. Additionally, using H2H service can decrease the coincidence loss of life charge. To in addition guide shrewd healthcare, the clinic wishes to implement new enterprise regulations. Hospitals' modern enterprise models include direct fee and medical insurance. Only a limited variety of illnesses are covered by means of the medical health insurance,

including COVID-19, the Ebola virus, being pregnant, and childbirth. The HIH commercial enterprise concept promises to offer simply hassle-free care without charge.

9. FUTURE SCOPE

Future state-of-the-art fitness care networks will in all likelihood combine elements of both 5G and 6G networks, as well as fog and cloud computing, Internet of Things (IoT) gadgets, and advancing organizational inclusion, execution, and security worries. The worldwide framework for 5G development has accelerated. Its additives make it ideal for enabling huge advancements inside the power and shortcoming of labeled human administrations programs, consisting of virtualization concepts, more basic handling of massive imaging statistics, in building facts across the board, and far-flung affected person checking [8]. Another correspondence invention will quickly surpass scientific offerings in importance.

Referred to as 6G, it is predicted to effect several industries, along with healthcare. Healthcare will be closely impacted by the 6G association and pc-based totally intelligence driven care.

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Generative AI: A Review Study

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ABSTRACT

This research paper provides a comprehensive review of generative AI, encompassing its underlying technologies, applications, and implications. Generative AI, including models such as GPT-4 and GANs, has rapidly evolved, enabling and creation of text, images, music, and other media with high fidelity and creativity. The review synthesizes current advancements in generative AI architectures, training methodologies, and deployment strategies, highlighting their capabilities and limitations. Key applications across various sectors, such as content creation, healthcare, education, and entertainment, are examined to illustrate the transformative potential of these technologies. Additionally, the paper addresses critical ethical, social, and technical challenges associated with generative AI, including issues of bias, intellectual property, privacy, and the environmental impact of training large-scale models. Through an analysis of existing literature and case studies, the paper provides insights into future directions for research and development, advocating for responsible innovation practices. The finding underscore the need for interdisciplinary collaboration to harness the benefits of generative AI while mitigation its risks, ensuring that its integration into society is both effective and equitable.

Keywords: Generative AI, Chat GPT, AI Content, Traditional AI, Challenges.

1. INTRODUCTION

We are living in the age of artificial intelligence. At present, AI has broken all the barriers which were earlier impossible for humans. Artificial intelligence has been transforming many industries, such as healthcare, where it helps doctors identify disease patterns, streamline the experience, and improve patient care. In the beginning of the first AI we learned how human's ability to think, understand and perform actions can be inbuilt in machines. Gradually we saw many changes. Used image based searching technique with the help of computer vision. Then more innovation happened and with the help of deep learning we came to know how image editing and video editing can be done with perfection. Generative AI was born as a subset of AI. Gen AI is such a branch of AI which can answer your questions in your own language. It can create new content by following your instructions. Generative AI has the creative capability by which it can do all those tasks for you that would take a lot of time for a common man to do. Whether you want to write a story, write a poem, create an image, design a website, write a blog or learn new skills. Gen AI can tell you everything and can give you solution to your every problem within seconds. With the help of Generative AI, revolutionary changes have taken place in every field.

2. GENERATIVE AI VS TRADITIONAL AI

Gen AI is a branch of AI that enables machine to learn patterns from vast data sets and then to automatically produce new content based on those patterns. GEN AI is like a magic box. We just wish them what we want. The best example of Gen AI is Chat GPT. With the help of which you can get solution to any kind of problem. It works on natural language processing and can give text suggestions. Its updated version GPT 4.o is one step ahead. With the help of GPT4, we can input data in different formats like image, video, audio, file etc. Gen AI can create new content. It can give you knew idea's, can create new painting, generate new images, create a website, and prepare personalized study material for students.

Traditional AI tools would just follow the instructions given by us and give output based on a predefined dataset. That is, a machine model in which all the instructions were fed in advance as to what solution is to be suggested for which problem. For example, in an online chess game all the moves are fed in advance. The computer takes the next move based on the instruction given by user. The computer does not take any new or innovative move, nor does it generate anything unique, it just processes the previous dataset. It selects the best pearls of data from the sea of internet.

Fig 1: Traditional AI VS Generative AI (Source: cubetech.com)

3. ARTIFICIAL INTELLIGENCE TOOLS

AI is rapidly evolving technology with many new tools emerging for different use cases. We can divide these AI tools in various categories like text based, image editing, image generator, AI assistant etc.

(a) Text-based tools - These tools are designed to understand and generate human-like responses to text-based, natural language prompts. They can generate text and code, translate language, write different kinds of creative content, and answer our questions in a conversational way.[1] –[2]

   i   **Google Gemini -** It is text based AI chatbot that is publicly available formerly knonw as BARD.

   ii   **Microsoft Copilot-** It is text-based AI chatbot. It can generate images also. It is publicly available.

   iii   **OpenAI ChatGPT -** It is text-based AI chatbot. It is also capable to generating images. But it has limited access coordinated by schools and units.

   iv   **Duolingo -** It is a Generative AI based app that is useful for learn new language. It is a personalized learning app. By using this app student can learn new language very faster way.

(b) Image-based tools- These tools enable us to generate images and text effects by simply typing key words or a description using natural language prompts.

   i   **Adobe firefly -** By using this tools we can generate images and text effects by simply typing key words or a description. Trained on stock images, openly licensed and public domain content.

   ii   **Photomath -** This app is launch by google for helping learner to learn, practice and understand maths problems with step by step.

(c) Assessment Tools - There are a lot of assessment tools that are designed to assist teachers in evaluating student performance, providing feedback, and streamlining the assessment process. AI-driven assessment tools must be rigorously validated to ensure their reliability and validity in measuring student learning outcomes.

   i   **Turnitin-** It is widely used AI powered tool that checks student submission for plagiarism and provides originality reports to educators. It helps teachers ensure academic integrity and maintain high standards of authenticity in student work.

   ii   **Grade Cam -** It is an assessment tool that use AI to grade mcq assessment, quizzes and assignment quickly.

   iii   **Proctorio -** it is an AI based proctoring tool that helps teachers, to ensure exam integrity in online assessments. The tool uses AI algorithms to monitor student behaviour during exams, detect suspicious activities, and prevent cheating.

iv **Edulastic:** Edulastic is an AI-enhanced assessment platform that allows teachers to create and deliver online assessments, analyze student performance data, and generate detailed reports. The platform uses AI to provide insights into student learning gaps and strengths.

v **Grammarly -** It is a cloud based typing assistant application, which is review spelling, grammar, punctuation, clarity engagement. It uses AI for detect plagiarism, identified error in content writing.

Apart from all this, there are a lot of apps that help us increasing productivity by using AI.

Fig. 2: Artificial Intelligence Tools (Source : https://theprocesshacker.com)

4. GEN AI IMPACT ON EDUCATION SYSTEM

The integration of generative AI in education offers a myriad of opportunities to enhance learning experiences. Personalized learning, tailored to individual needs and preferences, emerges as a prominent advantages of leveraging AI in education. Gen AI can generate custom quiz that belongs to specific learning objectives of course. These quizzes can help students to understand the topic and help teachers to formative assessment of students. It can also generate essay prompt for students to respond to allowing for a more personalized and diverse set of assignments. AI can provide feedback on various type of assignment, like coding, mathematical problem etc. This feedback can help students identify errors, better understanding of concept and improve their problem solving skills. Gen AI can analyse students' performance data and provide personalized learning based on their strength and weaknesses. This adaptive feedback can help students progress at their own pace and focus on areas that need improvements. [8]

By leveraging Gen AI as an assessment tool, educators can enhance the feedback process, provide personalized learning experiences, and streamline the assessment and grading process for a more efficient and effective educational experience. Furthermore, AI enables educators to unlock creativity in teaching and learning, fostering innovation and experimentation in educational practices. AI-driven content creation tools empower educators and students to generate multimedia artifacts such as videos, animations, and interactive simulations, facilitating active learning experiences and enhancing engagement. [7]

5. CHALLENGES OF AI

"When we think about the future of internet I would guess that 90% of content will no longer be generated by humans. It will be generated by bots. " - Latanya Sweeney (Computer Scientist)

AI is not a technology of the future; we are living in it now. Today every important application that is becoming popular is using AI, whether it is image editing, web designing, or research writing. Gen AI is destroying the creativity of humans because apps like chat GPT can create stories, poems, arts in few minutes, they can also keep creating without fatigue, then the need of humans will reduce in these areas and there will be a crisis of employment.

In the past few years, we have seen such viral deep fake videos in which people's photos were misused without their permission,

That is, AI is being misused. In some cases, we also saw that online fraud was done by creating voice clones with the help of AI tools, the AI voice chat app was used wrongly. AI has benefits as well as disadvantages. It depends on us how we utilize it. [6]

(a) **Job crisis** - As we have seen, with the advent of Gen AI, all our online work can be done quickly and easily by our robots, for which we will no longer need humans. This is true for every fresh graduate; According to India Today's resources, 36% of IIT Bombay graduates fail to get placement. That's signalling challenges in the job market and raising concerns about unemployment. I think the main reason for this is the increased use of GEN AI because most of the work in the field of technology is done online on computer or laptop, like website, software development and designing. Now language models like chat GPT can generate code for any website, design graphics, so nowadays every big company has AI tools to produce more in less time, to increase their marketing. So those who study in this field will become unemployed after graduation. If the use of AI continues to increase like this, then one-day people will stop getting jobs.

(b) **Fake content** - With the help of Gen AI, hackers create fake content in huge amount. Many times internet users get trapped in their trap because the content created with AI tools looks so real that a normal user cannot differentiate between right and wrong. We know that after the advent of Gen AI, the internet is filled with fake content. People are also committing online fraud through various types of voice chat apps. Every day we get to read news in the newspaper that people have become victims of online fraud. Hackers are taking wrong advantage of AI tools. Sometimes people misuse AI tools for their

(c) own enjoyment or to increase followers on social media, due to which common people have to face problems. [3]-[4] To address potential misuse in education, AI-generated content detectors such as Turnitin could be used and strict proctoring measures will need to be deployed. [9]

(d) **Lack of efficiency of students** – In the field of academic writing and language learning, student's writing habits are changing due to the rise of new technologies and the internet. New kind of AI-powered writing tools have emerged that are often freely available on the internet. With the use of these AI tools, children will not develop intellectually and their mental skills will decrease. In earlier times, children depended on books or their teachers to get the information, their search process remained a mystery but due to AI tools, now the information will be easily available to them and they can learn and write new things on their own; Thinking will be less which will help in their development and along with it the feeling will come to the students. [5]

6. CONCLUSION

That day is not far when we will be completely dependent on AI tools for all our small and big tasks. The speed with which AI is becoming a part of our daily routine is indeed a matter of concern. We need to be alert in time. Use AI tools in limited quantity. AI tools give better production capacity but they should not become a threat to the future of humans, therefore it is important that we change our habits, reduce dependency on AI tools, and also develop a habit of reading books because the knowledge we gain is from AI They have acquired that knowledge from books only. It will just take time. We can make AI our strength and not our weakness, awareness is necessary to avoid fraud due to misuse of AI tools, such initiatives should be started by tech companies on how to identify AI

generated content and whether it is fake or not. By prioritizing data privacy, mitigating algorithms bias, promoting transparency and accountability, and preserving human agency, educators and policymakers can harness the transformative potential of AI to create inclusive, empowering, and ethical learning environments for all learners. [8]

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A Study of Consumer Behaviour towards Organized and Unorganized Grocery Retailing in Bhopal Division of Madhya Pradesh

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ABSTRACT

The objective of this research paper is to analyze the consumer behavior towards Organized and Unorganized retailing in Bhopal division. Consumer behavior in the food sector is influenced by various factors including price, convenience, quality, and perception of safety. This paper examines the differences in consumer behavior between organized and unorganized food sectors, focusing on purchasing patterns, preferences, and decision-making processes. Through a comparative analysis, it highlights the impact of organizational structure, marketing strategies, and consumer trust on these behaviors. The food sector is a critical component of the global economy, encompassing both organized and unorganized segments. This paper explores consumer behavior within these two sectors, aiming to understand the differences in consumer preferences, purchasing patterns, and decision-making processes. By examining various factors influencing consumer choices such as quality, price, convenience, and trust, this research provides insights into how businesses can strategize to cater effectively to consumer needs in both organized and unorganized food sectors.

Keywords: Organized retailing, Unorganized retailing, Consumer behavior, price sensitivity, quality assurance, marketing strategies, consumer trust.

1. INTRODUCTION

The Indian retail sector is highly fragmented with 95 per cent of its business being run by the unorganized retailers. The organized retail however is at a very nascent stage. The sector is the largest source of employment after agriculture, and has deep penetration into rural India generating more than 10 per cent of India"s GDP. The food industry is characterized by its diversity, ranging from multinational corporations in the organized sector to small-scale vendors and local markets in the unorganized sector. Understanding consumer behaviour within these segments is crucial for businesses to tailor their strategies effectively. This paper aims to analyse and compare consumer behaviour in organized and unorganized food sectors, highlighting key factors influencing consumer choices.

2. FOOD AND GROCERY RETAILING

The food and grocery sector in India is witnessing a remarkable change in retailing patterns. Food retailing is coming of age from a period when food items were sold in small road side grocer shops and Mandis, Haats and bazaars by vendors to a stage when food and groceries are retailed through supermarket stores where consumers can inspect, select and pick up the products they like in a comfortable ambience and still pay a fair price for the product and the merchandise. Traditionally, Indians were used to buying their sugar, wheat, pulses, rice etc. from their neighbourhood store. The majority of food and food products were and still are retailed through neighbourhood Kirana stores. The majority of fresh produce is sold from the carts of traveling vendors. Such produce is deemed to be of low product quality, variety and hygiene. The retail food industry is revolutionizing the shopping experience of Indian customers. Growing at the rate of 30%, the Indian food retail is going to be and no doubt is the major driving force for the retail industry. Food accounts for the largest share of consumer spending. Food and food products account for about 50% of the value of final private consumption. Food has the largest consumption in the Indian economy and will remain the single largest category.

(a) **Overview of Organized and Unorganized Food Sectors:**
- **Organized Sector:** Comprises large-scale retailers, supermarkets, and restaurant chains characterized by standardized products, extensive distribution networks, and formal business operations.
- **Unorganized Sector:** Includes small independent retailers, street vendors, and local markets characterized by informal operations, variable product quality, and personalized customer interactions.

(b) Factors Influencing Consumer Behaviour:
- **Quality and Safety:** Consumers in both sectors prioritize food quality and safety, but perceptions and expectations may differ. Organized sectors often emphasize standardized quality assurance processes, while unorganized sectors rely on personal relationships and local reputations.
- **Price Sensitivity:** Price sensitivity varies between sectors; consumers in the unorganized sector may be more price-sensitive due to lower income levels and perceived affordability.
- **Convenience:** Organized sectors offer convenience through online platforms, home delivery services, and multiple payment options, whereas unorganized sectors rely on physical accessibility and personalized service.
- **Brand Loyalty and Trust:** Established brands in the organized sector benefit from brand loyalty and trust built through consistent product quality and marketing efforts. In contrast, trust in the unorganized sector is often based on personal relationships and word-of-mouth recommendations.

(c) Consumer Decision-Making Process:

Fig 1: Stages of the Consumer Decision-Making Process

(d) Implications for Businesses:
- Marketing Strategies: Tailor marketing messages to align with consumer preferences in each sector. Use digital marketing for the organized sector and community-based marketing for the unorganized sector.

- Product Development: Innovate to meet diverse consumer needs, focusing on quality improvement in the unorganized sector and convenience enhancements in the organized sector.
- Distribution Channels: Optimize distribution channels based on consumer preferences for physical stores, online platforms, or mobile marketplaces.

Fig 2: Interrelationship Between Marketing Strategies, Product Development, and Distribution Channels

3. REVIEW OF LITERATURE

(a) In their study titled "A Consumer Buying Behavior towards Retail Stores in Chennai District" [1], D observed that consumers' shopping preferences were predominantly shaped by factors such as reasonable pricing, product quality, excellent service, and convenient store accessibility.

(b) Hasan and Mishra [2] investigated the primary drivers influencing customer shopping behaviour in the retail market. They concluded that factors like shopping experience, store reputation, and perceived value for money significantly influence consumer purchasing decisions. Improving merchandise display,

maintaining store cleanliness, and reducing checkout times can enhance overall customer satisfaction during the buying process.

(c) Dr. Atul Pandey and Dr. Rahil Yusuf Zai [3] conducted a study titled "Window Display in Garments and Groceries Retailing: A Study of Rewa City," which explored the connection between window displays and consumer response, delving into insights into buyer psychology. The study also investigated how demographic patterns influence consumer perceptions of window displays.

(d) In another study, Biranchi Narayan Swar [4] authored "Challenges and Opportunities of Organized Retailing in India," published in the Journal of IMS Group Vol-4, July-Dec 2007. This research provides comprehensive insights into the Indian retail sector at both macro and micro levels. It highlights the potential for organized retailing in India, emphasizing the importance of infrastructure development and efficient supply chains crucial for modern retail operations.

(e) Anjali Kaushik and Satya Bandhu Gupta authored "Retail Industry: Problems and Challenges," [5] published in the bi-annual journal of the Institute of Management Education, June 2006. This paper provides an overview of the current landscape of Indian retailing, addressing the challenges and opportunities within the sector.

(f) S.A. Shaw and J. Gibbs wrote "Procurement Strategies of Small Retailers Faced with Uncertainty: An Analysis of Choice and Behaviour," which appears in the International Review of Retail, Distribution, and Consumer Research.[6]

4. OBJECTIVES

(a) To study how demographic factors (Education, Age, Income, Gender, etc.) influence consumer preferences in selecting retail outlets.

(b) To compare the frequency of purchases between unorganized and organized retail outlets.

(c) To analyse the factors (Product, Price, Promotion, Service, Process, etc.) that impact consumers' decisions to purchase from various retail outlets.

