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BEYOND BOUNDARIES

Integrating Insights from Diverse Disciplines

Sukheep Kaur & Reenu Kamboj

Beyond Boundaries

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MESSAGE

"Beyond Boundaries: Integrating Insights from Diverse Disciplines" embodies the spirit of change, embracing the need for collaboration, innovation, and holistic understanding in a rapidly evolving world.

This book is a testament to the power of diverse perspectives, uniting ideas from various disciplines to address the complexities of contemporary challenges. The chapters within explore transformative themes, from reimagining education and technological integration to social innovations symbolizing the transformative approach of breaking traditional silos in education and fostering a holistic learning environment. We need to understand the importance of **Cross-Disciplinary Collaboration** that is when we are moving beyond rigid academic compartments to create synergies between disciplines like technology, social sciences, environmental studies, and humanities, leading to a sustainable world.

By blending insights from diverse disciplines, the education system can nurture global citizens who are empathetic, innovative, and prepared to tackle complex challenges collaboratively for the well-being of future generations.

I extend my sincere gratitude to all the contributors whose scholarly works have enriched this compilation. This book is a step toward fostering deeper connections and cultivating a spirit of shared learning across domains.

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CONTENT

PROTECTION OF ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

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ABSTRACT

Environment protection is sine quo non for sustainable development and it has been a challenge to governments. The environmental degradation due to unplanned and arbitrary development has led to an adverse impact on environment and human health. With increased use and over consumption of natural resources through science and technology, has led to devastating impacts on environment. Indian Legal system has introduced laws and formed tribunals like National Green Tribunal to deter the environmental damage. However, inefficient implementation of these laws has left the governments clueless. The laws and policies are questioned on their effectiveness and seriousness in relation to the environmental laws. The Indian judiciary has played crucial role in environment sustainability by giving landmark judgments and orders by invoking its powers under Article 32. The "right to live in a healthy environment" is read into Article 21 by the courts. The doctrine of sustainable development is a multidisciplinary concept shared by law, economics and politics. This paper explores various aspects of sustainable development and interrelation of various legal aspects for environment protection in India along with the contribution made by judiciary in the form of decisions.

Keywords: Fundamental Rights, Sustainable Development, Environment Protection, National Green Tribunal Act, Article 21.

I. Introduction

There is a direct relationship between protection of environment and sustainable development. There is great role being played by state agencies in enforcing environmental laws and policies resulting in sustainable development. In great number of cases the higher courts and tribunals have adjudicated the environment related disputes keeping in mind the sustainable development issues.

Sustainable development is an approach involving concern by human beings towards environment and development without compromising the quality of life. Sustainable development is the best way to attain progress and quality of life. Environment and development are not antinomies; both are required to be addressed in balance for life to go on. Sustainable development means economic development without or with minimum depletion of natural resources. Sustainable development focuses on integration of development and environmental imperatives.[1] "Sustainable development is a Meta fix that will unite everybody from the profit-minded industrialist and risk-minimizing subsistence farmer to the equity-seeking social worker, the pollution-concerned, the growth-maximizing policy maker, the goal-oriented bureaucrat and the vote-counting politician.[2] Rio Declaration, Principle one states thus: "Human beings are at the center of concern for sustainable development" and that they "are entitled to a healthy and productive life in harmony with nature.

[1] *Gurdip Singh, Environmental Law, 24, 2nd Edition, Eastern Book Company, 2016.*
[2] *S. Lele, "Sustainable Development: A Critical Review" World Development 613 (1991).*

National Green Tribunal (NGT)

The NGT was established under the National Green Tribunal Act of 2010, has jurisdiction over all civil cases involving substantial environmental questions. The quasi-judicial body consist of technical experts along with judicial members which help in efficacious and expeditious decision making. It has appellate and original jurisdiction over seven statutes listed in schedule I of the NGT Act, 2010.[3] The NGT Act explicitly recognizes the environmental principles such as the sustainable development, precautionary principle and the polluter pays principle. The National Green Tribunal is required to apply these principles while deciding cases.[4]

II. Meaning of Sustainable Development

World Commission on Environment and Development (WECD) headed by Gro Harlem Brundtland, the Prime Minister of Norway, defined the concept of sustainable development thus: "Sustainable development means development that meets the needs of the present generation without compromising the ability of the future generations to meet their own needs." Though symbolic, this definition remains relatively unhelpful when it comes to providing clues for the legal characterization of the notion. Sustainable development does not belong to pure law; it may be an important philosophical or political objective. It may be an area where law can throw light upon it in terms of policies, schemes and regulations. The Sustainable Development may have impact on the International political objectives as such may influence the content of the law while remaining separate from it.[5] Development will be sustainable only when both intergenerational (environmental protection) and intra-generational (fair economic and social development) equity are guaranteed, and this is to be achieved through their integration.[6] This requirement is particularly well illustrated in Principle Four of the Rio Declaration which states: "In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it". Reconciliation of environmental protection and economic and social development, through their integration, is commonly seen as the core philosophy underlying the very concept of Sustainable Development. The vagueness of the concept of Sustainable Development and the impossibility of precisely defining it or clearly identifying its component parts have led some to conclude that it is empty of substance or incapable of legal classification. However, it is argued that the evolutive nature of sustainable development, rather than being a weakness, represents the strength of the concept.

In Silent Valley case, illustrates the conflict between a hydroelectric project and biodiversity conservation. In Char Dham Pariyojna, the impact of infrastructure development on the fragile Himalayan ecosystem was examined. In Asiatic Lion case, the court deliberated on the necessity of reintroducing the endangered Asiatic lion into Kuno, a potential second habitat. In the Central Vista Project, the Supreme Court's approach to the Rule of Law and democratic due process in the context

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[3] Schedule I of NGT Act, 2010:1. The Water (Prevention and Control of Pollution) Act, 1974; 2. The Water (Prevention and Control of Pollution) Cess Act, 1977; 3. The Forest (Conservation) Act, 1980; 4. The Air (Prevention and Control of Pollution) Act, 1981; 5. The Environment (Protection) Act, 1986; 6. The Public Liability Insurance Act, 1991; 7. The Biological Diversity Act, 2002

[4] S. 20 of National Green Tribunal Act, 2010

[5] Virginie Barra, Sustainable Development in International Law: Nature and Operation of an Evolutive Legal Norm, EJIL (2012), Vol. 23 No. 2, p. 378

[6] Gill, G. N. (2014). The national green tribunal of India: a sustainable future through the principles of international environmental law. Environmental Law Review, 16(3), 183-202.

of large-scale development projects is noteworthy. Each case reveals the complexities and limitations inherent in balancing developmental needs with environmental and societal considerations.