5. METHODOLOGY

This study is descriptive in nature and utilizes primarily primary data obtained through a survey aimed at analysing respondent behaviour. The data collection employed the stratified random sampling technique, selecting 100 respondents randomly from the Bhopal Division region. A structured questionnaire was developed for the survey, covering demographic segmentation, purchase frequency, and determining factors influencing retail outlet choices.The study focused on the Bhopal Division Region, which comprises five districts: Bhopal, Sehore, Vidisha, Raisen, and Rajgarh. Secondary data from the 2011 census report supplemented the study's background information. Data analysis involved statistical methods such as the Chi-square test for significance, the F distribution for testing variance equality, and Standard Deviation to examine data variability.

6. DATA ANALYSIS AND RESULTS

Data from the census report indicated significant urban population growth in the Bhopal region between 2001 and 2011. According to the 2011 census, the highest percentage of the population in the Bhopal division resides in urban areas, followed by Vidisha, Raisen, Sehore, and Rajgarh. This trend underscores the increasing acceptance and expansion of various retail formats in the Bhopal division. The rapid adoption of urban lifestyles and the emergence of mall culture have played pivotal roles in fostering the growth of organized retail in this region.

Table 1: Demographic and Socio Economic Profile of respondents of Bhopal Division.

Variable	Attribute	Respondents Frequency (In %)
FAMILY SIZE	2-4 MEMBERS	56
	4 MEMBERS AND ABOVE	44
FAMILY TYPE	NUCLEAR	71
	JOINT	29
MONTHLY INCOME	BELOW10000	2
	10000-25000	19
	25000-45000	36
	45000-100000	32
	ABOVE 100000	11
AGE	BELOW 20	3
	20-29	49
	30-39	17
	40-59	12
	OVER 60	13
GENDER	MALE	49
	FEMALE	51
EDUCATION	BELOW 10TH	1
	12TH /DIPLOMA	6
	GRADUATE	27
	POST GRADUATE AND ABOVE	66
PROFESSION	HOUSE WIFE	14
	SALARIED	29
	BUSINESS	17
	OTHERS	40
MARITAL STATUS	Married	78
	Unmarried	22

To assess the influence of demographic and socio-economic factors on consumers' choice of retail outlets, various attributes such as age, gender, marital status, education level, occupation, monthly household income, and family structure were considered. The study revealed that the largest segment of respondents in Bhopal fell within the 20-29 age range, comprising 48% of the sampled population, followed by those aged 30-39, accounting for 17%. Additionally, 78% of respondents were married. Family sizes varied, with 56% having 2-4 members and 44% consisting of 4 or more members. Respondents represented diverse professions, including business owners, salaried employees, housewives, consultants, and educators. Notably, approximately one-third of the population held a postgraduate degree or higher.

With these objectives in mind, the study aimed to determine how these demographic and socio-economic factors influence consumers' preferences for different retail outlet formats.

(a) **Test of Significance:** A Pearson chi-square test was employed to investigate the relationship or association between demographic factors and the selection of retail outlets. Hypotheses were formulated to explore the non-random variation among categorical variables, such as age group and retail preferences, and to assess the influence of gender on purchasing behaviour.

(b) **Age Group Impact on Retail Outlet Selection**

- **Null Hypothesis (Ho):** -The age group of the respondents does not influence their selection of retail outlets
- **Alternative hypothesis (Ha)-** The age group of the respondents influence their selection of retail outlets

Table 2: chi-square test on the age group

Age Group	Actual		Expected	
	Organised	Unorganised	Organised	Unorganised
BELOW 20	1	2	1.71	1.29
20-29	26	22	27.23	20.51
30-39	12	6	10.20	8.50
40-49	2	9	6.22	4.22
50-59	11	3	7.9	6.09
OVER 60	0	6	3.42	2.58
Total	52	48	56.68	43.32

Chi Square Critical Value- 10.070498 (Confidence level-95%, degree of freedom-5)
Chi Square Calculated Value--0.001880273

- **Interpretation-** As Chi Square calculated value 0.001880273 < critical value 10.070498. Hence accepting the null hypothesis and rejecting the alternative, it was concluded that the age group of the respondents and choice of retail format was statistically independent variable. It means that age group has no impact on the choice of retail outlet.

(c) **Gender Impact on the choice of retail Outlet Hypothesis:**
- **Null Hypothesis (Ho):** -The choice of retail format (organized and unorganized) is not dependent on the gender of the respondents.
- **Alternative hypothesis (Ha):** - The choice of retail format (organized and unorganized) dependent on the gender of the respondents.

Table 3: Gender Impact on decision making to choose retail outlet

Gender	Actual		Expected	
	Organised	Unorganised	Organised	Unorganised
MALE	27	21	27.36	20.64
FEMALE	30	22	29.64	22.36
TOTAL	57	43	57	43

Chi Square Critical Value- 3.741459139 (Confidence level-95%, degree of freedom-5)
Chi Square Calculated Value-- 0.874277609

Interpretation Since 0.874277609 < 3.741459139, $\chi 2$ is not in the rejection region, hence null hypothesis cannot be rejected. Thus it was concluded that there was no impact of respondent's gender on the choice of retail format.

(d) **Education Status Impact on the Choice of Retail Outlet-**
- **Null Hypothesis (Ho):** -The choice of retail format is not influenced by the level of education of the respondents.
- **Alternative hypothesis (Ha):** - The choice of retail format is influenced by the level of education of the respondents.

Table 4: Test of significance on the role of education status and the choice of different retail outlet

EDUCATION	Actual		Expected	
	Organised	Unorganised	Organised	Unorganised
BELOW 10TH	0	1	0.57	0.43
12TH/ DIPLOMA	2	4	3.42	2.58
GRADUATE	14	12	14.22	12.78
PG AND ABOVE	40	27	38.18	28.82
TOTAL				

Chi Square Critical Value- 7.114727764 (Confidence level-95%, degree of freedom-5)
Chi Square Calculated Value-- 0.51655

Interpretation The above table shows that the $\chi 2 <$ critical value, hence we cannot reject the null hypothesis. It was concluded that the two variables the level of education of the respondents and decision to choice retail format both are independent variables.

(e) Income Impact on the choice of Retail Outlet
- **Null Hypothesis (Ho):** -The choice of retail format is not associated with the income levels of the respondents.
- **Alternative hypothesis (Ha):** - The choice of retail format is associated with the income levels of the respondents.

Table 5: Impact of Income of the respondents on the choice of retail format

EDUCATION	Actual		Expected	
	Organised	Unorganised	Organised	Unorganised
BELOW10000	0	2	1.14	0.86
10000-25000	3	17	11.4	8.6
25000-45000	26	9	19.95	15.05
45000-100000	18	15	18.81	14.19
ABOVE 100000	10	0	5.7	4.3

Chi Square Critical Value- 9.587729037 Confidence level-95%, degree of freedom-5)
Chi Square Calculated Value--: 9.1746E-06

Interpretation Since the calculated $\chi 2$ (9.1746E-06) is less than the tabulated (9.587729037), it implies that the result of the chi test gives a strong support to the claim that monthly household income and choice of retail format both are independent variables.

Test for Equality of Variance: Bhopal Division of Madhya Pradesh

Table 6: Frequency of purchase of Grocery Products by Respondents (%age)

Grocery categories	Monthly	Twice a Month	Weekly	Twice/Thrice a week	Daily
DAIRY PRODUCTS	0	0	10	10	80
BEVERAGES	46	29	9	16	0
SPICES	71	18	1	10	0
FRUITS	0	0	22	40	38
STAPLE FOOD	66	30	4	0	0
TOILETTES	77	22	1	0	0
PERSONAL CARE	71	24	5	0	0

STATIONARY AND KIDS ITEMS	61	25	12	0	2
FROZEN FOOD	45	36	17	0	2
TOTAL (IN %)	48.3	21.5	8.8	9.2	12.2

- **Null Hypothesis(Ho): -**Frequency of purchase from organized and unorganized retail is not equal in Bhopal Division

$$Ho: \text{organized retail } \sigma2 \neq \text{unorganized retail } \sigma2$$

- **Alternative hypothesis (Ha):-** Frequency of purchase from organized and unorganized retail is equal in Bhopal Division

$$Ha: \text{organized retail } \sigma^2 = \text{unorganized retail } \sigma^2$$

Table 7: F-test between organized and unorganized retailing on frequency of purchase preferred by Respondent

GROCERY CATEGORIES	ORGANISED			UNORGANISED			F- DISTRIBUTION
	MEAN	SD	VARIANCE	MEAN	SD	VARIANCE	
DAIRY PRODUCTS	1.49	0.76	0.58	1.02	0.15	0.02	24.76
BEVERAGES	4.12	1.02	1.04	3.95	1.19	1.43	1.37
SPICES	4.56	0.82	0.68	4.42	1.07	1.15	1.70
FRUITS	1.91	0.71	0.51	1.74	0.82.	0.67	1.32
STAPLE FOOD	4.53	0.50	0.25	4.74	0.62	0.39	1.52
TOILETTES	4.65	0.48	0.23	4.91	0.37	0.13	1.73
PERSONAL CARE	4.81	0.40	0.16	4.47	0.70	0.49	3.11
STATIONARY AND KIDS ITEMS	4.70	0.46	0.21	4.07	1.10	1.21	5.68
FROZEN FOOD	4.53	0.60	0.36	3.81	1.01	1.01	2.80

(e) Critical Value-1.63.918742

F-Test has been conducted on two different samples taken from organized and unorganized retail shoppers. Here's a summary of the findings based on the F-test results for different categories of products purchased from organized and unorganized retail outlets:

- **Staple Foods (Atta, Rice, Pulses, Oil):** The F-test value (1.52) fell within the non-rejection region, indicating acceptance of the null hypothesis. This suggests that the frequency of purchases for staple foods is similar regardless of whether shoppers buy from organized or unorganized retail outlets.
- **Toilettes:** The F-test value (1.73) exceeded the critical value, leading to rejection of the null hypothesis. This implies that the frequency of purchases for processed foods differs significantly between organized and unorganized retail outlets.
- **Beverages:** The F-test value (1.37) was lower than the critical value (1.63), falling within the non-rejection region. Thus, the null hypothesis cannot be rejected, indicating that the frequency of beverage purchases is similar across both retail formats.
- **Fruits & Vegetables:** The F-test result supports the null hypothesis as the calculated value falls within the non-rejection region. Therefore, the frequency of purchases for fruits and vegetables is alike irrespective of whether shoppers choose organized or unorganized retail.
- **Dairy Products:** The F-test result fell in the rejection region, indicating significant differences in purchase frequency between organized and unorganized retail outlets for dairy products. Thus, the null hypothesis is rejected, suggesting distinct purchasing patterns between the two formats.

- **Spices and Condiments, Frozen Food, Toiletries, Personal Care, Stationery, Toys:** For these categories, the F-test values were sufficiently high to fall into the rejection region, leading to rejection of the null hypothesis. This indicates that purchase frequencies vary significantly between organized and unorganized retail outlets for these product categories.

Overall, the analysis reveals that while purchase frequencies are similar for staple foods, beverages, and fruits/vegetables across both organized and unorganized retail formats, significant differences exist in purchasing patterns for processed foods, dairy products, and several other categories.

7. ATTRIBUTES RESPONSIBLE FOR BUYING DECISION OF GROCERY PRODUCTS

The study also explored the evolving role of marketing strategies in attracting and retaining customers. To assess marketing and service-related factors, respondents were surveyed on attributes such as product quality, pricing, promotional activities, distribution channels, public relations, physical environment, operational processes, and retail service offerings. Consumer perceptions of these attributes were measured using a Likert scale ranging from "Strongly Agree" to "Strongly Disagree."

Data was gathered on consumer perceptions regarding product features, pricing strategies, promotional effectiveness, and distribution methods. Additionally, feedback was collected on operational aspects such as transaction speed and packaging efficiency, as well as service-related amenities like home delivery, parking facilities, payment options, membership benefits, time efficiency, one-stop shopping convenience, and consumer bargaining power. The study highlighted that customers value bundled benefits when making purchasing decisions and underscored the critical importance of these eight major attributes in shaping retail format preferences.

Table 8: Importance of various attributes in purchase of Grocery products by Bhopal Division Respondents

ATTRIBUTES	ORGANISED			UNORGANISED		
	MEAN	SD	MODE	MEAN	SD	MODE
PRODUCT RELATED						
Quality	4.55	5	0.601	4.1	5	0.88
Brand	4.74	5	0.479	3.8	4	1.136
PRICE RELATED						
Less then MRP	3.74	4	0.782	4.15	4	0.530
Credit system	2.92	3	0.777	3.71	4	1.121
PROMOTION RELATED						
Discount	4.00	4	0.378	4.12	4	0.625
Offer	3.87	4	0.422	3.71	4	0.855
PLACE RELATED						
Parking	4.11	4	0.79	4	4	0.722
Distance	4.22	4	0.377	4.12	4	0.622
PUBLIC RELATION						
Customer Care	4.33	5	0.711	3.55	4	0.981
Goodwill	2.91	3	0.755	4.22	4	0.66
PHYSICAL ENVIRONMENT						
Ambience	4.22	4	0.554	2.77	3	0.966
Display	4.3	4	0.52	2.88	4	1.001

Here's a summary of the findings related to different attributes influencing consumers' choice of retail outlets:
(a) **Product attributes:** Respondents favoured organized retail for its wide product range, better quality, multiple brand choices, and fresh stock availability. Unorganized retail was preferred mainly for better quality and variety of sizes.

(b) **Price attributes:** Consumers from unorganized retail emphasized lower prices than MRP and availability of credit systems as significant factors in their choice.

(c) **Promotion attributes:** Discounts, sales promotions, and privilege benefits were highly valued by respondents across both organized and unorganized retail formats.

(d) **Location attributes:** Proximity to residence was crucial for choosing a shopping outlet, irrespective of retail format. Unorganized retail shoppers particularly preferred reliable local shopkeepers.

(e) **Public relation attributes:** Organized retail shoppers appreciated customer care services, which significantly influenced their purchasing decisions. Unorganized retail shoppers valued personalized attention from shopkeepers and local goodwill.

(f) **Physical environment attributes:** Organized retail shoppers preferred systematic product displays and clean store ambience, while responses from unorganized retail shoppers were neutral on display quality.

Overall, the study highlighted that while both organized and unorganized retail formats cater to distinct consumer preferences and priorities, factors such as product range, pricing, promotions, location proximity, customer service, and service offerings significantly influence consumers' decisions in selecting retail outlets.

8. CONCLUSION

The study emphasizes that consumers make purchases from both organized and unorganized retail outlets. It was found that demographic factors such as Age, Gender, Education status, and income do not influence the choice of retail format.

Regarding the frequency of grocery purchases, monthly purchases were most preferred by respondents, followed by twice a month, with daily products being exceptions bought on a daily basis.

The results of the F-test indicated differences in purchase frequency between organized and unorganized retail shoppers for staple foods, processed foods, beverages, and fruits & vegetables. However, no significant frequency differences were observed for daily products, Spices, Frozen Food, Toiletries, Personal Care, Stationery, and Kids items.

Respondents agreed that location and offers are the most critical criteria for choosing an outlet, regardless of its retail format. Attributes such as a wide range of products, efficient billing processes, customer service, parking facilities, and systematic displays attract consumers to organized retail outlets. Conversely, factors like convenience, lower prices compared to MRP, and local goodwill influence consumers to purchase from unorganized retail outlets.

Given the rapid evolution of consumer lifestyles and preferences in the competitive Indian retail industry, both organized and unorganized retailers must innovate continually to attract and retain consumers.

Consumer behaviour in the food sector is shaped by a complex interplay of factors related to price, quality, convenience, and trust. While organized sectors offer standardized products and enhanced consumer trust through branding and regulatory compliance, the unorganized sector appeals to consumers seeking affordability, local flavours, and convenience. Future research could explore evolving consumer preferences amidst technological advancements and changing market dynamics.

9. RECOMMENDATIONS

To thrive in a competitive landscape, stakeholders in both sectors should focus on enhancing product quality, leveraging digital platforms for outreach, and addressing regulatory compliance issues. Building consumer trust through transparent communication and consistent service delivery will be crucial for sustainable growth.

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Internet of Things: A Stepwise Evolution of Net's Evolution

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ABSTRACT

This paper focuses on the future implications of internet of things (IoT). Internet of Things (IoT) refers to a networked collection of physical objects, frequently known as "things," that are ready with sensors, software, and other technology for networking them and allowing statistics alternate between gadgets and structures over the Internet. The importance of the reality that IoT is step by step emerging as the following step within the evolution of the internet can't be underestimated; hence it is important to point out diverse viable regions where IoT can be implemented and their corresponding studies challenges. The IoT is projected to permeate every element of day-by-day existence inclusive of smart cities, healthcare, smart agriculture, logistics and retailing or even smart houses or environments. Despite tremendous advances in present days in IoT enabling technology, there are many issues which nevertheless want to be addressed. Since IoT concept originates from disparate technology many researchers face a plethora of demanding situations. Making development from simple gadgets in the direction of smarter ones (IoT) an increasing number of serves as a stepwise stage in net's evolution; as a consequence, it turns into critical to discover specific capability domains for IoT deployment in conjunction with associated medical troubles. From smart communities through health care shipping to agricultural manufacturing stock control/retail commercial enterprise operations up till home/domestic smartization down all can be covered through this concept called Internet of Things (IOT). Although there has been development on current enablers for IOTs within current years however there remains plenty extra issues that desires addressing. It manner that several studies questions stand up out of various technologies at the back of IOT concept.

Keywords— Internet of Things; IoT applications; IoT demanding situations; destiny technology; smart cities; clever surroundings; clever agriculture; clever living, strength system

1. INTRODUCTION

This Internet may be characterized because the community for communication linking individuals to records, while The Internet of Things denotes an interconnected machine of uniquely addressable bodily entities with varying processing, sensing, and actuation capabilities, able to interoperating and speaking via a shared Internet platform[1].Consequently, the number one intention of interconnected gadgets is to be related with other entities and persons from any area or at any time via numerous networks, pathways, or offerings. The Internet of Things is gradually being identified as the following phase inside the development of the Internet, allowing regular gadgets to hook up with the net to accomplish numerous wonderful objectives. Presently, only a predicted 0.6% of capability IoT gadgets are related [2] yet it is predicted that by way of 2020, greater than 50 billion gadgets will have net connectivity.