In Society for Protection of Silent Valley vs Union of India and Others[7]
The Society for Protection of Silent Valley v. *Union of India and Others*[8] case was a landmark environmental issue in India. It revolved around the proposed construction of a hydroelectric dam in the Silent Valley region, which is a biodiversity hotspot. The Kerala High Court's decision in 1980 did not stop the project, citing the limited scope of judicial intervention in policy decisions.[9] The court initially showed its reluctance to intervene in policy decisions. This stance potentially undermined the significance of environmental considerations in judicial decision-making. Additionally, the case underscored the limitations of legal frameworks at the time in addressing and prioritizing ecological concerns, especially in the context of development projects. This highlighted a gap in the legal system's ability to effectively balance environmental conservation with developmental needs. However, continuous public advocacy and environmental concerns eventually led to the project's cancellation in 1983. This case is significant as it highlights the growing environmental awareness and activism in India during that period, and the eventual declaration of Silent Valley as a National Park in 1985 was a major victory for environmental conservation.[10]

In Chardham case petitioner approached the Supreme Court against NGT decision regarding construction of roads in Chardham. The Supreme Court in favor of a wide, 10-meter tarred surface double-lane paved shoulder (DL-PS) road design for the Char Dham Pariyojna (CDP) marks a significant setback for environmental conservation in the Himalayas. The CDP project aims to improve and develop a 889-kilometer-long national highway network, including the Char Dham pilgrimage route, which passes through ecologically fragile valleys of the Bhagirathi river basin. Petitioners and experts had advocated for a narrower intermediate width (IW) of 5.5 meters, highlighting the ecological sensitivity of the region. However, the Supreme Court's decision endorsed the DL-PS standard, emphasizing the impermissibility of second-guessing the infrastructural needs of the Armed forces. The judgment emphasized the concept of 'sustainable development' and the need to balance social and economic needs with environmental considerations. It also stressed that sustainable development should aim at preservation for present and future generations. However, it failed to address the practical challenges on the ground, including landslides, roadblocks, and tragic deaths that have occurred due to the extensive road construction in the Himalayas.[11]

Furthermore, the judgment referred Government circulars and guidelines to justify the DL-PS standard, even though some of these documents had been hastily amended to align with the project's

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[7] *Decided by Kerala High Court on 2nd January 1980.*
[8] *O.P Nos. 2949 and 3025 of 1979*
[9] *Legal. (n.d.). Society for protection of Silent Valley vs Union of India and Others. Legal60.com. Retrieved December 16, 2023, from https://legal60.com/society-for-protection-of-silent-valley-vs-union-of-india-and-others/*

[10] *Prasad, M. K. (n.d.). Silent valley case: An ecological assessment. Cusat.Ac.In. Retrieved December 16, 2023,from http://dspace.cusat.ac.in/jspui/bitstream/123456789/10999/1/Silent%20Valley%20Case%20An%20Ecological%20Assessment.PDF*
[11] *Bhardwaj, P. (2021, December 15). Chardham highway project. SCC Blog. https://www.scconline.com/blog/post/2021/12/15/chardham-highway-project-environmental-compliance-not-a-mere-checkbox-committee-headed-by-justice-ak-sikri-to-oversee-implementation-of-hpcs-recommendations-sc/*

objectives. The judgment's reliance on these documents overlooked the ecological fragility of the region and the potential consequences of such wide roads. the Supreme Court's decision in the Char Dham Pariyojna case raises concerns about the impact of infrastructure development on the fragile Himalayan ecosystem. It highlights the need for a more balanced approach that considers both developmental and environmental imperatives to ensure the long-term sustainability of the region.[12]

The limitation of the Supreme Court's judgment on the Char Dham Pariyojna focuses on its failure to adequately address the ecological fragility of the Himalayas. The decision, by prioritizing infrastructural needs, overlooks the practical challenges and environmental impacts such as landslides and roadblocks caused by extensive road construction in a sensitive ecological zone. This highlights a gap in balancing developmental objectives with the urgent need for environmental conservation in vulnerable regions like the Himalayas.

In Asiatic Lion case[13] the Supreme Court of India deliberated on the necessity of reintroducing the endangered Asiatic lion into Kuno, a potential second habitat. While the State of Gujarat argued against this, citing existing sanctuaries in Gir and potential conflicts with local communities, the Supreme Court ruled in favor of reintroduction. The court emphasized the historical presence of Asiatic lions in Kuno and the adequate prey base, deeming the move essential for the species' survival. Consequently, the court directed the Ministry of Environment and Forest to facilitate this reintroduction within six months.

The limitations in the Supreme Court's judgment on the reintroduction of Asiatic lions into Kuno primarily revolve around potential conflicts with local communities and the prioritization of anti-poaching measures. The State of Gujarat's concerns about community conflicts, particularly with farmers, and the emphasis on fighting poaching rather than establishing new sanctuaries, were significant considerations that the Court had to balance against the urgent need for species conservation. These factors highlight the challenges in implementing conservation measures in human-inhabited landscapes.

Central Vista development Project had the objective of providing good infrastructure which leads to strengthening the functioning of legislature and improving efficiency and productivity of administration.[14] The Environmental sustainability was ensured in the construction process and strategy to increase green cover was made. Nonetheless the Central vista project was challenged in the Supreme Court.

The Supreme Court of India upheld Environmental Clearance of the Central Vista in *Rajeev Suri*[15] *case*, it was contended that public consultation was not done effectively. In a democratic country public consultation in administrative decisions is very important and cannot be treated just as a formality. Any developmental project would have an impact on public at large thus Environmental Impact Assessment notification 2020 has made public consultation precondition before proceeding with the developmental project. The Supreme Court stated that public participation shall not become

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[12] *Patel, P. (n.d.). When the Himalayas lose: Assessing Char Dham Pariyojana judgment. Org.In. Retrieved December 16, 2023, from https://www.downtoearth.org.in/blog/environment/when-the-himalayas-lose-assessing-chardham-pariyojana-judgment-80755*

[13] *Centre for Environmental Law v. Union of India WP(C) No.202 of 1995*

[14] *https://centralvista.gov.in/guiding-principles.php#sect2 last visited on 16th December 16, 2023 7:50 pm*

[15] *Rajeev Suri v. Delhi Development Authority, 2021 SCC OnLine SC 7.*

impediment to a developmental work.[16] It is also argued that the grant of Environmental Clearance falls under the jurisdiction of NGT and the Supreme Court should not curtail the power of NGT, since two other petitions were pending regarding the same subject matter the orders of the Supreme Court will prevail.