As the net evolves, it has transcended from a trifling computer community to a network comprising numerous devices, while IoT features as a network [3] of interconnected gadgets, illustrating a network of networks. In modern-day instances, gadgets which include smartphones, automobiles, business structures, cameras, toys, buildings, and several others can change facts over the Internet. Irrespective of their length or function, these gadgets can carry out intelligent reconfigurations, tracking, positioning, manage, real-time monitoring, and procedure control. In latest years, there has been a extensive proliferation of Internet-capable gadgets, with the maximum outstanding business effect discovered in purchaser electronics, mainly the revolution of smartphones and the recognition of wearable devices. The attention has shifted closer to the convergence of virtual and physical geographical regions as opposed to simply connecting individuals.

Considering those elements, the Internet of Things (IoT) is projected to similarly expand its scope regarding the variety of devices and functionalities it may accommodate. The fluidity in defining "Things" underscores the mission in delineating the increasing obstacles of IoT. Despite ongoing commercial successes, IoT presents a really countless array of opportunities, not most effective in enterprise but additionally in research. As an end result, this observe examines the capacity software domain names of IoT and the research demanding situations related to those applications.

There are a few cool programs in this area which have already been well-established, like the Aware home and the Smart Santander functionalities. In the US, huge towns like Boston are arising with plans to bring the Internet of

Things into exceptional systems, such as parking meters, streetlights, sprinkler structures, and sewage centers. The goal is to connect all this stuff to the net. These programs are anticipated to bring about some main advancements in phrases of saving expenses and strength.

By combining system and person prompts, the aim is to make the assistant's text sound more like it become written by means of a human, whilst still retaining all the important data intact and accurate.

2. APPLICATION OF IOT

Applications of the net of Things are not simplest several but additionally quite various as they penetrate sincerely all factors of each day lives together with individuals, establishments and societies. IoT applications cover a wide range which includes production or Power machine, business sector, health sector, agriculture, smart cities, safety and emergencies and many other areas.
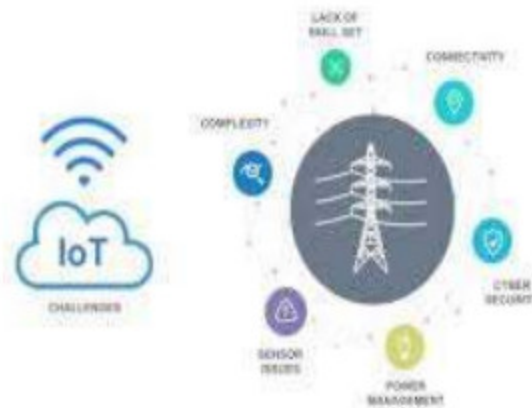

Fig. 1: Power System Using IOT

The Internet of Things (IoT) has made excellent progress in the electric power area, revolutionizing numerous components. The utility of IoT in power structures is a topic well worth exploring:

(a) **Smart Grids:** The implementation of IoT has enabled the improvement of clever grids, which appreciably improve the performance and reliability of electricity distribution. By utilising sensors and conversation networks, clever grids can screen and manipulate power waft, making real-time modifications based totally on demand and supply situations. These grids play a vital function in enhancing energy performance, reducing losses, and improving grid resilience. Smart meters are a vital element of clever grids, offering real-time insights into power intake that permit utilities to optimize load distribution and make sure correct billing.

Millions of smart meters are presently in operation, making them a crucial part of the clever grid. This is how it operates.

(i) **Optimizing Energy Generation and Distribution:** By modifying energy era and distribution in reaction to call for, the clever grid makes better use of the energy this is presently available. This entails connecting clever devices to substations thru Ethernet-primarily based communique, allowing automated and centralized strength go with the flow regulation.

(ii) **Identifying Power Imbalances:** The smart grid's Internet of Things generation assists in determining regions in which there is ever a surplus or deficit of power. By using these statistics, producing stations can modify their output and come online to hold a balanced supply.

(iii) **Real-Time Monitoring and Control:** Unlike conventional structures that depend upon antiquated information, the clever grid collects modern load facts via internet-connected smart meters established at precise patron locations. The usage of this facts therefore allows for greater effective control of the creation and intake of neighbourhood energy.

(iv) Improved Fault Detection and Restoration: By analysing information from clever meters, the smart grid can become aware of issues or interruptions in the electric system extra quick. Maintenance and issuer recovery can continue quicker as a result.

(v) Management of Demand Response: One of the main blessings of an IoT-based totally clever grid is its more advantageous capacity to deal with top call for periods. High-power intake obligations, like jogging home equipment or recharging electric powered cars.

(vi) Decentralized Energy Flow: The clever grid allows bidirectional electricity float among provider carriers and consumers, in comparison to conventional structures that only permit strength to drift from power plants to clients in a unmarried course. This helps the incorporation of renewable energy resources and empowers customers to take an lively role in controlling their energy intake.

Fig. 2: Grids Using IOT

With the usage of IoT in clever grid generation, energy shortages and excesses can be immediately diagnosed, enabling producing stations to step up and fill the space. The clever grid obtains contemporary load statistics rather than relying on previous records through employing internet-related smart meters positioned at precise purchaser locations. Accurate consumer billing results from the greater powerful management of local strength technology and consumption made possible via using this information. Furthermore, by way of using the data from those smart meters, grid problems may be swiftly placed and quicker restoration may be facilitated. The capacity to software excessive-electricity electric gadgets to run when the grid is not as busy is some other benefit of an IoT-based totally clever grid. A smart grid has the subsequent critical grids.

(i) Efficient: It meets evolving patron wishes without requiring the most enormous infrastructure enhancements.

(ii) Reliable: The sensible grid's primary goal is the uninterrupted and wonderful switch of energy.

(iii) Flexible: It offers prospects for improvement and development via making it simple to consist of sparkling ideas and technological improvements when needed.

(iv) Resilient: Due to its decentralized layout, the smart grid is more resilient to assaults and herbal screw ups.

(v) Environmentally-friendly: With the shift towards cleaner energy sources, the smart grid plays a crucial role in promoting sustainable practices and reducing carbon emissions.

(vi) Empowering: It gives customers the energy to determine how tons power to use based totally on financial and environmental issues by using enabling real-time spoken communique among them and energy groups. But so as for smart grids to become extensively used, some limitations must be overcome.

(vii) Security: Because of the intermixing of IT structures, the intelligent grid is vulnerable to vulnerabilities and cyberthreats.

(viii) Privacy: The large amount of data generated by various smart devices in the grid raises concerns about consumer privacy.

(ix) Stakeholder involvement: Since the clever grid remains being applied, stakeholders can be resistant or cynical. It's critical to allay their worries and make it obvious to all parties worried what benefits clever grid era offer.

(x) Cost: Some customers may also find it hard to simply accept this technology because of the sizable preliminary outlay needed to install a clever grid. We can construct an electricity system this is more sustainable, dependable, and green in the future through putting off those barriers and using the Internet of Things to its fullest quantity within the clever grid.
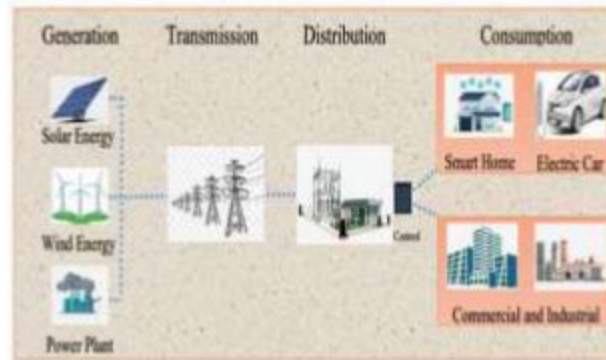

Fig. 3: Smart Grids Using IOT

(b) **Energy Management:** IoT gadgets play a vital position in tracking and controlling electricity intake in actual time. For instance: Demand-facet management: IoT sensors gather records on electricity utilization patterns, permitting utilities to put into effect load-moving strategies and mitigate peak call for. Predictive renovation: Through sensor generation, equipment health can be continuously monitored, anomalies detected, screw ups expected, enabling timely renovation and reducing downtime. Energy optimization: Algorithms driven via IoT optimize electricity production and distribution, taking into account elements including renewable electricity assets, strength storage, and grid stability.

(c) **Distribution Automation:** IoT gadgets automate distribution networks by overseeing substations, transformers, and power strains. These gadgets can swiftly come across faults, reroute power, and expedite carrier recovery at some stage in outages. SCADA (Supervisory Control and Data Acquisition) structures utilize IoT principles to remotely supervise and control substations, switches, and different components of the grid.

(d) **Building Automation:** Building management structures enabled by using IoT optimize energy intake within each industrial and residential buildings. These systems regulate lighting, HVAC, and other utilities primarily based on occupancy stages and environmental situations.

(e) **Connected Public Lighting:** Smart streetlights, prepared with IoT sensors, modify brightness degrees primarily based on ambient mild and pedestrian activity, thereby lowering energy usage and improving protection.

(f) **Smart Metering:** IoT-enabled clever meters provide real-time records on energy intake, permitting utilities to remotely read meters, track usage patterns, and offer time-of-use pricing.

(g) **Predictive Analytics:** The combination of IoT records and system studying algorithms permits predictive analytics, permitting utilities to forecast call for, discover capacity problems, and optimize useful resource allocation.

(h) **Renewable Energy Integration:** The integration of renewable strength sources, together with solar panels and wind mills, into the grid is facilitated by way of IoT. Sensors are hired to reveal their performance, expect

output, and control fluctuations effectively. Microgrids, powered via renewable assets and prepared with IoT devices, can function autonomously or connect with the principal grid as required.

Applications of Big Data and Internet of Things in Power System" delves into the usage of huge facts and IoT in energy systems, masking diverse regions wherein IoT programs are beneficial, together with metering, transformer monitoring, and demand prediction. Enabling Technologies in IoT: Energy, Sensors, Cloud Computing, Communication, IoT Integration, and IoT Protocol and Standards" sheds mild on diverse IoT technologies, encompassing energy sectors, sensors, cloud computing, verbal exchange, and protocols.AI-Powered IoT in the Energy Industry: Digital Technology and Sustainable Energy Systems" explores the incorporation of AI, IoT, and system getting to know in the layout and modelling of power structures, together with renewable energy structures.AI, IoT, and machine learning in the design and modelling of energy systems, including renewable energy systems.

(i) **Connected Public Lighting:** In smart city projects, IP-based lighting is connected to wireless IoT solutions. This enables intelligently connected external LEDs for public lighting systems controlled from a central control station. The ability of this system to dynamically adjust lighting intensity based on environmental factors is one of its main advantages, as it offers significant savings in operating costs and electricity consumption.
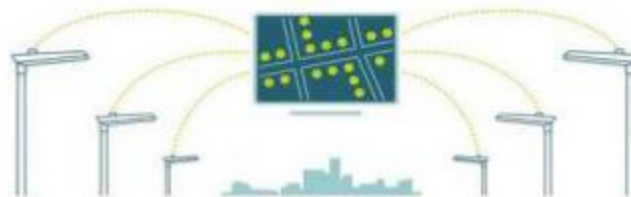

Fig. 4: Public Lighting Using IOT

The Internet of Things (IoT) is instrumental inside the advancement and management of shrewd urban regions. Through the combination of various sensors and devices into city infrastructure, IoT allows an extra powerful and adaptable urban environment. This is how IoT contributes to the development of smart cities:

(a) **Data Management:** IoT devices accumulate extensive records from urban settings, which may be applied for site visitors manage, pollutants discount, and infrastructure optimization. Sustainability: IoT technologies resource in promoting sustainable urban growth by using overseeing and regulating power utilization, water intake, and waste management. Quality of Life: Smart towns searching for to beautify the well-being in their population by means of making use of IoT for ongoing emissions tracking, visitor's detection sensors, and interconnected building structures. Efficiency: IoT and device studying are harnessed for analysing huge-scale records, ensuing in greater informed choice-making and progressed efficiency of urban services.

Fig. 5: Smart city Using IOT

Fundamentally, IoT acts because the middle of clever towns, supplying the vital generation for setting up interconnected, sustainable, and habitable urban environments for the destiny. According to scholarly sources, IoT performs a pivotal function in improving city intelligence and in-Fra shape.   Smart towns within the purview of IoT utilize several IoT programs consisting of clever transportation structures, clever buildings, site visitor's management, waste disposal, smart lighting fixtures, clever parking, and concrete mapping. The packages intensively involve censuring for instance the supply of parking space, the popularity of bridges or buildings systems, the sound sensor in crowded urban center's, or the range of humans crossing busy streets. Smart Cities relies on AI-applied IoT systems to reveal, moderate, and reduce congestion. IoT is also the premise by way of which shrewd lighting fixtures primarily based on climate forecasts complements the human sense-capacity waste disposal approaches and the monitoring of trash automobiles for instance the gathering days. Furthermore, Smart Roads shows urgent lighting-percentage data materials for instance, if there is a traffic jam or bridge twist of fate, or alternative direction's lights.

Various programs of IoT in the improvement of smart cities embody shrewd transportation structures, smart homes, traffic control, waste disposal, clever lighting fixtures, smart parking, and urban mapping. These functionalities may additionally involve monitoring parking availability, assessing structural conditions of bridges and homes, deploying sound sensors in crucial city regions, and tracking pedestrian and vehicular visitors' levels. AI-pushed IoT structures may be employed to screen, adjust, and alleviate traffic congestion in Smart Cities. Additionally, IoT helps the setup of adaptive road lighting fixtures primarily based on climate conditions and the tracking of waste disposal techniques and boxes through monitoring trash series schedules. Intelligent roadways can issue alerts and vital facts, together with opportunity routes based on weather conditions or unexpected events like site visitors' congestion and accidents.

Actualizing smart towns via IoT implementation requires radio frequency identity and sensor use. Examples include the packages of the Aware domestic and features used by Smart Santander. The United States has developed precise strategies in enormous cities which include Boston to make use of the Internet of Things throughout more than one structures, comprising however now not constrained to parking meters, streetlights, sprinkler structures, and sewage infrastructure. The integrated packages are lined up to accomplish huge upgrades in price and strength competences.

Fig. 6: Smart Agriculture and Smart Farming Using IoT.

Smart agriculture denotes the combination of IoT solutions in agricultural practices. By utilizing IoT sensors to amass environmental and machinery information, farmers can make well-knowledgeable decisions to decorate diverse aspects of their agricultural operations. Benefits of clever agriculture embody progressed management of livestock and crop cultivation, leading to enhanced predictability, performance, and sustainability. Smart agriculture and clever farming make use of the talents of the Internet of Things (IoT) to convert conventional agricultural strategies. The realm of smart farming and its have an impact on on agriculture thru IoT utilize the capabilities of the Internet of Things (IoT) to transform conventional agricultural methods. The realm of smart farming and its influence on agriculture through IoT.

(a) **Data-Driven Decisions: -** For instance, smart agriculture sensors are instrumental in monitoring crop fitness, soil conditions, and weather patterns.

(b) **IoT's Role in Smart Farming:** Precision Farming: Real-time information on soil great, crop development, and weather situations allows precision farming. This enables farmers to optimize aid usage, growth productivity, and promote sustainable methodologies. Smart Monitoring: IoT sensors acquire significant statistics on climate situations, soil excellent, and livestock well-being to inform selection-making strategies and bolster standard efficiency. Supply Chain Management: IoT technologies useful resource in tracking and managing the agricultural deliver chain, ensuring punctual shipping of agricultural goods. Agrochemical Applications: Smart agriculture helps particular utility of agrochemicals, thereby lowering waste and environmental effect. Disease Management: Early detection of diseases via IoT sensors enables in keeping off crop losses. Smart Water Management: Effective water usage primarily based on real-time statistics complements irrigation practices.

(c) **Market Trends and Growth:** The development of IoT solutions in agriculture is dynamic, with the market share for IoT in agriculture having reached $ thirteen. Seventy-six billion in 2022. The growth of smart farming technology has been expedited by means of disruptions due to COVID-19 and hard work shortages, with a predicted marketplace percentage of $28.Fifty-six billion with the aid of 2030.

(d) **Challenges and Opportunities:**
- Sensor Technology: The development of sensor technology is vital for records series. Data Security: Safeguarding touchy agricultural data is paramount.
- In conclusion, smart agriculture empowered via IoT offers widespread ability to revolutionize farming techniques, amplify productiveness, and foster a sustainable future.
- Avoid combining SI and CGS units, consisting of present day in amperes and magnetic field in oersted. This frequently ends in confusion due to the fact equations do no longer balance dimensionally. If you need to use blended devices, truely country the units for each quantity.
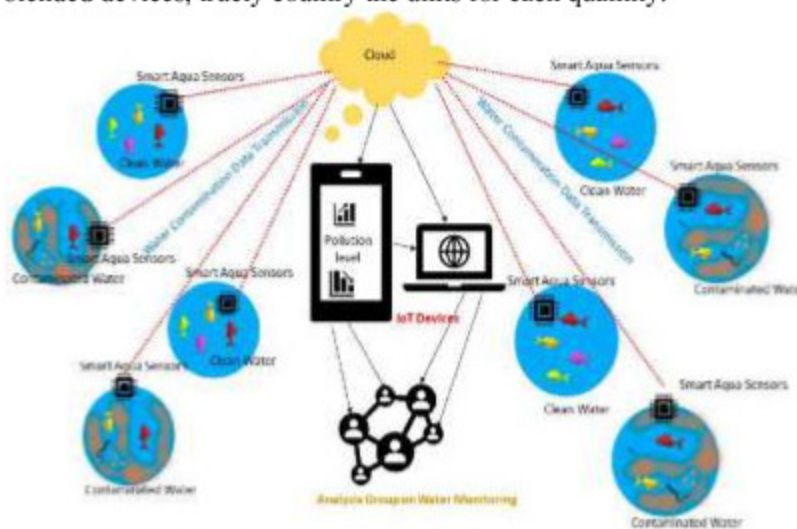

Fig. 7: Smart Environment Monitiring System Using IoT

Smart Environmental Monitoring Systems (SEMS) which utilize the Internet of Things (IoT) and sensor technologies are pivotal in making sure the sustainability and nicely-being of the environment. Let us delve into numerous vital components bearing on SEM:

(a) **Objective and Significance of SEM -** Air Quality Assessment: SEM enables the monitoring of air high-quality thru the size of pollutants together with particulate count (PM), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and ozone (O_3). The real-time acquisition of statistics allows for spark off interventions to ameliorate air excellent. Water Quality Evaluation: SEM frameworks compare water excellent parameters

along with pH, turbidity, dissolved oxygen, and contaminants. Monitoring water resources is essential for making sure potable water deliver and safeguarding aquatic ecosystems. Radiation Pollution Surveillance: SEM can detect ionizing radiation degrees, making sure protection in nuclear centres, scientific establishments, and regions contaminated by way of radiation. Monitoring of Agricultural Systems: SEM contributes to precision agriculture by way of monitoring factors inclusive of soil moisture, temperature, and crop fitness.