The limitations of the Supreme Court's judgment in the Central Vista case include a narrow scope of judicial review, focusing mainly on the legality of executive actions rather than broader policy implications. This approach potentially limits the Court's capacity to address complex socio-environmental aspects of large-scale development projects. Additionally, the reliance on constitutional due process without a substantive evaluation of the project's impact reflects a restrained interpretation of judicial power in governance matters.

In the Central Vista case, the Supreme Court of India's judgment highlighted the constrained scope of judicial review in India's governance, focusing on constitutional compliance rather than broader policy implications. This approach, while ensuring legal adherence, potentially limits judicial capacity to fully address the multifaceted impacts of large-scale developmental projects, reflecting a careful balancing act between legal scrutiny and respect for legislative and executive domains.[17]

Good environment is essential to ensure basic human rights, even the right to life, for no human right can be secured in a degraded environment. An example will highlight the importance of a green and healthy environment. Misuse of our natural resources, a key environmental issue, has direct impact on fundamental human rights such as right to food, right to water, right to air and right to life itself. It is important to draw linkages between environment and human rights to further build bridges between legislations relating to the two. Human beings can ensure fundamental equality and adequate conditions of life in an environment that permits a life of dignity and well-being. There is an urgent need to formulate laws keeping in mind the fact that those who pollute or destroy the natural environment are not just committing a crime against nature, but are violating human rights as well.[18]It is realised that the environment and its protection are crucial in maintaining the tempo of development. This issue has been taken up seriously by all the organs of government.

III. CONCLUSION

The Supreme Court of India and the National Green Tribunal play crucial roles in environmental conservation in India. Through landmark cases, they have effectively balanced development and environmental protection, contributing significantly to sustainable development. 4 major cases are covered in this article they are, the Silent Valley case, the Supreme Court prioritized ecological preservation over a hydroelectric project, highlighting its commitment to environmental protection. The Chardham case reflected a judicial attempt to balance development with environmental concerns in the Himalayas. In the Asiatic Lion case, the court demonstrated proactive conservation efforts by ordering the relocation of Asiatic lions to mitigate extinction risks. The Central Vista judgment

[16] *Das, A., & Naik, S. (2021). India as a Participatory Democracy & the Central Vista Judgement: A Discussion. GNLU L. Rev., 8, 1.*

[17] *Unravelling the central vista judgment: Democratic due process and judicial review. (n.d.). LawBeat. Retrieved December 16, 2023, from https://lawbeat.in/columns/unravelling-central-vista-judgment-democratic-due-process-and-judicial-review*

[18] *V, Shaharban, Preservation of the Environment and Sustainable Development - A Constitutional Perspective (March 31, 2018). Available @SSRN: https://ssrn.com/abstract=3153328 or http://dx.doi.org/10.2139/ssrn.3153328*

showcased a nuanced approach to urban redevelopment, balancing heritage conservation with modernization needs. These cases collectively demonstrate the judiciary's vital role in shaping India's environmental jurisprudence. Sustainable development has been the result of realising negative environmental and social consequences of arbitrary economic development approaches. Sustainable development is a process that envisions a favorable future for human societies in which living conditions and the use of resources meet human needs without compromising the integrity, beauty, and stability of vital systems. Sustainable development provides solutions to the structural, social, and economic patterns of development to address issues such as the destruction of natural resources, the destruction of biological systems, pollution, climate change, population growth, injustice, and the declining quality of life of present and future humans. Sustainable development is answers the current and future needs in the use of resources, investment guidance, technology development orientation, and institutional change. Sustainable development is emphasized in terms of human development related to the environment and future generations. Human development implies cultivation of human capabilities. Sustainable development approach to environment protection answers the twin questions of development and sustainability for future development.

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KARNATAKA'S CULTURAL HERITAGE: SAFEGUARDING GEOGRAPHICAL INDICATIONS

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ABSTRACT: Geographical indication, which is one of the intellectual property rights, is a sign used on goods that have a specific geographical origin and possess qualities, reputation or characteristics that are essentially attributable to that origin. GI is mainly used to assign good belonging to different products. The products include agricultural, handicraft, manufacturing and food stuffs from a particular region or place. GIs have been recognized as a vital tool for preserving cultural heritage and promoting sustainable livelihoods for rural communities. It leads to human development. The chapter highlights the benefits of GIs, including enhanced market value, preservation of traditional skills, and increased tourism. This chapter explores the impact of Geographical Indications (GIs) on traditional industries in Karnataka, India.

Keywords: Geographical Indications, traditional industries, cultural heritage, rural development, sustainable livelihoods, Karnataka.

INTRODUCTION

Geographical Indications indicates that particular goods originates from a country, region or locality and have some special characteristics, qualities or reputations which are attributable to its place of origin. These special characteristics, qualities or reputation may be due to various factors, example natural factors such as raw materials, soil, regional climate, temperature ,moisture etc; or the method of manufacture or preparations of certain products such as traditional production methods; or other human factors such as concentration of similar businesses in the same region, specialization in the production or preparation of certain products and the maintaining of certain quality standards.[1]

The connection between the goods and place becomes so famous that any reference to the place reminds the goods being produced there and vice versa.

Geographical Indications, also referred to as appellations of origin, are "indications which identify a good as originating in the territory of a member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin".[2] Obtaining the status of protected Geographical Indication requires "a precise product specification which includes a definition and evidence of the link to the geographic area in which the product originates.[3] Geographical Indications (GIs) have emerged as a vital tool for promoting rural development and preserving cultural heritage in India. By recognizing the unique characteristics of local products and services, GIs provide a framework for rural communities to leverage their traditional knowledge and skills to access new markets and opportunities. Karnataka, a state in south western India, has been at the forefront of GI registration, with a diverse range of products and services recognized, from Mysore Silk and Dharwad Pedha to Coorg Coffee and Udupi Mattu Gulla

[1] *Surekha Vasishta and Amar Raj Lall,'Geographical Indications of Goods(Registration and Protection)Act,1999' In AK Koul and V K Ahuja(eds),The Law of Intellectual Property Rights:In prospects and Retrospects,2001,p.248.*
[2] *World Trade Organisation www.wto.org.*
[3] *The Journal 2004, "Move over the River Is a Tide of Change for SS" May 20, ed 1 P.S. New Castle Chronicle and Journal Ltd., New Castle, UK.*

Brinjal. This paper examines the impact of GIs on rural development in Karnataka, exploring the ways in which GIs have influenced rural livelihoods, entrepreneurship, and cultural preservation.