(b) **Components of SEM:** Sensors: Intelligent sensors accumulate environmental statistics together with temperature, humidity, light depth, and water stages. Wireless Sensor Networks (WSNs): These networks permit seamless communication among sensors and records processing gadgets. IoT Devices: Interconnected gadgets procedure sensor statistics and transmit it to cloud structures or records centres.

(c) **Advantages of IoT-Based Environmental Monitoring:** Early Detection Capability: SEM structures directly become aware of irregularities, leaks, or hazardous conditions. Data Analysis Insights: Real-time records analysis gives actionable insights for knowledgeable choice-making. Alerts and Automation: SEM triggers signals through email or textual content notifications, allowing well timed responses. Environmental Responsibility: Industries can embody green technologies to decrease their ecological footprint.

(d) **Challenges and Recommendations:** Sensor Technology: Progress in sensor generation complements the accuracy of SEM. Machine Learning Applications: Robust gadget studying strategies beautify facts analysis and predictive skills. Wireless Communication Standards: The improvement of appropriate requirements for WSNs guarantees reliable communique.

(e) **Smart Management of Waste Systems:** IoT-Integrated Waste Receptacles: Deployment of smart boxes ready with sensors to monitor waste tiers and composition, facilitating green waste series and sorting. Utilization of Waste-to-Energy Technologies: Conversion of waste into renewable energy thru methods like anaerobic digestion or incineration with electricity recovery.

(f) **Tracking and Mitigation of Pollution:** Mobile Monitoring Units: Utilization of portable devices for tracking pollution levels in diverse locations, supplying a comprehensive overview of environmental health. Drone Surveillance: Deployment of drones for monitoring inaccessible regions to perceive illegal dumping or sources of pollution.

(g) **Optimization of Resources:** Water Reuse: Adoption of advanced remedy strategies to recycle wastewater, reducing the reliance on freshwater sources and curbing water pollutants. Energy Efficiency: Implementation of clever grids and electricity-efficient technologies to decrease the carbon footprint of industries and transportation.

(h) **Engagement and Education of the Public:** Awareness Initiatives: Implementation of packages to teach the public at the environmental impact of their movements and sell sustainable practices. Involvement of Citizens in Scientific Projects: Encouraging network participation in information series and environmental monitoring tasks.

(i) **Policy and Regulation Framework:** Environmental Policies: Strengthening legislation to hold polluters accountable and incentivize sustainable practices. Data-Driven Governance: Utilization of data from smart monitoring systems to inform policy-making and enforce regulation effectively.
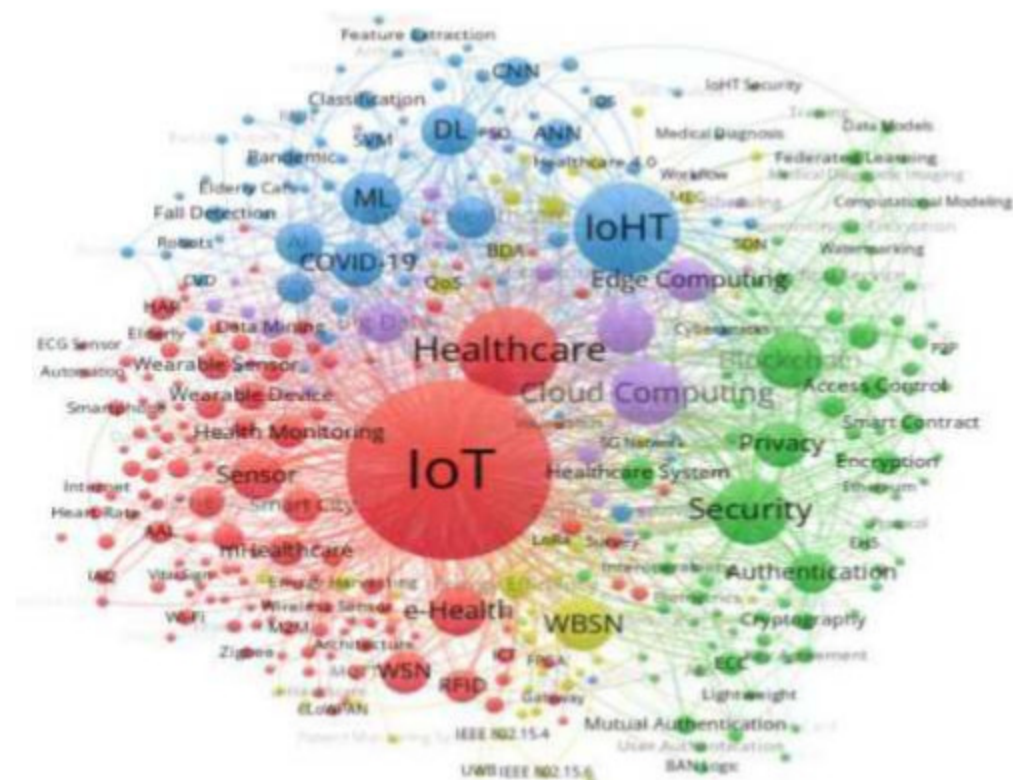
Fig. 8: Health Care Using IOT

Most healthcare structures in numerous nations exhibit inefficiencies, delays, and a susceptibility to errors, presenting a possibility for transformation. The healthcare enterprise closely relies on various obligations and tools which might be amenable to automation and enhancement via technological improvements. Implementing extra technologies capable of facilitating operations such as sharing reports across a couple of people and locations, retaining records, and coping with remedy dispensation would notably revolutionize the healthcare sector.

The benefits presented through IoT programs in healthcare predominantly revolve around affected person, group of workers, and item monitoring, character identification and authentication, and automated statistics collection and sensing. Tracking affected person drift can greatly decorate sanatorium workflow performance, at the same time as authentication and identity processes help mitigate risks to sufferers, ensure correct file-keeping, and reduce incidents of infant mismatching. Moreover, automating statistics series and transmission plays a critical position in method streamlining, expedited form processing, automatic procedure auditing, and efficient clinical inventory management. Sensor gadgets are instrumental in patient-centric capabilities like condition prognosis and real-time tracking of fitness signs.
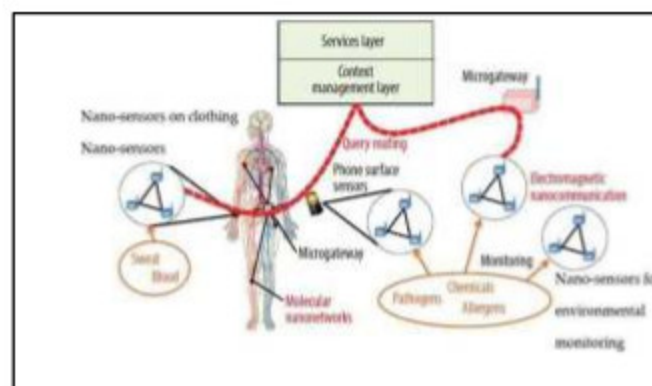

Fig. 9: The Internet of Nano-Things

Application domains inside the healthcare quarter encompass affected person compliance tracking, telemedicine answers, and alerts for patient nicely-being, with sensors being applicable to both outpatient and inpatient settings. The use of dental Bluetooth devices, toothbrushes presenting utilization facts, and affected person surveillance similarly illustrate the flexibility of IoT in healthcare. Additionally, RFID, Bluetooth, Wi-Fi, and different technologies appreciably beautify the size and tracking of important capabilities such as blood pressure, temperature, heart charge, blood glucose tiers, and cholesterol levels.

The expansion of Internet of Things (IoT) and Internet of Everything (IoE) is now progressing towards the realization of the Internet of Nano-things (IoNT). IoNT involves the integration of Nano-sensors into various objects through Nano networks, with a particular emphasis on medical applications. In the medical field, IoNT facilitates the retrieval of data from internal body parts that were previously inaccessible to conventional medical instruments due to their bulky sensor sizes. Consequently, IoNT opens up new avenues for collecting medical data, leading to groundbreaking discoveries and improved diagnostic capabilities.

In this discipline, the Internet of Things (IoT) reveals application in the realm of far flung manipulate gadgets which facilitate the far-flung operation of appliances, thereby mitigating the threat of injuries and protecting strength [1, 3]. Smart home devices, together with refrigerators equipped with LCD (Liquid Crystal Display) monitors, provide the functionality to show the contents inside, identify gadgets that have been stored for too lengthy or are close to expiration, and imply merchandise that need replenishing. This statistic also can be synchronized with a cellular utility, permitting customers to access it even as away from home and make necessary purchases

Fig.10: Smart Living Using IOT

Moreover, washing machines can offer the functionality for far flung monitoring of laundry activities. Additionally, a diverse array of kitchen home equipment can be interconnected through a phone, allowing customers to alter settings including temperature, for instance, within the context of an oven. Ovens offering a self-cleansing feature also can be effortlessly overseen. Regarding family protection, IoT technologies can be leveraged for alarm structures, even as cameras can be deployed to oversee and pick out times of unauthorized window or door access, thereby thwarting capability intruders [3].

(a) **Industries:** Numerous sectors use the Internet of Things (IoT) to instantly optimize supply chain networks and production procedures. This is the technique of becoming a member of sensors, actuators, manage structures, and machinery in the production enterprise. In order to increase efficiency and provide a stable distribution community, it makes a specialty of automating system controls, provider records structures, and operator gear the use of virtual controllers for manner industries.

Fig. 11: Industries Using IOT

The tasks of Industrial Internet of Things (IIoT) are:
- Real-time monitoring and control of processes
- Deploying smart machines, smart sensors, and smart controllers with proprietary communication and internet technologies
- Maximizing safety, security, and reliability through high precision automation and control

3. RESEARCH CHALLENGES

To determine the viability and functioning of some of the aforementioned IoT packages, appropriate feasibility studies across numerous domain names need to be performed. IoT has its consequences and issues, just like some other step forward or generation, which want to be resolved earlier than it could be broadly followed. New research horizons are being spread out by the fact that, despite current vast improvements in IoT permitting technology, a large number of troubles nonetheless need to be addressed. Many studies troubles are positive to expand because the Internet of Things (IoT) concept stems from heterogeneous technology that are employed in sensing, gathering, appearing, processing, inferring, transmitting, notifying, managing, and storing of information.

(a) **Privacy and   Security: -** IoT is now a vital part of the future internet, which means that that security and consider should be properly addressed. Flaws in lots of IoT gadgets are now known to researchers. For this purpose, the Internet of Things inherits the privateness and security concerns from WSN structure due to the fact it's miles built on top of the present wi-fi sensor networks (WSN) [3, 10]. Comprehensive protection solutions that keep records and systems secure are indicated by means of diverse attacks and flaws in IoT systems. As a result of several assaults, attackers use vulnerabilities within gadgets to breach into their structures hence compromising protection device.

(b) **Processing Analysis and Management of Data:** Numerous feasibility research are required in various areas to establish the opportunity and performance of some of the above cited IoT applications. The Internet of Things like some other technological development has its personal dangers, weaknesses or flaws that should be addressed before it turns into widely used. Several research guidelines are being spread out through the truth that despite latest high-quality achievements in enabling technologies for IoT there still exist a variety of troubles to be solved. This is because; considering that its idea is predicated on heterogeneous technologies for sensing, gathering, acting, processing, inferring, transmitting, notifying, handling and storing records, such a lot of research issues have to come up.

(c) **Observation and Perception:** Even whilst monitoring and sensing technologies have advanced considerably, they may be although usually converting, with an emphasis on shape and electricity efficiency. In order to collect real-time information, sensors and tags are commonly anticipated to be active all the time. This makes them essential for electricity efficiency, mainly in terms of lifespan extension. Actuators and sensors at the nanoscale were made viable via recent traits in miniaturization and nanotechnology/biotechnology.

(d) **Communication Protocols and M2M (Machine to Machine) Communication:** The subject of system-to-gadget (M2M) communique is expanding quick and deals with statistics sharing between networked devices

without the need for human interaction. It is a crucial a part of the Internet of Things (IoT), which makes a number of packages feasible, which includes commercial automation, smart grids, and e-fitness. There are many extraordinary styles of research problems in M2M communication, consisting of: Scalability: Systems want with a purpose to grow correctly because the number of linked devices reaches billions. Interoperability: It is probably tough to make certain exclusive devices and protocols can speak with every other without any problems. Security and privacy: It's crucial to safeguard records and maintain privacy in M2M conversation. Energy Efficiency: Since a whole lot of M2M devices run on batteries, it is important to maximise power utilization. Maintaining consistent and reliable verbal exchange, in particular in crucial.

(e) Quality of Service: -
   (i) Low latency and real-time data processing are frequently needed for IoT applications.
   (ii) balancing network and resource limitations with QoS expectations.

(f) Interoperability: - A essential aspect of the Internet, interoperability is turning into increasingly more essential inside the context of the Internet of Things (IoT). It guarantees that many programs, gadgets, and systems may also coexist peacefully, which is crucial for the diverse atmosphere of the Internet of Things. This involves a standardized set of standards that manage records exchange and communication among devices.

The requirement for more ranges of interoperability grows as the Internet of Things develops. It allows more effective machine operation and integration across various groups and sectors, enhancing scalability, cutting charges, and improving user experiences. In order to promote innovation and the advent of latest offerings and programs, the goal is to establish a coherent network in which devices made by way of many manufacturers and for diverse purposes can communicate with each other without experiencing compatibility issues.

4. CONCLUSION

The IoT is maximum as it should be characterized as a Complex Adaptive System (CAS) so that it will go through continuous evolution, hence necessitating novel and inventive processes to software engineering, structures engineering, venture management, and a multitude of other disciplines in an effort to increase its improvement and governance inside the impending years. The domains of application for IoT are incredibly varied, allowing it to cater to numerous users with differing desires. It serves three wonderful user categories: individuals, societal or communal organizations, and establishments. As evidenced in the software segment of this academic look at, the IoT undeniably possesses massive potential to act as a profoundly transformative effect, which already, to a degree, and will more and more, positively effect the lives of thousands and thousands globally. Recent reports have highlighted a growing interest inside the IoT concept from numerous governments international, with many increasing investments within the quarter to facilitate in addition exploration, as exemplified by using the Chinese Government. Numerous studies collectives had been mounted globally, with a number one intention of advancing IoT-related investigations. As research endeavor's proliferate, new facets of IoT processes, associated technology, and connectable gadgets are always emerging, thereby establishing up avenues for better software functionalities of IoT. The sheer expansiveness of IoT and its pervasive impact across all components of daily life render it a essential issue of take a look at throughout a variety of interconnected fields, consisting of statistics generation (IT) and pc technology (CS). This scholarly paper delineates numerous ability utility sectors for the IoT and the accompanying studies limitations.

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An Analytical Study on AI-Driven Narratives: How Artificial Intelligence is Redefining Political Communication in India with reference to India's 2024 Lok Sabha Elections

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ABSTRACT

The Indian Lok Sabha elections in 2024 marked a significant shift in 'Political Campaigning' trends in the country, characterized by the intensive and expansive use of Artificial Intelligence (AI) technologies in political Communication and marketing communications. The research paper examines the emerging role of Artificial intelligence (AI) and its use by various national and regional political parties in the country to inform the electorate, enhance voter engagement, disseminate information, and influence public perception. While AI tools provided innovative ways to connect with voters, they have also raised concerns about misinformation and ethical implications. This study aims to discuss the case studies of the use of AI by the political parties of India in the recently held elections in 2024. It also discusses the nature of AI and its impact on democratic processes in India, offering insights that may inform future electoral strategies globally.

Keywords: Artificial Intelligence (AI), Deepfake Augmented Reality (AR)

1. INTRODUCTION

In May 2024, the Lok Sabha elections in India were held. We witnessed unprecedented advancements and evident changes in political campaigning strategies driven largely by the integration of technologies, especially the use of artificial intelligence (AI).

With over 968 1 million registered voters, political parties sought innovative methods to reach diverse electorates nationwide.

This research paper explores the various applications of Artificial Intelligence (AI) in political campaigning, focusing on its implications for voter engagement and its challenges to democratic integrity.

India's major national elections that brought the historic third time for Prime Minister Narendra Modi, this time with a weakened mandate, have moved forward into more increased drives for using artificial intelligence (AI)-tools transforming political campaigns or really interacting with voters. They can, however, reach a larger electorate, but they also raise issues of misuse in spreading disinformation-with the problem growing, thanks to the increase in AI generated synthetic media called 'deepfakes.'

With the Use of Artificial Intelligence (AI) In the 2024 elections held recently, political players extensively used digital tools to engage voters, create narratives, and even manipulate perceptions.

The 2024 elections were noteworthy for using social media analytics and targeted advertising in a way never seen before. Massive volumes of user data are analyzed by AI-powered algorithms to micro-target particular demographics with customized political messaging.

2. OBJECTIVES

The three prime objectives for this research paper are:

(a) **To Analyze the Role of AI in Political Campaigning**: To examine that how various national and regional political parties in India utilized artificial intelligence technologies during the 2024 Lok Sabha elections to fulfill various functions like, to inform the voters, enhance engagement, and to influence public perception.

(b) **To Identify and Discuss the varied ethical issues and challenges**: This paper discusses various ethical concerns surrounding the use of AI in political campaigning and their potential impact on democratic processes.

(c) **To Provide Insights for Future Technology driven Political Campaigning Strategies**: The research intends to offer insights derived from case studies of AI applications in the 2024 elections, which may inform and guide future electoral strategies in India.