FUNCTIONS OF GEOGRAPHICAL INDICATIONS

Geographical indications perform a variety of economic and other functions, which may depend on how producers use geographical indications and consumers view them.[4]

i) Origin function: Designations operate as indicators of origin from which the products come or are in some other way connected.

ii) Quality Functions: Designations symbolise qualities which certain products have or which consumers associate them with and guarantee that they measure up to expectation.

iii) Investment or advertising function; Designations are ciphers around which investment in the promotion of a product is built and that investment is a value which deserves protection as such, even when there is no abuse arising from misrepresentations either about origin or quality.

iv) Culture protecting function: Designations protect culture by preserving traditional productions methods, habits of consumption and cultural identity.[5]

The Functions underlie the nature and scope of geographical indication protection.

GEOGRAPHICAL INDICATIONS AS A PRODUCER DEVICE

It is in the interest of a producer to try in some way to differentiate his products from those of others. This power of branding has traditionally evaded producers of highly commoditised products such as agricultural products.[6] Geographical indications may provide producers with a new or an extra means to identify their products as satisfactory and thereby attract further purchases from the consuming public.[7] This may be especially important to small-scale producers who may not be able to make the substantial investments which are needed to promote an individual brand.[8]

Geographical indications allow producers to create an attractive product image, possibly even an image of exoticness, quality or prestige, which the consumer associates with the product. The image that is formed has a sales-promoting effect. This is what is traditionally meant by the advertising or investment function. The sales promoting effect of given geographical indication is usually connected to the quality of the product but geographic indications can also generate their utility through evocative and aesthetic uses. In such cases, the geographic indication itself becomes a desired characteristic of a good or services, regardless of quality. Thus, a geographical indication can gain 'a selling-power above that of the underlying goodwill'.[9] In other words, with the help of geographical indications producers may obtain premium prices for products that would otherwise be regarded as a commodity product.

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[4] These functions are similar to those traditionally distinguished for trademarks. See e.g. Jeremy Philips, Trademark Law: A Pravrical Anatomy (2003); and Onno Brouwer, community Protection of Geographical Indications and Specific Characters as a means to enhance Foodstuff Quality (1991) 28 ML Rev. 615, 630.

[5] Tomer Broude, "Taking Trade and Culture" Seriously: Geographical Indications and Cultural Protection in WTO Law (2005) 649 Express Opreprin Series, 16; MEMO/03/160 why do Geographical indications matter to us, 30 July 2003.

[6] Norma Dawson, 'Famous and Well-known Trademarks: usurping a corner of the Giant's Robe' (1998) I.P.Q. 350, 378.

[7] Chiquita and Dole are one of the few who have been successful in promoting highly commoditised products, namely bananas and pineapple.

[8] Jermy Philips, Trademark Law: A Practical Anatomy (2003) 28 ML Rev. 26.

[9] Sanjeev Agarwal and Michael J. Barone,.

Others may try to imitate a geographical indication and use the goodwill the producers have built up. By using the geographical indications on a similar or different product, third parties can transfer the sales-promoting effect to their products through the inevitable association in the consumers mind. This may be seen as unfair competition. Producers can use geographical indications to shore up the prices of their products only if the advertising and investment function is properly protected. Geographical indications are valuable to producers as they allow producers to 'unlock value by capitalising on consumer desire for diversity, typical, quality products.

PROTECTING LOCAL CULTURE AND TRADITIONS

Geographical indications seem apt for the preservation of local traditions, national culture and cultural diversity. This is because geographical indications do not reward innovation but rather producer adherence to the traditional methods used in the region of production. Geographical indications enhance the commercial value of traditional artisan products and may even rescue 'national treasures' from certain extinction.[10] According to Broude, geographical indications products may be 'cultural' in three ways through (1) the cultural of its production, (2) the culture of its consumption or (3) as a part of the culture identity. A product does not receive geographical indication protection only by virtue of its geographical origin but because it complies with a given set of criteria pertaining to content and production methods. In many cases, these practices are rooted in social and historic circumstances and are not necessary for the characteristics and qualities of the finished product. If the practices were to become extinct, it would also result in the eradication of the associated culture of production. Thus, geographical indication rules can also be seen to preserve a certain historical and cultural purity of production. However, for product qualities and characteristics to survive and be appreciated, they need a culture of consumption. This culture of consumption is maintained by providing consumers with accurate information on the geographical origin of products.[11] Geographical indication products may also be cultural symbols part of cultural identity.[12] They can symbolise or even personify a country or a region. Thus, geographical indications can be seen as guardians of cultural identity and a defence against homogeneity brought about by globalisation.

GEOGRAPHICAL INDICATIONS IN KARNATAKA

Karnataka is a state in the southern part of India, bordered by the Arabian Sea coastline to the west, Goa to the northwest, Maharashtra to the north, Andhra Pradesh and Telangana to the east, Tamil Nadu to the southeast and Kerala to the southwest. On 1st November 1956, all the Kannada language-speaking regions were merged to form the State of Karnataka, with the passage of the States Reorganization Act. Formerly called as the State of Mysore, it was renamed as Karnataka in 1973. It is the sixth-largest state in India. Bengaluru (earlier Bangalore) is the capital city of Karnataka and is regarded as the silicon valley of the country. Karnataka is a treasure trove of traditional industries and cultural heritage. From the majestic Mysore Palace to the vibrant folk art of Yakshagana, the state is home to a rich legacy of craftsmanship, artistry, and entrepreneurship. To preserve and promote these traditional treasures, the concept of Geographical Indications (GIs) has emerged as a vital tool. Karnataka has been at the forefront of GI registration, with several products recognized for their unique characteristics and cultural significance. Being the fourth most popular destination for tourism

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[10] Andrew Griffiths, The Impact of the Global Appreciation Approach on the Boundaries of Trademark Protection (2002) I.P.Q. 326 see also David Aakes, Building Strong Brands (1996) 7, who identifies goodwill consisting of the following four elements: awareness, loyalty, perceived quality and positive associations.

[11] Nany Harmon Jenkins, 'Food court" the European Union has judged hundreds of traditional foods to be national treasures. Here is why cooks are celebrating', food and wine, August 1999.

[12] Broude, supra n.5, at 10-12.

in India, Karnataka has secured 44 Geographical Indication (GI) Tags on handicrafts, agricultural, manufactured and food products.

The latest to get the GI tag from Karnataka is the Kari Ishad Mango,' (Application no 843).The lead taken by Karnataka State in getting GIs for its products augments the efforts made by both the government and voluntary organizations to protect and promote the state's cultural and biological diversity. The GIs will help the state maintain exclusivity about its products.

The huge number of Karnataka GI tags is clearly helping the State maintain its uniqueness. Not only does it help in preserving the heritage, but also promotes the culture and flavour of individual cities and towns while emphasizing on biodiversity.

The impact of Geographical Indications (GIs) on rural development in Karnataka is significant:

1. Income generation: GIs have created new income streams for rural communities, enhancing their livelihoods and reducing poverty. GIs have generated economic benefits for local communities, enhancing their livelihoods and encouraging entrepreneurship. The GI status has enabled Dharwad Peda makers to expand their market reach and increase their income. Increased sales, improved quality, and premium prices have generated more income for rural producers.
2. Employment opportunities: GI-protected products have generated employment opportunities in rural areas, particularly in traditional crafts and agriculture.
3. Rural entrepreneurship: GIs have encouraged rural entrepreneurship, enabling local communities to develop and market their unique products. The GI status has helped Channapatna Toy makers to improve their livelihoods and promote traditional toy-making techniques.
4. Preservation of traditional knowledge: GIs have helped preserve traditional knowledge and skills, ensuring their continuation and transmission to future generations. GIs have helped preserve traditional crafts like Mysore Silk, Ilkal Saree, and Molakalmuru Saree, ensuring their continuation and promotion. The GI status has helped Mysore Silk weavers to improve their livelihoods and preserve traditional weaving techniques. GI status has helped preserve traditional skills, recipes, and cultural practices.
5. Community empowerment: GIs have empowered rural communities, enabling them to take control of their cultural heritage and economic development. GIs have safeguarded local industries like Dharwad Pedha, Ilkal Saree and Udupi Mattu Gulla Brinjal, shielding them from unauthorized use and misrepresentation.
6. Infrastructure development: GI initiatives have led to infrastructure development in rural areas, including training centers, workshops, and market facilities. The Karnataka government has actively supported GI initiatives, providing infrastructure and resources for promotion and protection.
7. Market access: GIs have facilitated market access for rural products, connecting them to national and international markets. The GI status has helped Mysore Agarbathi manufacturers to improve their production quality and expand their market reach.
8. Premium prices: GI-protected products often command premium prices, increasing the earnings of rural producers and artisans. The GI status has helped Coorg Coffee farmers to improve their coffee quality and fetch better prices.

9. Cultural preservation: GIs have helped preserve rural cultural heritage, including traditional practices, customs, and language.
10. Rural-urban connectivity: GIs have fostered rural-urban connectivity, promoting collaboration and exchange between rural and urban communities. By promoting rural development, GIs have contributed to the overall growth and prosperity of Karnataka, demonstrating the potential of intellectual property rights to drive sustainable development.

CHALLENGES AND CONCERNS

Despite Karnataka's rich cultural heritage and traditional industries, the state has witnessed a decline in GI registrations post COVID-19,lagging behind other states. This trend raises concerns about the potential loss of traditional knowledge and practices, as well as the economic opportunities that GI provides. To revitalize karnataka's GI ecosystem, it is essential to address the challenges faced by artisans, farmers, and entrepreneur's, such as

1. lack of awareness about the GI registration process, benefits ,and requirements.
2. Insufficient financial resources, infrastructure, and support systems for GI promotion and registration.
3. Inadequate institutional framework, infrastructure and resources for GI promotion, registration, and enforcement.
4. Shifts in consumer preferences, market trends, and global trade agreements, requiring traditional industries to adapt and innovate.
5. Limited understanding and protection of intellectual property rights, making it challenging to safeguard traditional knowledge and practices.

   These challenges and concerns highlight the need for concerted efforts to address the decline in GI registrations, support traditional industries, and promote karnataka's cultural heritage and economic growth.

CONCLUSION

In conclusion, the decline in Geographical indications registrations in Karnataka post-COVID-19 is a pressing concern that warrants immediate attention. The challenges and concerns highlighted, including lack of awareness, complex registration processes, resource constraints, and changing market dynamics, have cumulatively contributed to this trend. To revitalize Karnataka's GI ecosystem and preserve its cultural heritage, it is essential to address these challenges through;

Enhanced awareness and capacity building initiatives

Streamlined registration processes and institutional support

Increased resource allocation and funding

Innovative marketing and promotion strategies.

By adopting a multi-faceted approach, Karnataka can unlock the full potential of its traditional industries, foster economic growth and safeguard its cultural heritage for future generations. The state's rich cultural legacy and traditional industries are too valuable to be lost, it is time for collective action to ensure their preservation and prosperity.

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INTERNET OF THINGS IN HEALTHCARE: SERVICES, APPLICATIONS, CHALLENGES AND EMERGING TRENDS

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ABSTRACT

The Internet of Things (IoT) is a framework that uses networking technology to enable real-world objects to interact and communicate with one another. The Internet of Things (IoT) revolution, which is defined by technological improvements, better economic efficiency, and good social ramifications, is having a transformative effect on the healthcare business. IoT plays a critical role in automating manual tasks and enhancing patient outcomes through the collection of key data. This change gives people the ability to actively control their own healthcare and has the potential to completely change medical procedures and preventive care, ultimately enhancing well-being for all people worldwide. The main advantages and inspiration for the creation of IoT-enabled healthcare systems are explained in the study. we examine the distinctive security and privacy aspects of IoT that are necessary for smart healthcare as actual risks and challenges to the widespread use of IoT in healthcare applications. Additionally, the study investigates the potential applications of cutting-edge technologies in the context of smart healthcare. In conclusion, we delineate the principal obstacles and prospects, particularly concerning the distinct demands of healthcare applications, and provide directions for future investigation grounded in the recognized holes.

Keywords: Internet of Thing, IOT, Healthcare, Security, Privacy, E health, Telemedicine

IOT

The Internet of Things, or IoT, is a network of physicalobjects such as automobiles, electronics, and home appliances that are implanted with software, sensors, and network connectivity to allow them to communicate and gather data[1].A revolutionary change in the provision, control, and administration of medical services is brought about by the Internet of Things (IoT) in the healthcare industry.
An outline of the main elements services, applications, technology, security issues, and new trends—is provided below.

1. IoT in Healthcare

It has been projected that by 2028, the IoT healthcare industry will have grown from $128 billion in 2023 to $289 billion. That is an annual growth rate of about 18%![2].IoT is helping medical professionals to provide better, more proactive treatment by tracking medical assets and keeping an eye on patients' vital signs in real time. In this, we'll examine the definition of IoT, its present uses in healthcare, its main advantages, as well as some of its major drawbacks. As a result, a variety of patient data is collected via IoT-based healthcare systems, and physicians and other medical specialists provide feedback [3]. Continuous glucose monitoring insulin pens are the greatest example of this. All of these devices have the ability to share data and work together to provide life-saving help during an emergency. In order for doctors to take the necessary action, an Internet of Things (IoT) healthcare device would collect the data and then send this crucial information to the cloud [4]. This

suggests that the possible use of IoT in healthcare could enhance patient outcomes, staff productivity, and hospital operations.