3. THE ROLE OF AI IN POLITICAL CAMPAIGNING

(a) **AI Improves Voter Participation** - Artificial Intelligence technologies can stimulate the creation of excellent and unique communications with voters that touch them personally. Political parties deployed these new technologies in avatars and chatbots to bring citizens to talk with them rather than individually-situated regarding their issues or preferences. For instance, Prime Minister Narendra Modi's speeches have translated into different regional Indian languages just using AI tools such as Bhashini for the benefit of members of the population who do not speak Hindi.

(b) **Using Deepfake and Synthesized Media** - Perhaps the most glaring use of AI in the elections was deepfake video, which creates manipulated representations of things to be used to distort public perception.

During the elections, many political parties circulated 'Deepfake' videos. These videos are manipulated media generated by the use of artificial intelligence that portrays a person as saying or doing something they did not. The two prominent national parties, both BJP and the Indian National Congress (INC), indulged in employing the technique of satire to make fun of the opponent and/or inflate their credibility by running their own ads and creating such relevant videos.

Examples would include putting together AI-generated videos featuring deceased politicians who endorse current candidates or videos that parody rival leaders using altered media.

A latest investigation by Access Now and Global Witness reveals that YouTube has disapproved 48 advertisements in multiple languages, English, Hindi, and Telugu, that have violated the policies of YouTube about advertising and election misinformation. These types of misinformation disrupt the integrity of elections, undermine the electoral process, and threaten democracy by misleading voters, distorting their understanding of critical issues, creating echo chambers, and replacing reliable information.

The role and responsibility of the government is to regulate and increase independent fact-checking platforms to avoid fake videos and false information that misguides citizens. In India, some fact-finding institutions are Alt News and Boom. The Indian government runs the Press Information Bureau (PIB), which runs the PIB Fact Check.

The Supreme Court of India has also recently ordered a stay on the establishment of a Fact Check Unit of the PIB as a body with the power to mark alleged misinformation published about the government and its agencies. Besides, the Election Commission of India issued multiple guidelines during the last 2024 Lok Sabha elections to curb misleading information and direct social media platforms to self-regulate as per their guidelines.

The BJP utilized AI-driven chatbots and robocalls to deliver hyper-personalized messages, including personalized WhatsApp videos addressing volunteers by name. Meanwhile, Congress politician Shashi Tharoor engaged voters through an interview with his AI avatar, showcasing innovative uses of technology in campaigning.

Another expert said that an app for Sikkim's chief minister, Prem Singh Tamang, was created in 2024 where in supporters can generate a selfie with the politician by scanning the QR Code. For Tamang's election campaign, a video was generated using AI to display him as a larger-than-life figure.

Misinformation and disinformation are also part of the top 10 risks flagged in the Global Risks Perception Survey. With user-friendly interfaces of large AI models, disinformation has taken off as never before, creating an extensive repertoire of falsified information and synthetic content from convincing voice clones to counterfeit websites, as cited in the Global Risks Report 2024

4. COST-EFFECTIVE CAMPAIGNING

AI has helped cut down costs on campaigning methods that have been in use over years. For example, AI using a voice interactive robot for voter outreach phone calls costs a party eight times less than paying human call center

agents to make those calls. The affordability allows parties to mount their outreach operations on an unprecedented scale, enabling them to reach millions of voters with personalized messages.
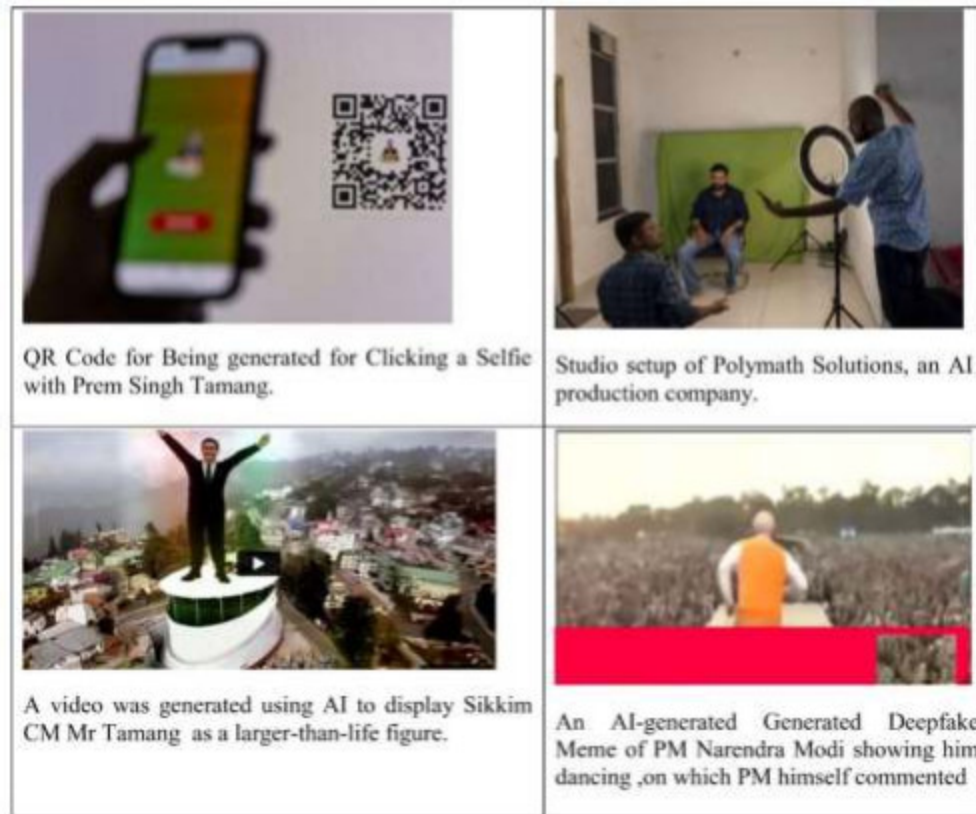

QR Code for Being generated for Clicking a Selfie with Prem Singh Tamang.

Studio setup of Polymath Solutions, an AI production company.

A video was generated using AI to display Sikkim CM Mr Tamang as a larger-than-life figure.

An AI-generated Generated Deepfake Meme of PM Narendra Modi showing him dancing ,on which PM himself commented

Fig . 1: Campaigning using cost-effective AI solutions

5. ETHICAL ISSUES AND CHALLENGES

The introduction of artificial intelligence in political campaigning has brought challenges. Deepfake technology raised ethical issues around misinformation and voter manipulation. According to reports, such misleading content was widely circulated, with largely absent regulation or oversight from authorities during the election period 25. While advisories have been issued by the Election Commission of India prohibiting the use of AI-generated deepfake, enforcement remains weak because of no specific laws governing the use of AI in elections.

6. RESULTS AND DISCUSSION

The 2024 Indian Lok Sabha elections represented a significant turning point in political campaigning, driven largely by the integration of Artificial Intelligence (AI) technologies. This section discusses the results of the research, highlighting the transformative role of AI in enhancing voter engagement, the ethical implications of its use, and the broader impact on democratic processes in India.

The research findings indicate that AI technologies have revolutionized how political parties engage with voters. The deployment of AI-powered tools such as chatbots and virtual assistants has enabled real-time communication between candidates and constituents, allowing for personalized interactions that were previously unattainable. For instance, political parties utilized AI to analyze vast datasets to identify voter preferences and tailor their messaging accordingly. This targeted approach not only improved voter outreach but also fostered a sense of connection between candidates and their constituents.

Moreover, the use of AI to translate speeches into multiple regional languages significantly broadened the reach of political messages. Prime Minister Narendra Modi's speeches were made accessible in languages such as Tamil, Telugu, and Bengali, thereby overcoming linguistic barriers that have historically limited political engagement in non-Hindi speaking regions. This innovative use of technology exemplifies how AI can empower voters by ensuring that critical information is available in their native languages..

Fig 2: Use of AI in the 2024 Lok Sabha elections

Additionally, **Polymath Solutions** developed a project where local politicians made automated calls to voters using AI-generated voices. These calls inquired about voters' concerns and preferences, allowing candidates to engage with constituents on a personal level without requiring extensive manpower.

Similarly, **Shashi Tharoor**, a Congress politician, conducted an interview with his AI avatar, showcasing innovative uses of technology in engaging voters. This approach allowed for a unique interaction that highlighted Tharoor's digital presence and appeal

Political parties also employed **AI-generated deepfake videos** featuring their late leaders, such as M. Karunanidhi and J. Jayalalitha in Tamil Nadu. These videos were used to evoke nostalgia and connect emotionally with voters. Furthermore, **AI-powered sentiment analysis** tools helped parties gauge public opinion on various issues during the campaign, enabling them to adapt their strategies based on real-time feedback from voters.

While the benefits of AI in political campaigning are evident, the research also highlights serious ethical concerns associated with its use. The rise of deepfake technology has introduced new challenges regarding misinformation and voter manipulation. Instances of AI-generated deepfake videos circulated during the election raised alarms about their potential to distort public perception and undermine trust in the electoral process. Political parties, particularly the BJP and INC, have been implicated in utilizing such tactics to sway voter opinions, emphasizing the need for robust regulatory frameworks to govern the use of AI in elections.

Despite these concerns, it is crucial to note that not all applications of generative AI are detrimental. Many campaigns used AI constructively to enhance voter engagement rather than deceive. For example, campaigns leveraged AI-generated content to create compelling narratives that resonated emotionally with voters. However, this duality underscores the necessity for clear guidelines on ethical AI usage in political contexts to mitigate risks while harnessing its benefits.

Moreover, some political parties have utilized **Augmented Reality (AR)** campaigns to create interactive experiences for voters. Candidates can superimpose digital images of themselves over real-world environments, allowing voters to engage with campaign messages in a novel way. Additionally, **QR codes** have been increasingly used in promotional materials; when scanned, these codes lead voters to personalized messages or videos from candidates.

The findings suggest that while AI can enhance voter engagement and streamline campaign strategies, it also poses significant risks to democratic integrity. The lack of stringent regulations governing the use of AI technologies during elections raises questions about accountability and transparency.

As observed during the 2024 elections, the absence of comprehensive oversight allowed for widespread dissemination of misleading content, which could potentially erode public trust in electoral outcomes. The research emphasizes the urgent need for regulatory bodies like the Election Commission of India to establish clear guidelines on the ethical use of AI in political campaigns. Such regulations should include provisions for labeling AI-generated content and holding tech companies accountable for their role in amplifying misinformation.

For instance, **the Indian government introduced an AI advisory** asking platforms to seek explicit permission before deploying generative AI models for electoral purposes. By implementing these measures, stakeholders can work towards maintaining the integrity of democratic processes while leveraging technological advancements.

Furthermore, enhancing digital literacy among voters is crucial for equipping them to critically evaluate content encountered online. As seen during this election cycle, while many campaigns employed innovative tactics like **automated feedback collection** through surveys via phone calls or messaging apps—allowing parties to quickly gather insights about voter preferences—the potential for misuse remains high without proper education on discerning fact from fiction.

7. CONCLUSION

To sum up, the multiplication of various AI activities in the Indian political campaigning of the 2024 elections has almost married innovative ways with traditional ones into new types of voter engagement strategies. Such technologies usher in novelties to reach otherwise varied electorates but also present grave risks of misinformation with regard to ethical governance. As democracies across the globe fight similar battles, India's experience tenders a serious case for examining the prospects of AI in politics.

The outcome of all this is that really strong accountability measures can put individuals at bay from harmful generative AI applications, lead institutions to mechanisms of reducing harm, and further reassure the public that, indeed, standards are being maintained in the democratic protection of elections. Political parties and consultants already have begun applying major machine-learning methods for the voter data analysis of targeted online political advertisements. Presently, these kinds of data-driven politics have become more common and efficient compared to the very recent and less widespread use of the AI-generated media to sway the mind of the voters.

Even if the new generative AI is still far from posing practical threats in misdirecting voters or targeting politicians with harassment, it will be inevitable to pretend that these major advances in easy access and sophistication will increasingly make it necessary to have more stringent regulations. It is thus going to be necessary to establish rules for regulating the use of AI at election time. The regulatory regime should include provisions for labeling AI-generated campaign content disseminated in a political context by political parties, candidates, and other political actors. Tech companies should also be held accountable by ensuring that they are included at the checkout line of any measures to mitigate the spread of disinformation and harassment related to elections. This would require commitment purposes with independent fact-checkers and against regulatory agencies. They would suffice to use such checks on misuses of technology and disallow spreading more false information for the betterment of society. Still, voters need to learn more about what actually happens in the digital world, thereby enabling them to analyze most content they meet critically.

A nation like India that possesses a huge electorate combined with a varied political environment could serve as a timely and effective test platform for conceptualization and refinement of good AI policies.

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Comparative Studies of Computational Modeling and Simulation of Structure Failure Under Extreme Loads

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ABSTRACT

Knowledge on how engineering structures respond to extreme loads is significant in increasing their safety and durability. This dissertation is concerned with numerics and simulations of structural collapse this can be as a result of earthquakes, blasts, or high-speed impacts. Using specifically FEA and the Kriging-based surrogate models, this work will try to model the failure mechanisms and factors affecting structural life. The models used here are therefore first tested for their reliability and performance against experimental data and real-life examples. The results indicate how better modelling would lead to enhanced emergence of safer structural capacity and reliability. The contribution of this research to structural engineering discipline is in the area of failure prediction by making suggestion for future research, and recommending practical application that may be useful in engineering practices and formulation of policies. Thus, the present research underlines the need for further development of the computational approaches to deal with increasing difficulties due to extreme conditions.

Keywords: computational modelling, extreme loads, finite element analysis (FEA), structural failure, structural integrity.

1. INTRODUCTION

(a) **Importance of Structural Safety Under Extreme Loads -** Structural integrity is an essential component of engineering that establishes the ability of structures to endure loads and forces that are encountered throughout their usefulness. This is particularly so under such conditions like earthquake, blast and high speed impacts whereby risks of total collapse are much higher. In order to evaluate and also improve the structures' performance under such conditions structural engineers employ number of computational methods many of which include the Finite Element Analysis (FEA) software intended to check and improve on the safety measures that have been put in place or to reduce the risks encountered.

(b) **Motivation Behind Using Computational Modelling -** Advantages that one comes across with computational modelling in structural engineering include the following especially in cases of complexity and extreme loading conditions. One of the chief advantages is that pretty much any condition or circumstance whatsoever can be recreated in the computer environment that would otherwise be highly complicated or utterly unachievable in actual practice. It similarly enables engineers to simulate structures' response to be stressed in forms such as how it will be in the event of an earthquake or a blast without having to undertake costly and lengthy physical testing. Also, Computer Aided models such as Finite Element Analysis (FEA) give very accurate results of stresses and areas of likely failure in a structure making safety and reliability more precise. These models can be so adjusted and improved by incorporating new data and transforming the designs so as to enhance their performance while at the same time bring down the overall cost.

2. LITERATURE REVIEW

(a) **Introduction to Structural Failure Mechanisms -** Structural failure is the inability of a structure and or part of a structure, to carry the loads applied on the structure or a part of the structure and consequently fail either partially or completely. There are several reasons by structures can fail, and these include fatigue of the material used when it is subjected to prolonged cyclic loading, corrosion, initial imperfection, and external loads such as earthquakes. The consequence of these failures can be disastrous such as loss of lives, damage to the environment, and financial losses.
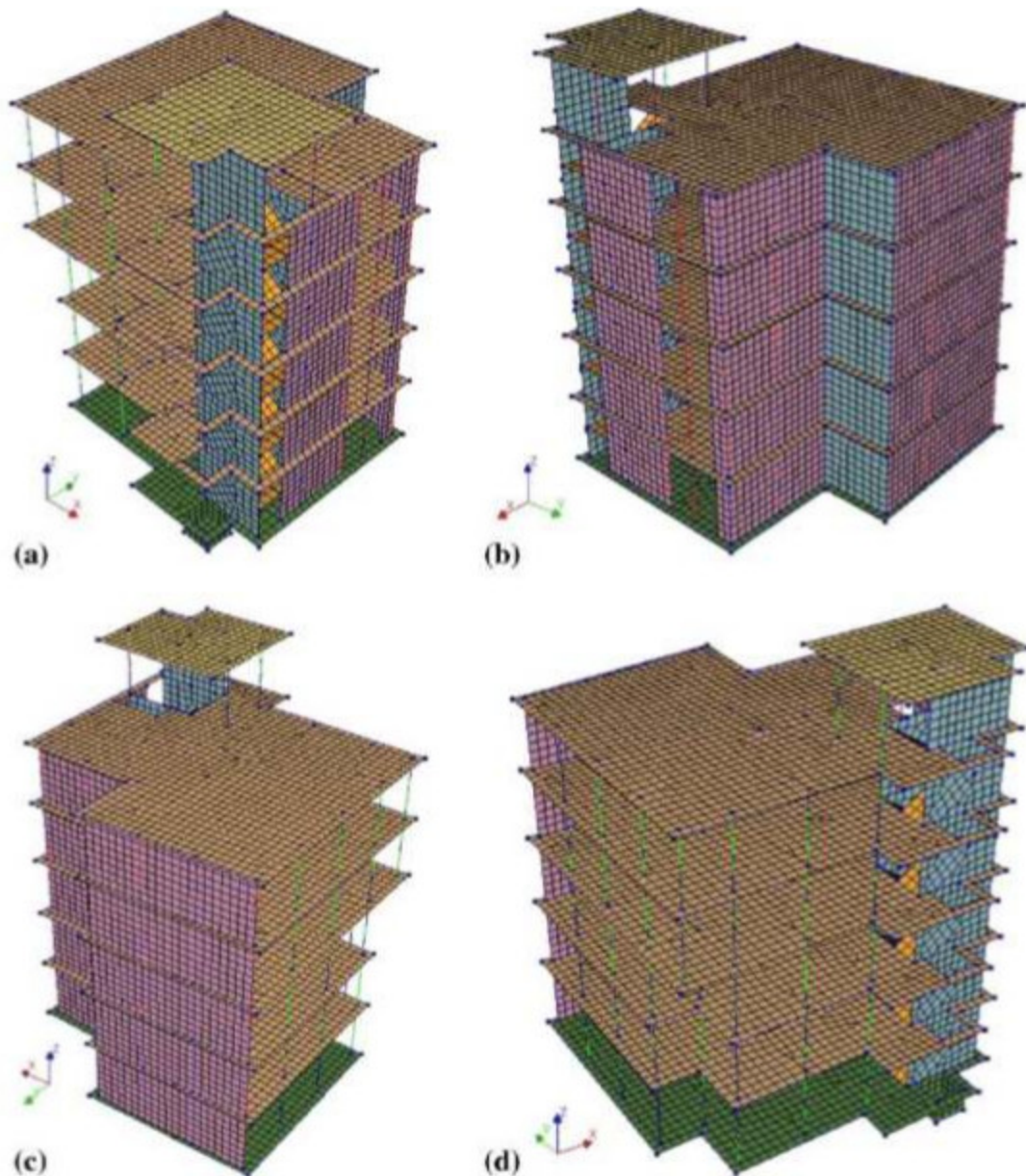
Fig. 1: FEA Model of a Building

(b) For example, fatigue fractures due to cyclic stress, accrue progressive damage over service-life and may cause an inconspicuous, abrupt and fatal failure. Knowledge of various failure mechanisms is important in the creation of structures that can bear expected and adverse loads more securely.