Here is the workflow of IoT healthcare:

A sensor gathers patient data, which a physician or nurse enters.

- The gathered data is analyzed using machine learning (ML) and other AI-driven methods.
- The gadget determines whether to send the data to the cloud or take action.
- Using the data supplied by IoT healthcare systems, medical professionals can make quick and well-informed judgments.

The healthcare IoT industry is anticipated to develop at a 17.8% annual rate (CAGR 2023–2028), as we have already covered, and reach a market value of US$289.2 billion by 2028[5].Other noteworthy data on IoT's present status in healthcare include:

- The services segment held a 59% revenue share in 2022.
- The hospital segment has garnered a 35% revenue share in 2022.
- Asia Pacific region is projected to grow at a CAGR of 18.50% from 2023 to 2032.here is a market share of IOT in healthcare ,by Region

Regions	Revenue Share in 2022 (%)
North America	40.30%
Asia Pacific	20.60%
Europe	25.70%
Latin America	9%
MEA	4.40%

- IoT gadgets are beginning to be incorporated into healthcare procedures in hospitals, clinics, assisted living facilities, and even patients' homes. Smart watches and fitness trackers are two of the wearable's that are most frequently utilized in the healthcare industry[6]. They give patients the ability to track their exercise levels and keep an eye on their health in real time. Early warning symptoms of diseases like cancer are being identified with the use of computer vision technology, and edible sensors are being used to track medication adherence and patient vital signs. IoT technology lowers healthcare expenses while enhancing patient outcomes. Patients can receive care from home thanks to the Internet of Things' applications in telemedicine and remote patient monitoring, which lowers the need for hospital stays and readmissions. IoT-enabled research is producing novel therapies and better patient outcomes

2. SERVICES IN IOT HEALTHCARE

2.1 Remote Patient Monitoring: Real-time tracking of patients' health state by healthcare providers through wearable gadget monitoring of patients' vital signs[7]. Remote Patient Monitoring (RPM)

enables medical professionals to keep an eye on patients' health from a distance using electronic gadgets. RPM is useful for monitoring a range of situations, such as acute illnesses, chronic disorders, and prenatal care.

- **Telemedicine**: Virtual consultations and follow-ups facilitated by IoT devices, improving access to care, especially in remote areas. Telemedicine services, also known as telehealth, are a way to access healthcare without visiting a doctor's office. They can be used for a variety of purposes, including: **Virtual visits**: Patients can see a doctor, nurse, or mental health counselor using a phone call or video chat. **Tracking health**: Patients can use technology to track their health and share information with their provider. **Sending messages:** Patients can safely send messages to their healthcare provider.
    - **Telepharmacy:** Patients can receive medication remotely, and pharmacists can review medications and conduct video consultations[8].
    - **Tele-audiology:** Patients can receive audiological services. Telemedicine services can be accessed using a smartphone, tablet, or computer with an internet connection. Before a visit, the healthcare team may provide information or forms to fill out online, and ensure the patient has the necessary technology[9]. **Telemedicine can be used for a variety of conditions, including: Migraines, Skin conditions, Diabetes, Depression, Anxiety, Colds, Coughs, and COVID-19**

2.2 Smart Medication Management: Systems that remind patients to take medications and track adherence using connected devices. Smart Medication Management refers to the use of technology and systems to enhance the way medications are prescribed, dispensed, and taken by patients[10]. It aims to improve adherence to medication regimens, reduce errors, and streamline the overall process of managing medications. Here are some key components:

- **Medication Tracking**: Apps and devices can help patients track what medications they need to take, when to take them, and if they have taken them[11].
- **Reminders and Alerts**: Systems can send reminders to patients via notifications or alarms to help them remember their medication schedules.
- **Data Analytics**: Collecting data on medication usage can help healthcare providers understand patterns and make informed decisions about treatment plans.
- **Smart Pill Dispensers**: These devices can dispense the correct dosage at the right time, reducing the chance of errors.
- **Patient Education**: Providing information about medications, including side effects and interactions, helps patients make informed decisions about their health.

Overall, smart medication management systems leverage technology to improve patient outcomes and enhance the efficiency of healthcare delivery [12].

2.3 Asset Tracking: IoT solutions for managing medical equipment and inventory, enhancing operational efficiency in hospitals.

Equipment Tracking: IoT devices can monitor the location of medical equipment (like wheelchairs, infusion pumps, and diagnostic machines) in real time, helping staff quickly locate necessary tools[13]. **Inventory Management**: IoT systems can automate the tracking of medical supplies, ensuring that items like medications, surgical instruments, and consumables are stocked appropriately and replenished as needed. **Condition Monitoring**: Sensors can monitor the condition of temperature-

sensitive items, such as vaccines and certain medications, alerting staff if they fall outside safe ranges [14]. **Patient Tracking**: Wearable devices can monitor patient movements and vital signs, providing real-time data to healthcare providers and enhancing patient safety and care. **Asset Utilization Analytics**: Data collected from tracked assets can be analyzed to determine usage patterns, helping healthcare facilities optimize resource allocation and reduce idle time [15]. **Maintenance Alerts**: IoT systems can track the usage and performance of medical equipment, providing alerts for scheduled maintenance to prevent unexpected failures and downtime. **Staff Efficiency**: By knowing where equipment is located and ensuring supplies are readily available, healthcare staff can spend less time searching for items and more time providing care. **Compliance and Reporting**: Automated tracking can help ensure compliance with regulatory requirements for equipment usage and storage, facilitating easier reporting and audits [16]. **Emergency Response**: In critical situations, quick access to necessary equipment can be facilitated through real-time tracking, potentially improving patient outcomes.

3. KEY TECHNOLOGIES

- **Sensors and Wearables**: Sensors and wearables are integral to modern healthcare, providing innovative solutions for monitoring health, enhancing patient engagement, and enabling personalized medicine [17]. Their ability to collect and analyze data in real time is transforming how healthcare is delivered and managed. Devices equipped with various sensors to collect health data, such as temperature, heart rate, and blood pressure [18].
- **Cloud Computing**: Cloud computing plays a crucial role in the Internet of Things (IoT) ecosystem by providing the necessary infrastructure and services to handle the vast amounts of data generated by IoT devices [19]. Its scalability, cost-efficiency, and ability to support advanced analytics make it a key enabler of IoT innovation and application across various industries.
- **Artificial Intelligence**: Enhances data analysis for predictive analytics, personalized medicine, and decision support [20].
- **Edge Computing**: Edge computing is poised to transform healthcare by providing faster, more efficient data processing and analytics. Its ability to enhance patient monitoring, improve privacy and security, and support the growing ecosystem of IoT devices makes it a critical component of modern healthcare infrastructure [21].