(c) In-depth Analysis of Specific Failure Mechanisms - There are various mechanisms of which structural failures are a part and these mechanisms are function of the physical and material properties. It is here that knowledge of these mechanisms is important to avoid major disasters in the field of engineered structures. Some of the frequent specific failure modes are buckling, fatigue and brittle fracture.

Fig.2: Fracture Failure - an overview

3. METHODOLOGY

The research carried out in this study is described in this chapter, including the approach used to analyse the structural failure mechanisms under extensive load employing Computational Modelling. Com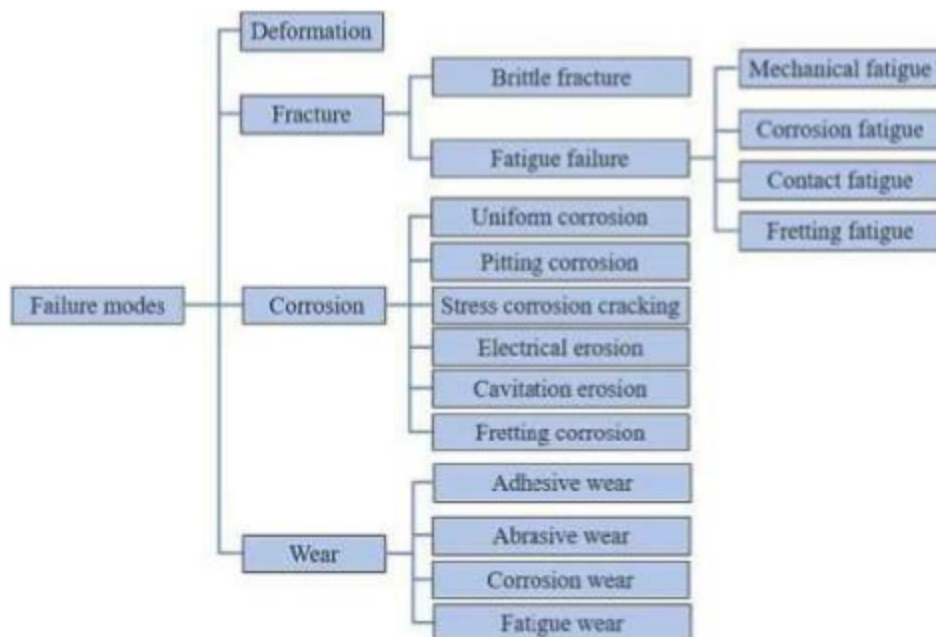putational modelling is a crucial aspect of structural analysis because of its capability of ensuring that structure responds to various load conditions such as earthquakes, blasts, and impacts and at various speed such as high-speed impacts. These models enable the engineer to simulate future failures and integrate a more safe, relatively stability into designs before the engineering and expensive model testing runs, which can take a fairly long period of time.

The method used in this work involves FEA, utilization of machine learning technique termed as Kriging to establish surrogate models, and MCS. These statuses are as follows; Every one of these techniques has a compelling part to grieve with the evaluation of structures under ruthless loading conditions out. This chapter is organized to give a clear account of the computational models employed in the study, the simulation specifics and the data gathering and analysis methods used in the study. Through a systematic way of tackling these aspects, the chapter creates a base on which forecasts the study's approach to modelling and analyzing structural failure in difficult situations.

4. RESULTS AND DISCUSSION

The results and discussion section contains simulation studies' findings, and the analysis of the results with relation to structural safety and engineering perspective. The organization of this section is designed to first show the basic data of the simulation results of stress, deformation, and the failure probability, and then a discussion of the results. This discussion also contains the comparative analysis with the other experimental data and models so as to prove the efficacy of the simulation.

Some of the techniques employed in getting at these results include FEA, Kriging based models, and MCS. These techniques were chosen because they allow for the simulation of structures at extreme loads for which they are designed to cater for including seismic loads. By incorporating such methods as the finite element method, the simulation gives an evaluation on how structures could behave under various stress conditions.

The rationality behind it is to draw the attention to the structural aspects in order to suspect and methadone failure pattern and also to suggest for improved structural reliability and soundness of engineering designs. This

discussion is paramount in translating the findings of the simulation into use in prominence issues that can enhance make structures safer in actual world conditions.

(a) Detailed Simulation Results

The outcomes of the structural simulation which includes stress, deformation and the probability of failure analysis are shown here in this section. These results are significant in analyzing the load carrying capacity of structure and also to discern various failure modes.

The load distribution in the structural elements was done using contour plots resulting from Finite Element Analysis (FEA). These plots demonstrate how stress is apportioned in the structure depending on such loading as seismic or impact. The important areas in stress analysis are, therefore, the areas of high stress gradient, referred to as the critical stress zones since they show areas of high potential for failure.

Table 1: Stress Distribution in Key Structural Components

Component	Maximum Stress (MPa) Seismic load	Maximum Stress (MPa) Blast load	Maximum Stress (MPa) Impact load
Beam 1	250	270	260
Column 2	230	300	240
Joint 3	210	280	250

(i) Visualization
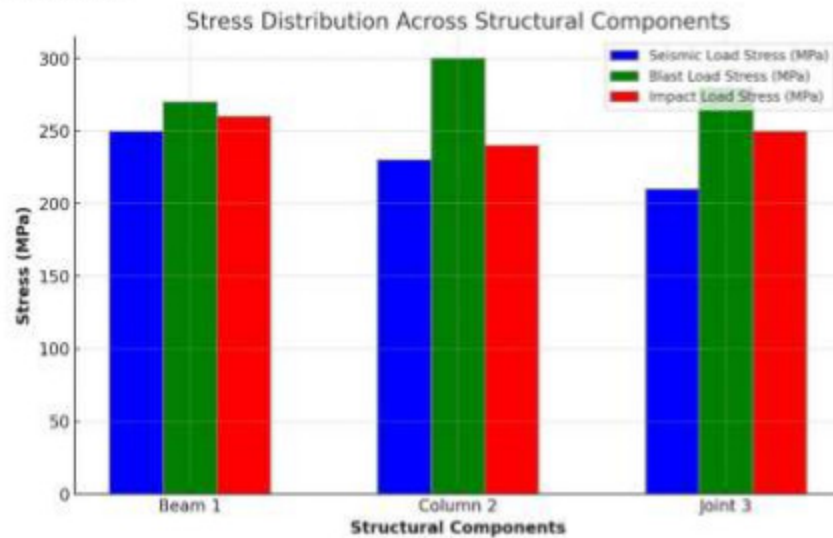
Fig. 3 : Stress Distribution Across Structural Components

Table 2 Failure Probability Estimates Under Different Loading Scenarios

ELoading Scenario	Failure Probability P_f)	Kriging Model Estimate	Monte Carlo Simulation Estimate
Seismic Load	0.02	0.018	0.020
Blast Load	0.05	0.048	0.050
Impact Load	0.03	0.029	0.032
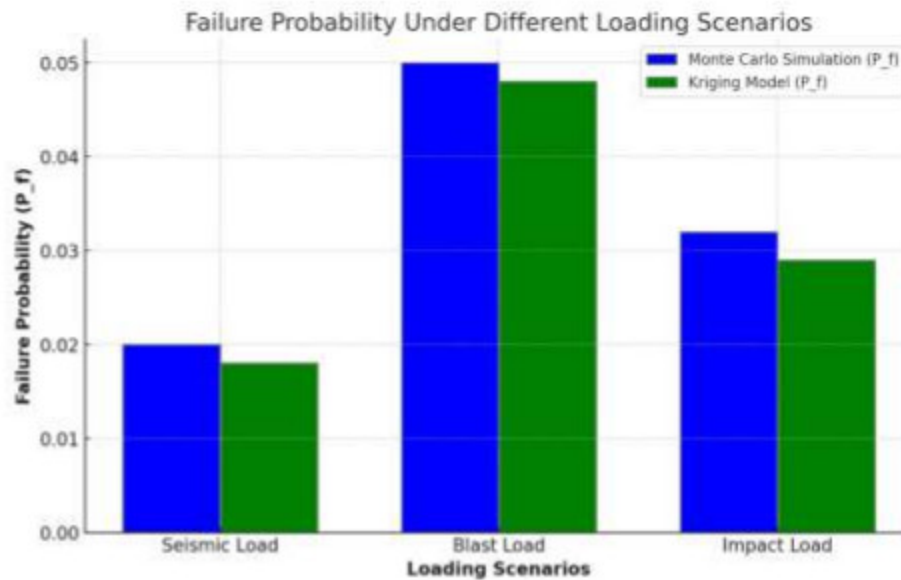
Fig. 4 : Failure Probability Under Different Loading Scenarios

Table 3: Deformation Data Across Structural Components

Component	Deformation Type	Loading Scenario Maximum Deformation (mm)		
		Seismic load	Blast load	Impact load
Beam 1	Bending	15	18	16
Column 2	Buckling	12	20	15
Joint 3	Shear	10	13	11

Fig. 5: Deformation of Structural Components Under Different Loading Scenarios

5. CONCLUSION

This research has been useful in explaining how buildings perform under extraordinary loads such as from earthquakes or blasts and other situations. The Finite Element Analysis (FEA), Kriging models, and Monte Carlo Simulations (MCS) that were adopted have given insight on the stress distribution, deformity and failure likelihoods. Moreover, accurate identification of critical stress zones as well as determination of failure probabilities proves t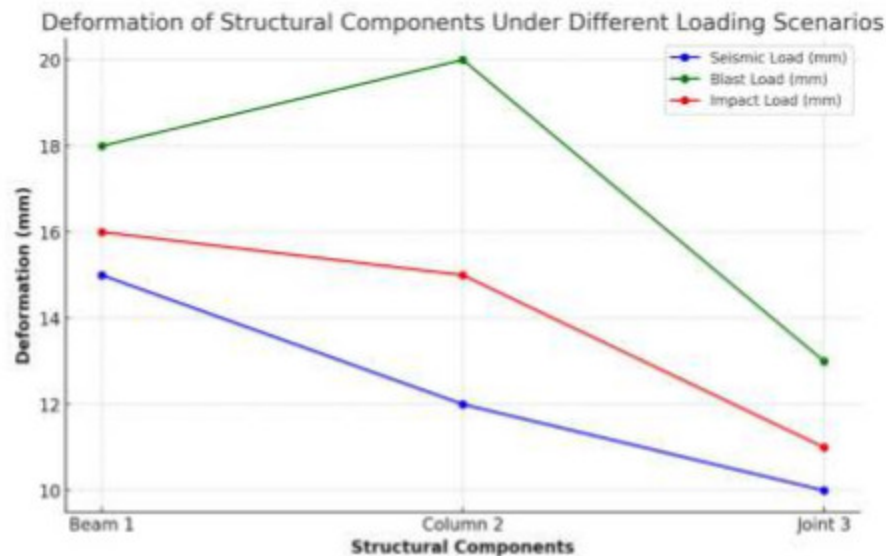o be most important for design and safety interventions. Such outcomes point out the growing demand for improving structural design that allows addressing the challenges of extreme environmental and operational conditions.

6. RECOMMENDATIONS FOR FUTURE RESEARCH

As we have seen, the study has contributed to the field in a significant way, but several issues arise. First, more detailed and realistic material properties can be taken into account to get better results of the proposed simulation models, as well as to overcome the problems which are connected with the usage of geometrical approximations. The next tasks are to extend the models for further complexity owing to the recognition of the nonlinear processes of the material behavior under high stress and the interconnection of distinctive structures.

Further, it is necessary to broadened the usage of the above mentioned simulations covering longer terms of performances also with regard to fatigue and wearing off constructions. Machine learning complementarity with the classical simulation models could represent an effective way of improving the forecasting performances, especially as regards the time evolution of the structural damages.

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A Predictive Modeling of Crop Yield for Improving Productivity Using Data Mining Technique

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ABSTRACT

Data mining is an evolving area of research in the analysis of crop yields. Predicting yield is a critical concern in agriculture, as farmers are keen to ascertain the expected output. Historically, yield predictions relied heavily on the experience of farmers regarding specific fields and crops. The challenge of yield prediction continues to be a significant problem that needs to be addressed using the data that is currently available. Data mining techniques represent a superior option for this objective. Various data mining methods are employed and assessed in the agricultural sector to forecast crop production for upcoming years. This study introduces and executes a system designed to predict crop yields based on historical data. The prediction is accomplished through the application of association rule mining on agricultural datasets. This study centers on the development of a predictive model intended for forecasting future crop yields. The paper provides a concise examination of crop yield prediction utilizing data mining techniques grounded in association rules, specifically for the district of Tamil Nadu in India. The experimental findings indicate that the proposed approach effectively predicts crop yield production.

Keywords -Agriculture, Yield Prediction, Data Mining

1. INTRODUCTION

Data mining refers to the application of various computational learning methodologies to systematically analyze and extract significant and valuable insights, patterns, or conclusions—essentially, knowledge—from extensive data collections. It involves the skill of uncovering hidden insights that were previously unknown and may hold potential utility within large databases. This process employs a variety of techniques to assess different patterns within substantial datasets. Data mining serves as a powerful instrument for analyzing data and extracting meaningful information from vast amounts of raw data. It facilitates the organization of data, the classification of information, the prediction of future trends, the discovery of correlations, and the identification of patterns within the dataset. The exceptionally large volumes of data present in contemporary life have rendered data mining an essential element.

Data mining has a wide range of applications, including web analysis, collaborative analysis, recommender systems, basket data analysis for targeted marketing, medical and biological data analysis, agriculture, customer relationship management, financial fraud detection, healthcare, education, customer retention, and research analysis. One significant area where data mining can offer substantial assistance is in agriculture. This sector is crucial to the economy of many countries, particularly in developing nations such as India, where agriculture serves as the backbone of the economy. According to the 2011 Census, over half of the population, specifically 54.6% of the total workforce, is involved in agricultural and related activities, contributing 16.5% to the country's Gross Value Added (GVA) for the fiscal year 2020-21 (at current prices). However, despite the increasing demand for food, agricultural output has been notably low in recent times.

Data mining refers to the technique of extracting valuable patterns from extensive datasets. The field of agriculture generates a significant amount of relevant data. By leveraging information technology, farmers can enhance their decision-making processes and optimize crop yields. In addition to growing crops, agricultural practices yield substantial data that can be analyzed. A considerable volume of agricultural data is accessible, and data mining serves as a means to convert this extensive information into actionable insights. However, many farmers lack fundamental knowledge regarding their soil types and the appropriate crops to cultivate in various conditions. This deficiency hinders their ability to select suitable crops, forecast yields, determine necessary fertilizers, anticipate market prices, and identify potential crop diseases. Consequently, this can lead to substantial financial losses, causing farmers to perceive agriculture as an unreliable source of livelihood.

2. CROP SELECTION

R. Kumar et al [1] characterized crop selection as the method of choosing crops for a particular season, taking into account a range of environmental and economic considerations. These factors include soil characteristics,

rainfall amounts, average temperatures, market prices and demand, current farming conditions, adaptability of specific crops or varieties, resistance to pests and diseases, farming practices, and available technology, all aimed at achieving optimal benefits. Crop selection involves identifying the most appropriate crop or set of crops based on land characteristics, geographical location, and the specific time of year.

Karandeep Kaur [2] outlined several critical factors to consider when selecting crops, including the types of crops, the availability of essential inputs, and various soil and climatic conditions. It is important to enhance or sustain soil fertility, safeguard the land from erosion, and take into account yield, market price, disease resistance, and fertilizer requirements. The primary goals of crop selection include reducing fertilization and liming costs, lowering overall cultivation expenses, and minimizing the variability of potential returns. Additionally, it aims to maximize both the worst-case and expected returns, increase production levels, and ensure environmental protection. Factors influencing crop production encompass soil characteristics such as pH, nitrogen, phosphate, potassium, organic carbon, calcium, manganese, copper, iron, and soil depth, as well as climatic elements like rainfall, temperature, humidity, and market prices.

According to P. Priya et al. [3] crop yield significantly influences farmers' income. A decline in crop yield may lead to a decrease in rural income. Predicting crop yield is a critical issue in agriculture. Farmers consistently seek to estimate the yield they can expect from their sowing activities. Historically, yield predictions have been based on farmers' prior experiences with specific crops. The agricultural yield is influenced by various factors, including weather conditions, seasonal changes, pest infestations, and the planning of harvest operations. For effective agricultural risk management, having accurate historical crop yield data is essential. Before planting, farmers assess the expected yield per acre for the specific crop. Crop yield prediction entails forecasting the yield based on available historical data, which may include weather parameters, soil characteristics, seasonal factors, and previous crop yields. This predictive analysis aids farmers in determining whether to continue with the intended crop or consider alternative options.

Farmers primarily focus on cultivating crops that enable them to market high-quality products at competitive prices. According to Kit Chan [4], farm management encompasses more than merely planting and harvesting; it involves the comprehensive processes of producing, delivering, and marketing superior crops at optimal prices in the most advantageous market locations. In recent years, the complexity of agribusiness has escalated, underscoring the growing significance of agricultural planning. Crop producers make informed decisions regarding production and sales based on yield and price forecasts.

Agriculture serves as the fundamental pillar of the Indian economy. With advancements in technology, it has become feasible to produce sufficient food for the entire global population. According to Richard N. and Peter R. Scott [5], factors such as climate change, plant diseases, and soil erosion pose significant threats to food security. A diverse array of microorganisms can attack plants, leading to complex interactions where microbes extract nutrients from the plants while the plants attempt to defend themselves against these invaders. In addition to the global implications for food security, plant diseases result in substantial financial losses for farmers. To mitigate these losses, it is crucial for farmers to identify diseases at an early stage and apply the appropriate pesticides. Typically, farmers rely on their experience and visual inspection to detect plant diseases; however, this approach necessitates a comprehensive understanding of the various types of diseases. Some diseases exhibit similar symptoms, which can lead to confusion in accurate identification. Therefore, the automation of plant disease identification is essential to support farmers. Symptoms of different diseases can be compiled into a dataset, and data mining techniques can be utilized to diagnose diseases based on the observed symptoms.

This study primarily focuses on the utilization of data mining techniques to forecast the types of crops to be cultivated, taking into account factors such as soil quality, yield, market price, and fertilizer usage. Additionally, it aims to predict potential diseases affecting the cultivated crops, enabling farmers to enhance their profitability and improve their quality of life.

(a) **Difficult for the choosing the right crop:** Farmers often encounter challenges in selecting the appropriate crops for cultivation, as they must consider soil nutrient levels, forecast yields based on current climatic conditions, determine suitable fertilizers, anticipate market prices, and identify potential diseases that could harm their crops. These difficulties can lead to significant financial losses, causing farmers to perceive agriculture as an unreliable source of income. To address these issues, it is essential to provide effective solutions that can assist farmers in achieving improved yields and profitability. The primary objective of this initiative is to develop innovative algorithms and design a framework that facilitates the selection of profitable crops for cultivation. This framework will be based on predictions regarding crop yield, expected market prices, necessary fertilizers, and early identification of diseases, utilizing various data mining techniques.

(b) **Experimental design of the study:** In this work, all the problems will be implemented using PYTHON with the dataset. Based on the nature of the problem and dataset, classification or clustering or time series or regression model will be designed. The performance of the algorithms will be analyzed based on the corresponding metrics. Some new algorithms and techniques those are better than the existing one will be proposed.

The steps involved are
- Collection of data
- Preprocessing the data
- Identifying the model to be designed
- Applying the existing algorithms
- Proposing a new better algorithm or technique
- Finally giving a framework

3. CONCLUSION

This research aims to develop a framework that will aid farmers in selecting crops for cultivation by considering factors such as soil nutrients, market prices, crop yields, and fertilizer requirements. Additionally, the study will focus on identifying diseases affecting cultivated crops, thereby mitigating potential losses. An analysis of various classification algorithms for crop prediction will be conducted, evaluating their performance. Furthermore, the study will assess existing algorithms for yield prediction and propose a new algorithm to enhance predictive accuracy.

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Environment Conservation for Prosperous and Safe Bharat

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ABSTRACT

CNG may serve as a pivotal transitional fuel during the next decade as the globe changes towards broad electric vehicle (EV) usage. CNG, as compared to diesel and petrol, produces much fewer pollutants and greenhouse gases, thereby serving as a more environmentally friendly choice. While the infrastructure for diesel and petrol is well-established, these fuels contribute heavily to air pollution and climate change. As EV technology and charging infrastructure advance, it will still take several years for EVs to fully dominate the transport sector. During this transition, CNG offers a viable solution to reduce emissions and reliance on more polluting fossil fuels. Additionally, CNG is frequently more cost-effective, possibly cutting fuel prices for households and companies. The rising proportion of savings indicates that the use of CNG is getting more cost-effective as time goes on. The saving vary between 6-8 % basis vehicle model. CNG is widely regarded to be a cleaner alternative to diesel since it produces less pollutants and greenhouse gases. With saving cost of fuel CNG fuel has saved 30 Tonnes of CO_2 from 62 fleet surveyed in Nov'23 , while for July 2024 month 117Tonnes of CO_2 emission has been saved for 130 CNG fleet.

1. INTRODUCTION

Transportation's negative externalities have long been recognized. The demand for international freight transportation has consistently increased as a result of trade globalization, encouraging the growth of international logistics. In the interim, strategies frameworks are under expanding tension because of the effect of the regular habitat. [1]. From 1990 to 2022, transportation emissions increased at an annual average rate of 1.7%, faster than any other end-use sector other than industry (which also increased at a rate of around 1.7%). In 2023, there was a 1.1% increase in CO_2 outflows associated with vitality worldwide, producing 410 million tons (Mt) and a modern record tall of 37.4 billion tons (Gt). In contrast, there was a 1.3% development of 490 Mt in 2022. (Transport - Energy System - IEA, n.d.) [2] It's widely recognized that moving goods by freight is responsible for the biggest portion of emissions from logistics. As a result, finding ways to reduce emissions from transportation, choosing the right types of transportation, and improving the layout of transportation networks are among the most important areas of focus in eco-friendly logistics [3]. As industries evolve, businesses must adopt green logistics and other Environmental, Social, and Governance (ESG) trends to remain competitive. Green logistics involves using fuel-efficient transportation powered by biodiesel and other sustainable fuels, significantly reducing carbon emissions and reliance on non-renewable energy sources. Eco-friendly warehouses equipped with advanced energy management systems can substantially mitigate the environmental impact of business operations by controlling electricity, heat, water, and gas usage. Additionally, the adoption of circular supply chains, emphasizing the reuse and recycling of materials and resources to minimize waste, will become increasingly vital in the coming years. This paper analyses logistics strategies and methods to achieve sustainability in three key areas: Price, People, and Planet.

2. RESEARCH OBJECTIVES

This research focuses on four primary objectives:

(a) Alternative Fuel Selection: Identifying a sustainable alternative fuel to reduce fuel costs and logistics expenses.
(b) Carbon Footprint Reduction: Assessing the impact of green fuels on reducing carbon footprints.
(c) Infrastructure Challenges: Identifying current infrastructure-related challenges in the transition to green logistics.
(d) Policy Evaluation and Recommendations: Evaluating and recommending government policies to enhance stakeholder engagement and participation in green logistics.

3. GREEN FUEL - COMPRESSED NATURAL GAS (CNG)

Compressed Natural Gas (CNG) is a gaseous fuel primarily composed of methane. It is compressed to 200-250 Kg/cm² for automotive use to increase vehicle storage capacity. CNG is a substitute for traditional fuels like petrol, diesel, and Auto LPG. Compressed Natural Gas (CNG) is a form of natural gas kept at a pressure range of 200 to 250 bars, which is clear, odourless, and non-corrosive. It mainly contains a high concentration of Methane (CH4) gas, which generates power for engines when combined with air and undergoes combustion in Internal Combustion Engines (IC Engines). The makeup of the constituent gases in CNG can also differ based on its source. CNG can be manufactured in industrial settings through three common methods: thermogenic (thermal treatment), biogenic (biological treatment), and mixed (which includes both thermal and biological treatment methods). The CNG made using the thermogenic method typically has a higher percentage of CH4 (over 60%) compared to biogenic methane (also over 60%) and mixed CNG (50–60%). Compressed Natural Gas (CNG) offers several benefits over vehicles powered by traditional fuels. When comparing the various physical and thermodynamic characteristics of CNG with those of fossil fuels [4].

(a) **Benefits:**
- **Cost Efficiency:** CNG is economical, delivering excellent performance at a reduced cost and enhancing vehicle mileage.
- **Engine Durability:** CNG does not pollute or thin crankcase oil, thus prolonging engine life.
- **Environmental Advantages:** Emission Reduction: CNG drastically lowers harmful exhaust emissions such as carbon dioxide, carbon monoxide, and particulate matter.
- **Climate Change Mitigation:** By decreasing emissions, CNG contributes to mitigating global warming.
- **Public Health Benefits:** CNG is non-toxic, non-corrosive, and non-carcinogenic, thereby improving public health.

(b) **Safety and reliability:**
- **Safety Profile:** CNG (Compressed Natural Gas) is less dense than air, allowing it to dissipate rapidly and preventing the buildup of dangerous concentrations.
- **Flammability:** CNG has a narrower range of flammability compared to other fuels, making it a safer option.
- **Ignition Temperature:** CNG requires a higher temperature to ignite than other fuels, reducing the risk of accidental ignition.

(c) **Reduction of Emissions: Carbon Footprint**
- **Emissions Produced by CNG Engines**
  - ✓ **Comparison with Diesel:** CNG trucks offer significant environmental benefits compared to their diesel counterparts. In Indian delivery vehicles, CNG trucks emit 75% less carbon monoxide, 49% less nitrogen oxides, and 95% less particulate matter than diesel trucks of the same age. This drastic reduction in emissions makes CNG a much cleaner alternative to diesel, contributing to improved air quality and reduced health risks associated with air pollution.

  - ✓ **Cleaner-Burning Qualities:** The Indian Protection Agency emphasizes the advantages of CNG over diesel due to its inherently cleaner-burning properties. CNG combusts more completely and efficiently, producing fewer pollutants and particulate matter. This cleaner combustion process not only helps in reducing harmful emissions but also enhances engine efficiency and performance.

  - ✓ **Emission Reductions:** CNG vehicles demonstrate substantial reductions in various harmful emissions. They produce only half the particulate matter compared to typical diesel cars, significantly decreasing the release of airborne particles that can cause respiratory and cardiovascular problems. Carbon monoxide emissions from CNG vehicles are also notably lower, contributing to better air quality. Additionally, CNG vehicles reduce nitrogen oxide and volatile organic hydrocarbon emissions by 50%, further mitigating their environmental impact. Depending

on the source of the natural gas, carbon dioxide emissions from CNG vehicles can be reduced by up to 25%, aiding in efforts to combat climate change by lowering greenhouse gas emissions.

(d)   Safety Aspects of Natural Gas Vehicles (NGVs);
CNG is among the safest transportation fuels available, often safer than gasoline or diesel due to its physical characteristics.

- **Flammability Range:** Compressed Natural Gas (CNG) has a narrow flammability range of 4.3% to 15.2% by volume in air, meaning it will only ignite within this specific concentration range. Even if a spark is present, CNG will not burn outside these concentrations. This narrow range significantly reduces the likelihood of accidental combustion compared to other fuels, providing an additional layer of safety.

- **Auto-Ignition Temperature:** CNG has a high auto-ignition temperature of 540°C. This means that CNG requires a significantly higher temperature to ignite on its own compared to many other fuels. The high auto-ignition temperature minimizes the risk of accidental ignition in typical operating conditions, enhancing safety in storage and handling.

- **Density and Dispersion:** Being lighter than air, CNG quickly rises and disperses into the atmosphere if a leak occurs. This property ensures that CNG does not accumulate at ground level, where it could pose a hazard. Instead, it dissipates rapidly, reducing the risk of explosive or flammable conditions forming near the ground, which is a common concern with heavier-than-air fuels like gasoline or diesel.

- **Cylinder Safety:** CNG cylinders are engineered with specialized materials and construction techniques to withstand the high pressures required for storing compressed gas. These cylinders are typically made from high-strength steel or composite materials, designed to endure the stresses of high-pressure storage and transportation. Their robust construction and rigorous safety standards make CNG cylinders safer than conventional petrol tanks, which can be more susceptible to punctures and ruptures. This construction ensures that CNG is securely contained and significantly reduces the risk of leaks and explosions.

(e)   Environmental Benefits of Green Fuel:
- **Methane Emissions Concerns:** Concerns were first raised about the methane emissions from CNG cars and infrastructure, which suggested that they might make global warming worse in a big way. Methane, a highly potent greenhouse gas, was believed to harm the environmental advantages of compressed natural gas (CNG). Nevertheless, by tackling methane leaks at every stage of the CNG lifecycle, these effects can be reduced. Follow-up research has demonstrated that the CNG program's decrease in black carbon emissions, which are significant warming agents, effectively counterbalances the potential adverse impacts of methane emissions. Black carbon, which is emitted in substantial amounts by diesel engines, is a significant driver of climate change. Reducing black carbon emissions yields substantial environmental advantages. There is no text provided.

- **Comparative Studies:** A study conducted in British Columbia has shown that compressed natural gas (CNG) vehicles have a much lower total climate effect compared to older diesel fleets. The study revealed that the warming potential of black carbon emissions from older diesel vehicles much surpasses that of methane emissions from CNG vehicles. CNG is a favourable choice for mitigating the overall environmental impact of transportation. Adopting compressed natural gas (CNG) not only decreases the presence of harmful pollutants, but also aids in minimizing the impacts of global warming by reducing both black carbon and other emissions of greenhouse gases.

(f)   Natural Gas in the Transportation Sector in India
- **Current Usage:** India has made substantial progress in adopting Compressed Natural Gas (CNG) as a more environmentally friendly substitute for conventional fuels. The number of CNG vehicles now in use

on Indian highways exceeds 3.3 million, indicating the increasing use and incorporation of CNG technology. The utilization of Compressed Natural Gas (CNG) has been seeing a steady growth, with a Compound Annual Growth Rate (CAGR) of 7.7%. Nevertheless, in order to maintain and fulfil the expected future need, a significant enlargement of the CNG infrastructure is necessary. The increase rate signifies a strong movement towards more environmentally friendly transportation choices, but it also emphasizes the necessity for further advancements in refueling infrastructure to facilitate this transition.

- **Infrastructure Requirements:** Although there are a significant number of CNG vehicles, the availability of refueling infrastructure is still limited. India has an insufficient 2,207 retail locations for the purpose of recharging vehicles using compressed natural gas (CNG). China, on the other hand, has 4.5 million vehicles that run on compressed natural gas (CNG) and has an impressive 6,500 recharging stations. The significant difference highlights the urgent requirement for India to allocate resources and enhance its CNG refueling infrastructure to enable easier and more comfortable access for owners of CNG vehicles. Improved infrastructure will be essential in facilitating the increasing number of CNG cars and guaranteeing the ongoing prosperity of CNG as a feasible and environmentally friendly fuel choice.

(g) **Regional Distribution:** CNG is now accessible in only 16 states in India, with Delhi, Gujarat, and Maharashtra being the pioneers. These three states are the main contributors and users of CNG, making up more than 80% of the country's CNG use. This concentration suggests that although there has been notable advancement in specific areas, there is a want for a wider dispersion of compressed natural gas (CNG) infrastructure across different geographical locations. In order to achieve universal adoption and ensure a balanced distribution of compressed natural gas (CNG) throughout the country, it is crucial to increase the availability of CNG in additional states. The regional discrepancy underscores the necessity for synchronized endeavors to improve the availability and dissemination of compressed natural gas (CNG) throughout India.

Table 1 : State wise CNG Data

State	No. of CNG Stations	No. of CNG Vehicles	CNG Consumption
Gujarat	28.81%	28.57%	23.34
Delhi/NCR	18.98%	22.96%	34.25
Maharashtra	16.76%	30.13%	26.21
Rest of India	35.43%	18.32%	16.19
Total	2207	3375718	264

(h) **Barriers in CNG Adoption:** Compressed Natural Gas (CNG) currently holds a strong position in international transportation markets, although there are still numerous obstacles that need to be overcome for its widespread adoption. Below are some of the issues associated with Compressed Natural Gas Vehicles:

- **Challenges with Natural Gas Vehicles (NGVs):**
  - ✓ **Driving Range:** One significant drawback of NGVs is their restricted driving range in comparison to conventional gasoline or diesel vehicles. CNG vehicles generally have a reduced range since compressed natural gas has a lower energy density, necessitating more frequent refilling intervals. This can provide significant challenges for long-distance transportation and demanding tasks that require a substantial range.
  - ✓ **Loss of Cargo Capacity:** One challenge that NGVs, particularly light-duty vehicles, deal with is restricted cargo capacity. The CNG cylinders used for storing fuel are commonly located in the vehicle's trunk, occupying up to 50% of the available area for luggage and storage. The decrease in the amount of cargo space that is accessible can restrict the practicality and usefulness of NGVs for the transportation of goods and passengers, hence affecting their overall efficiency and attractiveness.

✓ **Lack of Refueling Stations:** A significant challenge faced by NGVs is the limited availability of refueling stations. The scarcity of infrastructure results in extensive lines at the current CNG fueling facilities, generating irritation and delays for vehicles. The limited availability of refueling choices further curtails the operational scope of NGVs, rendering it challenging for drivers to depend only on CNG for extended trips or in regions with a scarcity of stations.

✓ **Vulnerability of Fuel Supply:** The dependence on a centralized natural gas distribution network implies that any harm or interruption to the network has the potential to sever the fuel supply to an entire city or a specific region. This vulnerability presents a substantial threat to the continuous supply of Compressed Natural Gas (CNG), emphasizing the requirement for a strong and durable infrastructure to sustain Natural Gas Vehicle (NGV) operations.

4. INDIA'S CNG CORRIDOR

India's CNG corridor underwent major improvements in 2023, which was expected given the increasing use of compressed natural gas (CNG) as a fuel for automobiles. During the year, there was a significant rise in the sales of Compressed Natural Gas (CNG) vehicles, mostly due to their cost-effectiveness and positive impact on the environment. In FY2023, there was a significant increase of 46% in sales of CNG vehicles, surpassing the milestone of 650,000 units for the first time. The main reason for this rise is the advantageous price difference between compressed natural gas (CNG) and conventional fuels such as petrol and diesel. Maruti Suzuki dominated the market with a substantial 69% share, with Hyundai and Tata Motors following closely behind. The CNG refueling infrastructure in India has been being expanded by both public and private sectors to meet the increasing demand. Refueling will become more accessible and easier as the number of compressed natural gas outlets is projected to rise from 4,500 to 8,000 in the next two years till 2026.

The price of compressed natural gas (CNG) was reduced by Rs 8 per kilogram in April 2023, marking a substantial price drop. The goal of this change was to make compressed natural gas (CNG) vehicles more appealing to buyers in comparison to diesel and gasoline vehicles. Although there has been progress, there are still difficulties that need to be addressed, such as the limited availability of CNG components and the competition from electric cars (EVs). There is, however, reason to be optimistic about the future of the CNG corridor in Indi, given the ongoing efforts to develop the CNG infrastructure and the ongoing launch of new CNG models by manufacturers. All of these changes show that India is committed about getting the word out about compressed natural gas (CNG) as a sustainable and cost-effective alternative fuel.

- **Study Results: CO_2 Emissions from 263 Trucks**

A survey of 263 trucks from a transport company evaluated emissions from Diesel and CNG vehicles. The findings are summarized as follows:

Table 2: Emission data of logistic company - Nov'23

Emission data of logistic company if the CNG fleet vehicle arc of Diesel, the total emissions would have been 808.05 tonnes of CO_2 eq.				
Vehicle Type/ No. of Veh.	**Vehicle Category**	**Number of vehicles**	**Total emissions Tonnes of CO_2 per month**	**Avg per vehicle CO_2 tonnage per month**
Diesel (195)	HDV	138	584.34	4.2
	MDV	45	85.58	1.8
	LDV	12	33.6	2.7
CNG (68)	HDV	5	7.44	1.48
	MDV	53	63.06	1.18
	LDV	10	4.4	0.44
TOTAL		263	778.43	
% of CO_2 emissions reduction		3.8		

- **Diesel Fleet Vehicles**
  The diesel fleet consists of various vehicle types, including Heavy Duty Vehicles (HDVs), Medium Duty Vehicles (MDVs), and Light Duty Vehicles (LDVs). The emissions data is as follows:
  - ✓ **HDVs:** With 138 vehicles, this category emits a total of 584.34 tonnes of CO_2 per month, averaging 4.2 tonnes per vehicle.
  - ✓ **MDVs:** This category has 45 vehicles, contributing 85.58 tonnes of CO_2 monthly, averaging 1.8 tonnes per vehicle.
  - ✓ **LDVs:** Consisting of 12 vehicles, LDVs emit 33.6 tonnes of CO_2 per month, with an average of 2.7 tonnes per vehicle.

- **CNG Fleet Vehicles**
  In contrast, the CNG fleet comprises 68 vehicles, distributed among different vehicle categories:
  - ✓ **HDVs:** There are 5 HDVs emitting a total of 7.44 tonnes of CO_2 per month, with each vehicle averaging 1.48 tonnes.
  - ✓ **MDVs:** This category includes 53 vehicles, producing 63.06 tonnes of CO_2 monthly, which is 1.18 tonnes per vehicle on average.
  - ✓ **LDVs:** The 10 LDVs emit a total of 4.4 tonnes of CO_2 per month, averaging 0.44 tonnes per vehicle.

- **Emission Reduction**
  Overall, the total emissions from the CNG fleet amount to 778.43 tonnes of CO_2 per month. When compared to the hypothetical scenario where the fleet would have been powered by diesel, which would have resulted in 808.05 tonnes of CO_2 eq emissions, there is a notable reduction in emissions. This reduction amounts to 3.8%, underscoring the environmental benefits of switching from diesel to CNG for fleet vehicles.

The data clearly demonstrates the environmental advantages of CNG over diesel. Despite the fewer number of vehicles, the CNG fleet significantly reduces the total CO_2 emissions, contributing to lower greenhouse gas emissions and a cleaner environment. Expanding the use of CNG vehicles and the necessary refueling infrastructure could further enhance these benefits, promoting a more sustainable transportation sector.

Key Findings:
Environmental Impact Reduction: The carbon dioxide (CO_2) emissions stemming from the transportation sector have steadily increased over time, with freight transportation having a substantial part in driving this upward trend. Implementing eco-friendly logistics solutions, such as the utilization of Compressed Natural Gas (CNG), can greatly contribute to the reduction of emissions. Based on the data analysis of 263 trucks, the study found that CNG vehicles emit considerably less CO_2 than diesel vehicles. Theoretical emissions from a fleet of diesel vehicles would have amounted to 808.05 tonnes of CO_2 equivalent each month, while the fleet of vehicles powered by compressed natural gas (CNG) emitted only 778.43 tonnes of CO_2, resulting in a reduction of 3.8%. The research highlights the environmental advantages of transitioning to compressed natural gas (CNG), demonstrating significant decreases in carbon dioxide (CO_2) emissions. This transition supports the goal of a cleaner environment and aids in the fight against climate change.

The statistics indicates that if the existing CNG fleet were replaced with diesel vehicles, the total emissions would have reached 1055.7 tons of CO_2 equivalent (CO_2 eq) each month. The emissions breakdown for diesel automobiles is as follows: 147 heavy-duty vehicles (HDV) emit 617.4 tonnes of CO_2 per month, with an average of 4.2 tonnes per vehicle. Additionally, 42 medium-duty vehicles (MDVs) emit 75.6 tonnes per month, averaging 1.8 tonnes per vehicle. Lastly, 62 light-duty vehicles (LDV) emit 167.4 tonnes per month, with an average of 2.7 tonnes per vehicle.

Table 3: Emission data of logistic company with increased fleet – June 24

Emission data of logistic company if the CNG fleet vehicle are of Diesel, the Total Emissions Would Have Been 1055.7 Tonnes of CO_2 Eq.				
Vehicle Type/No	Vehicle Category	Number of vehicles	Total emissions Tonnes of CO_2 per month	Avg per vehicle CO_2 tonnage per month
Diesel (251)	HDV	147	617.4	4.2
	MDV	42	75.6	1.8
	LDV	62	167.4	2.7
CNG (87)	HDV	3	4.44	1.48
	MDV	49	57.82	1.18
	LDV	35	15.4	0.44
TOTAL			338	938.06
% of CO_2 emissions reduction			12.5	

On the other hand, the CNG vehicles have markedly reduced emissions. Regarding CNG vehicles, the emissions of CO_2 per month are as follows: 3 heavy-duty vehicles (HDV) emit a total of 4.44 tonnes, with an average of 1.48 tonnes per vehicle; 49 medium-duty vehicles (MDV) emit a total of 57.82 tonnes, with an average of 1.18 tonnes per vehicle; and 35 light- duty vehicles (LDV) emit a total of 15.4 tonnes, with an average of 0.44 tonnes per vehicle. The overall emissions amount to 938.06 tons of CO_2 per month when considering the combined fleet of both diesel and CNG cars. This leads to a decrease in CO_2 emissions of 12.5% when compared to a fleet consisting entirely of diesel vehicles.

5. RESULTS & DISCUSSION

According to the numbers, switching to CNG vehicles from diesel ones is a money-saver. The total fuel cost for 68 compressed natural gas (CNG) cars in November 2023 was ₹3,260,605, which was 10.35% less than diesel's ₹3,637,212. In June 2024, there were 86 compressed natural gas (CNG) vehicles on the road, which resulted in ₹44,11,800 for CNG fuel compared to ₹50,27,391 for diesel. As a consequence, fuel expenses were cut by 12.24%, leading to greater savings of ₹6,15,591

An increase in the percentage savings from 2023 to 2024 is due to the increasing number of compressed natural gas (CNG) vehicles in the fleet. According to the numbers, the advantages of compressed natural gas (CNG) over diesel will become more apparent as the fleet size of CNG vehicles grows. This pattern highlights the monetary benefit of switching to compressed natural gas (CNG) cars, which includes savings on fuel and, maybe, on running costs in the long run.

Table 4: Savings of fuel

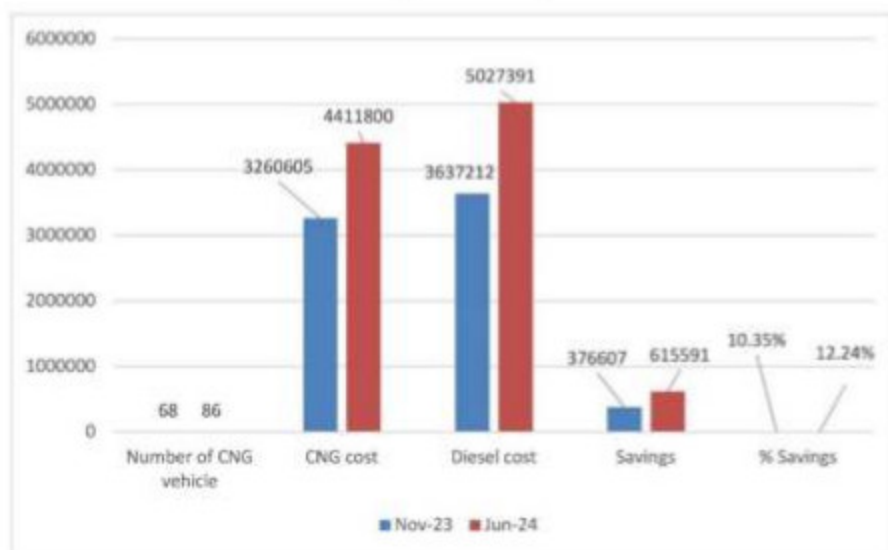| Year	Number of CNG vehicle	CNG cost	Diesel cost (₹)	Savings (₹)	% Savings
Nov-23	68	32,60,605	36,37,212	3,76,607	10.35
Jun-24	86	44,11,800	50,27,391	6,15,591	12.24

Fig. 1: Graphical Representation of study

In addition, the fact that the percentage savings have grown steadily throughout the two time periods shows that CNG may be scaled up to be a better, more economical alternative to diesel. It also implies that there may be larger financial returns with a larger fleet size from the original investment in CNG infrastructure and automobiles.

Cost-Effectiveness: The rising proportion of savings indicates that the use of CNG is getting more cost-effective as time goes on. This makes it a feasible choice for the logistics firm.

Environmental Benefits: CNG is widely regarded to be a cleaner alternative to diesel since it produces less pollutants and greenhouse gases. This is one of the factors that contributes to its environmental benefits. With saving cost of fuel CNG fuel has saved 30 Tonnes of CO_2 from total fleet, while till July 2024 117 Tonnes of CO_2 emission has been saved.

Infrastructure and Transition: Until the widespread acceptance and full development of electric vehicles (EVs) and associated infrastructure, compressed natural gas (CNG) acts as a realistic and pragmatic alternative. It delivers a beneficial mix of cost savings and environmental benefits.

6. CONCLUSION

Fossil fuels have been the dominant source of energy for powering industries, transportation, and homes around the world for many years. However, their negative impacts such as greenhouse gas emissions, air pollution, price instability, and geopolitical issues have prompted a reassessment of energy sources. This has driven the exploration and adoption of cleaner, more sustainable alternatives like Compressed Natural Gas (CNG), bioethanol, electricity, and other alternative fuels.

Transitioning to these alternatives can create a pathway to a cleaner, more sustainable future. Alternative fuels are characterized from two perspectives, i.e., the fuel mix for short to medium-term use and the fuel mix for long-term use. Generally, CNG and biofuel are identified to be useful fuel mixes for short to medium-term frameworks (14). Currently, there are 2208 CNG stations in India (15).

Compressed Natural Gas (CNG) may serve as a pivotal transitional fuel during the next decade as the globe changes towards broad electric vehicle (EV) usage. CNG, as compared to diesel and petrol, produces much fewer pollutants and greenhouse gases, thereby serving as a more environmentally friendly choice. While the infrastructure for diesel and petrol is well-established, these fuels contribute heavily to air pollution and climate change. As EV technology and charging infrastructure advance, it will still take several years for EVs to fully

dominate the transport sector. During this transition, CNG offers a viable solution to reduce emissions and reliance on more polluting fossil fuels. Additionally, CNG is frequently more cost-effective, possibly cutting fuel prices for households and companies. Therefore, although EVs represent the ultimate aim for sustainable transportation, CNG may successfully bridge the gap, lessen environmental damage, and assist the transition from conventional fossil fuels to a completely electric transport system.

8. FUTURE RECOMMENDATIONS

(a) **Infrastructure Investment:** Investing in the expansion of the infrastructure for refilling with CNG is absolutely necessary. Increasing the number of CNG stations in India across a bigger number of states will make it easier for people who drive vehicles that run on CNG to adopt the fuel and make it more accessible to them. For the purpose of supporting the increasing number of CNG cars, it is vital to develop a supply network that is both robust and resilient in order to guarantee that fuel availability is not interrupted.

(b) **Policy Support:** There is a need for government policies and incentives to encourage the adoption of compressed natural gas (CNG) and other green logistics practices. These policies and incentives include subsidies for CNG vehicles, tax benefits, and funding for infrastructure development. Policies that aim to reduce methane leaks throughout the lifecycle of CNG can further enhance the environmental benefits of CNG, ensuring that it has a positive impact on the mitigation of climate change.

(c) **Public Awareness and Industry Collaboration:** For the purpose of bringing about change, it is essential to educate stakeholders, such as enterprises, policymakers, and the general public, about the advantages of compressed natural gas (CNG) and environmentally friendly logistics. Collaboration between various participants in the industry, government agencies, and environmental organizations has the potential to encourage innovation and the application of best practices in environmentally responsible logistics.

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A Review on Green Cloud Computing

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ABSTRACT

A relatively new field, "green cloud computing" aims to lessen cloud computing's negative effects on the environment by implementing greener, more energy-efficient practices. A review of green cloud computing, its goals, obstacles, and potential solutions are presented in this article. Virtualization, server consolidation, and renewable energy sources are some of the methods we look at to achieve green cloud computing. We go on to talk about the financial benefits for companies and the possible environmental benefits of green cloud computing, including less energy usage and carbon emissions. Finally, we take a look at what the future holds for green cloud computing and how it could affect both the IT sector and the environment.

Keywords: - Green cloud computing, Energy efficiency, Data center optimization, Green IT, Green data centers.

1. INTRODUCTION

Many businesses are turning to cloud computing as a way to save expenses and boost productivity. On the other hand, cloud computing's meteoric rise has resulted in massive increases in both energy usage and carbon emissions, both of which exacerbate global warming. To mitigate cloud computing's negative effects on the environment without sacrificing its usefulness, "green cloud computing" has grown in prominence as a field of study. The idea, difficulties, and potential benefits of green cloud computing are discussed in this article.

2. LITERATURE SURVEY

The term "green cloud computing" describes an approach to cloud computing that uses eco-friendly methods and tools to lessen the negative effects on the environment, such as energy usage and carbon emissions. Researchers and practitioners are becoming interested in green cloud computing, according to a literature review. They are investigating different parts of energy-efficient computing, renewable energy sources, and sustainable behaviors. Within the framework of environmentally conscious cloud computing, several studies have examined energy-efficient computer systems. Beloglazov et al. [1] and Lin & Zou [2] are two examples of studies that looked at how virtualization, load balancing, and power management may be used in cloud systems to lower energy consumption and increase resource utilization. Cloud data center energy optimization using AI and ML algorithms has been the subject of other research [3]. In the context of green cloud computing, renewable energy sources including wind and solar power have also been investigated. To keep energy costs down and environmental impacts to a minimum, certain cloud service providers have begun using renewable electricity to power their data centers, while others have investigated energy storage options [3]. Also, researchers have thought of ways to distribute resources that are conscious of energy use and renewable power sources [4].

Loh and Shafie [5] note that green cloud computing has also investigated sustainable strategies such server consolidation, decommissioning of outdated technology, and recycling initiatives. In order to enhance environmental sustainability in a broader sense, several academics have investigated how green cloud computing might facilitate new types of cooperation and information exchange across many stakeholders, including governments and corporations [6]. In spite of these encouraging trends, green cloud computing still faces several obstacles and has many unanswered concerns. For instance, according to Zhang et al. [7], there should be better ways to assess the cost-effectiveness of green computing technologies and more precise and trustworthy metrics to analyze the environmental impact of cloud computing. Additional multidisciplinary studies that unite environmental science, energy engineering, and computer science are required.

Finally, a literature review on green cloud computing shows that the topic is becoming more popular as both academics and industry professionals investigate many facets of sustainable practices, renewable energy, and energy-efficient computing. The area of green cloud computing has a lot of potential for lowering cloud

computing's environmental effect and fostering sustainability in general, but there are still a lot of obstacles and unanswered problems.

3. STRATEGIES FOR ACHIEVING GREEN CLOUD COMPUTING

When it comes to cloud computing, "green" means using methods that cut down on energy usage and pollution. Some of these methods include:

(a) **Virtualization:** This technology cuts down on the need for physical servers and energy usage by allowing several virtual computers to run on a single physical server.
(b) **Server Consolidation:** This method reduces energy consumption and maintenance expenses by merging several underused servers into a smaller group of more powerful servers.
(c) **Renewable Energy:** Switching to renewable energy sources like solar or wind power can lessen our need on fossil fuels and cut down on pollution.

4. BENEFITS OF GREEN CLOUD COMPUTING

Among the many advantages that green cloud computing offers are:
Green cloud computing helps companies cut down on energy use and the expenses that come with it. Green cloud computing helps the environment by reducing carbon emissions through the use of renewable energy and energy-efficient technology. In terms of money, green cloud computing is a good choice as it may help companies save money in the long run.

5. CHALLENGES AND OPPORTUNITIES

Green cloud computing has several potential benefits, such as lowering energy usage and carbon emissions, but it also has certain drawbacks, such as: Green cloud computing methods and technologies can be difficult to implement and sometimes need substantial financial and human resources commitments. Data Sovereignty and Location: The utilization of renewable energy sources and regulatory compliance might be affected by the physical locations of cloud data centers. Potentially conflicting goals in cloud computing include energy efficiency and performance/availability.

6. FUTURE OF GREEN CLOUD COMPUTING

As companies strive to lessen their influence on the environment and embrace sustainable practices, the prospects for green cloud computing are bright. Green cloud computing may be made more accessible through the creation of new standards and technology like the Energy Star for Data Centers and the Green Grid. Further innovation in renewable energy sources is possible through the use of technologies like blockchain, energy storage, and microgrids. Green cloud computing is quickly becoming a standard in the IT sector, thanks to the rising demand for environmentally friendly activities.

7. CONCLUSION

To lessen the negative effects on the environment, researchers and developers in the field of "green cloud computing" are hard at work. Green cloud computing is a way to preserve the advantages of cloud computing while drastically reducing energy usage and carbon emissions. It does this by utilizing energy-efficient technology, renewable energy sources, and sustainable practices. Green cloud computing is an appealing alternative for companies who want to lessen their influence on the environment, despite the fact that it isn't without its difficulties. With the constant advancement of technology and the growing importance of sustainability in business, the future of green cloud computing seems bright.

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