4. APPLICATIONS

IoT has also introduced several wearable's & devices which has made the lives of patients comfortable [22]. These devices are as follows

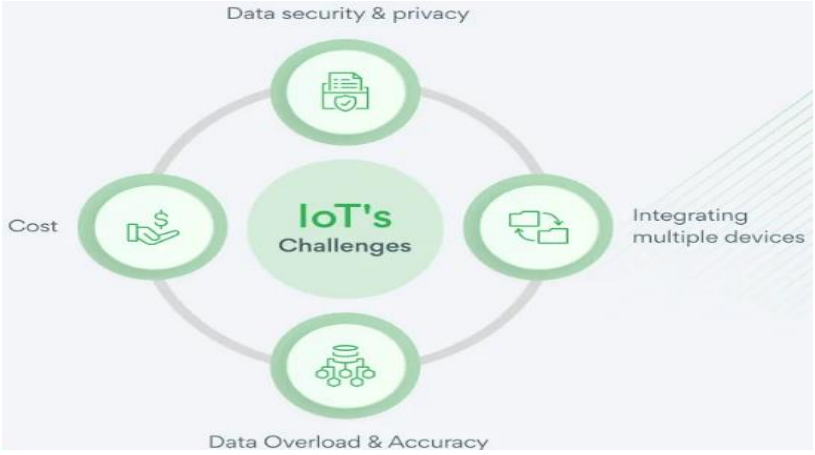
- **Wearable Devices:** Smart watches and fitness trackers that monitor heart rate, activity levels, and other health metrics.
- **Hearables**: The way those with hearing loss interact with the outside world has fundamentally changed because to wearable technology, or hearables. These days, wearables can be paired with your smartphone via Bluetooth[23]. Real-world sounds can be enhanced using layered features, equalization, and filtering. The best example of it is Doppler Labs.
- **Ingestible Sensors**: Incredibly, edible sensors are a modern science marvel. These are tiny sensors the size of pills that keep an eye on the medication we take and alert us if they notice any abnormalities in our bodies[24].For a diabetic patient, these sensors can be quite helpful

as they can reduce symptoms and offer early detection of serious health problems. One instance of this is Proteus Digital Health.

- **Moodables**: Moodables are gadgets that elevate our mood and work to keep us happier all day long[25]. Though it seems like science fiction, it's not that far from the truth. It's already under development by Thync and Halo Neurosciences, who have made great strides. Wearable's that attach to the head called "Moodables" use low-intensity currents to improve our mood.
- **Computer Vision Technology**: Drone technology, which attempts to replicate visual perception and decision-making based on it, has been made possible by computer vision technology and artificial intelligence [26].Computer vision technology is used by drones such as Skydio to identify and avoid obstacles. People who are blind or visually challenged can also effectively navigate with the help of this technology.
- **Healthcare Charting:** IoT gadgets like Audemix cut down on the amount of manual labor a doctor must perform when charting patients. It records patient data and is operated by voice commands. It facilitates easy access to the patient's data for review. It reduces the workload of doctors by fifteen hours every week.
- **Insulin Pens and Smart CGM:** These gadgets are used to share data via a specific mobile app and check blood glucose levels in real-time. Diabetes sufferers can use these gadgets to monitor their blood sugar levels and even transmit this information to their physician and other appropriate medical personnel [27].
- **Smart Video Pills:** An intelligent tablet passes through the intestines of a patient to capture an unobstructed image. After that, it can transmit such images to a wearable gadget that is linked to specific medical apps. Additionally useful for remote colonoscopy and gastrointestinal tract visualization are smart pills [28].

5. SECURITY AND PRIVACY ISSUES IN MODERN HEALTHCARE SYSTEMS

To ensure an acceptable level of privacy, the healthcare system must adhere to multiple overarching security and privacy criteria. While IoT has the potential to revolutionize healthcare, several challenges need to be addressed:



Data Security & Privacy

One of the main challenges that IoT poses to the healthcare sector is data security and privacy[29]. IoT security gadgets broadcast and record data instantly. However, most IoT devices don't adhere to data protocols or security guidelines. In addition, there's a lot of ambiguity around the regulations controlling who owns data on technical equipment. Because of all these factors, the data is extremely susceptible to hackers who might break into the system and compromise the Personal Health Information (PHI) of doctors and patients. Fraudsters can obtain prescription drugs and medical supplies that they can resale by using patient electronic health records to create false identification cards. In addition, hackers may submit a false insurance claim using a patient's name [30].

Integration: Multiple Devices & Protocols

Integration of different devices is a barrier to IoT implementation in the healthcare sector. This issue arises from the fact that device makers cannot agree upon communication standards and protocols[31].As a result, in situations where several devices are connected, the differences in their communication protocols hinder and make data collection more difficult. The non-uniformity of the linked devices' protocols slows down the process and reduces the possibility for IoT scalability in the healthcare sector[32].

Data Overload & Accuracy

As previously mentioned, the utilization of many communication protocols and standards poses challenges for data aggregation. However, IoT devices continue to collect enormous amounts of data. Data collected by IoT devices is utilized to derive significant insights [33].However; the amount of data available is increasing, making it more difficult for doctors to make decisions based on it, which finally results in a reduction in the standard of care. This will eventually pose a risk to patient safety. Moreover, this concern is growing as more devices become connected and record larger volumes of data [34].

Cost

Are you surprised that there are financial considerations in the challenging parts? Though I'm sure most of you would be, the reality is that IoT hasn't yet made affordable healthcare services available to the general public[35]. The rising expense of healthcare is a concern for all parties involved, particularly those who reside in industrialized nations. As things are, people with serious illnesses can receive healthcare in developing countries for as little as tenth of the price; this is a practice known as "Medical Tourism." The idea of IoT in healthcare is intriguing and thrilling[36]. Nevertheless, the financial issues remain unresolved at this time. IoT app development needs to be inexpensive in order for stakeholders to embrace it and reach maximum optimization; else, it will always stay in the future

6. FUTURE DIRECTIONS AND TRENDS.

The healthcare industry has already benefited from IoT, and its potential for the future is exciting. With the healthcare sector becoming more and more digitalized, IoT will play a critical role in shaping its future. The following are some future projections for IoT in healthcare:

1. AI Integration: The most well-known analytical topics in practically every industry, including network security, these days are machine learning and deep learning[37]. Many devices that are capable of learning entire network intrusion detection tactics have been submitted recently, and they may also be used in IoMT healthcare systems. Since deep learning networks are frequently used by medical service providers for diagnosis, research on their application for systems security and privacy is also worth taking into consideration. In this case, PHI is searched at various IoMT system layers in order to identify centralized attacks via deep learning networks.A trend toward better data analysis

and predictive healthcare through the integration of IoT with AI and machine learning is seen in numerous surveys. The way these technologies cooperate is as follows:

Enhanced Data Analysis: IoT devices provide enormous amounts of real-time data from a range of sources (such as wearables, medical equipment, and environmental sensors). Artificial intelligence (AI) and machine learning algorithms are better at analyzing data because they can identify patterns and trends that traditional methods would miss[38].**Predictive analytics:** By using real-time inputs from Internet of Things (IoT) devices and previous data, artificial intelligence (AI) may anticipate patient outcomes, such as the possibility of an illness progressing or a readmission to the hospital. This allows health care providers to take preventative measures[39]. **Customized Treatment Plans:** Machine learning algorithms may assess particular patient data, including genetic data, lifestyle characteristics, and health indicators, to develop customized treatment plans that are more effective than one-size-fits-all approaches[40].**Better Decision Support:** AI can help medical personnel make more informed clinical decisions and better patient outcomes by offering evidence-based recommendations during patient assessments.AI algorithms are capable of continuously monitoring data from Internet of Things (IoT) devices to identify changes in a patient's health or anomalies. This allows for early intervention before the patient's condition worsens[42]**.Operational Efficiency**: The combination of IoT and AI can optimize resource management in healthcare facilities by predicting patient flow, managing inventory, and scheduling maintenance for medical equipment.**Drug Development**: AI-driven analysis of data collected from IoT devices can accelerate drug discovery and clinical trials by identifying suitable candidates for trials and predicting their responses to treatments.**Public Health Monitoring**: By analyzing data from multiple IoT sources, AI can help monitor population health trends, track disease outbreaks, and inform public health policies[43].

2. **Blockchain:** Its purpose was to safely hold accounting records in order to make the blockchain's "blocks" interconnected. In order to provide strong and comprehensive security and privacy protection for IoMT health systems, it will also be used with deliverable medical information kept on a medical server[44]. However, because of their restricted capabilities, IoMT devices might not be able to produce blocks using blockchain technology, which requires a substantial amount of computational power. Blockchain, on the other hand, can be used to store and safeguard electronic health records on medical servers. MedRec is a prominent instance of this application, having led the way in investigating the use of blockchain technology to control access to medical data..

3. Security Assessment: Research teams usually perform their own security assessments, therefore there are no set standards for judging the recommended IoMT security team's security capabilities. Adversarial analysis is one technique academics employ to evaluate the safety of their work[45]. Nevertheless, these critical assessments are incomparable since they are based on different theories and conceptions. In this web-based IoMT security assessment framework (IoMT-SAF) assessment model, recommendations can be produced depending on user input. But this research needs to consider the security benefits of existing crypto tests or checks for cryptographic algorithms. Further research is needed to assess the security capabilities of IoMT healthcare systems[46]. In order for networks to accommodate growing numbers of users, devices, and services without sacrificing security or speed, scalability must be achieved. Communication is another important issue, and in order to facilitate easy communication between different platforms and systems, protocols are required. Security is a continuous problem because of the dynamic risk environment, which compromises strong encryption, authentication, and access control measures meant to protect sensitive information and stop malicious actors[47]. Modern technologies such as edge computing, 5G networks, and the Internet of Things present new difficulties for aid limitations, latency reduction,

and fine-of-provider optimization[48]. Furthermore, the growing reliance on cloud computing and distributed architectures highlights the critical need for resilient, fault-tolerant networks to reduce downtime and provide continuous availability[49]. In order to create forward-thinking solutions that push networking paradigms toward increased performance, dependability, and flexibility in the face of changing technological environments, a comprehensive approach is needed to address such difficult circumstances. This approach should incorporate standards from engineering, mathematics, laptop technology, and cyber security[50].

CONCLUSION

IoT use in healthcare offers the potential to enhance patient outcomes, save costs, and promote preventative care. There is great potential for IoT integration in healthcare to enhance operational effectiveness and improve patient outcomes. Resolving security challenges and guaranteeing legal compliance remain crucial for wider use. Despite the fact that wearables, ingestible sensors, and smart video pills are examples of cutting edge technology, the number of IoT applications continues to rise. The state of IoT in healthcare will continue to shift as a result of ongoing research into cutting-edge trends and technologies, opening the door to creative solutions that improve patient care and operational effectiveness. The rate at which digital health technologies are evolving is revealed by surveys relating to the Internet of Things and the healthcare sector. While there are a lot of benefits and opportunities, there are still a lot of important challenges that need to be addressed, including security, interoperability, and cost. By understanding these dynamics, stakeholders can better navigate the hurdles of incorporating IoT technology, improving patient care and healthcare delivery systems.

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BIG DATA ANALYTICS IN EDUCATION: A SURVEY

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ABSTRACT

Big data analytics has triggered a paradigm shift across numerous trades and education is not an exception. Today, educational institutions have incomparable access to large volumes of data from students, faculty, and administrative systems. Utilizing big data analytics empowers education institutions to make more conversant decisions, boost student learning outcomes, simplify operational processes, and drive heightened efficiency. This complete paper offers a detailed survey of big data analytics in the domains of education. It focuses on the basic concept, various approaches, and the practical applications across various educational domains, prevalent confronts, and the promising future prospects. Additionally, the study highlights the latent of big data to transform education by developing highly personalized and data-driven learning environments that satisfy individual student needs and learning designs.

Keywords: Big Data, Analytics, Education, Machine Learning, Personalized Learning, Educational Data Mining.

1. INTRODUCTION

1.1 Big Data and Its Emergence

Big data includes very huge and diverse sets of information that are expanding at an accelerating pace. It consists of data characterized by high volume, velocity, and variety, often referred to as the three Vs of big data (Gandomi & Haider, 2015). The surge of big data is accredited to technological advancements, particularly in areas such as machine learning, cloud computing, and the Internet of Things (IoT), which facilitate the real-time collection and analysis of vast data sets.

1.2 Role of Big Data Analytics

The field of big data analytics covers the composite process of collecting, processing, and analysing very large and diverse datasets in order to uncover meaningful patterns, correlations, and other valuable insights (Jagadish et al., 2014). Over the past few years, educational institutions have gradually accepted the use of big data analytics to perform their decision-making processes and improve student learning experiences and outcomes. By leveraging the capacity of data-driven insights, educational institutions are able to optimize learning environments, recognise areas for improvement, and ultimately improving student success.

1.3 The Need for Big Data Analytics in Education

In the area of education, the need for big data analytics has arisen due to the growing availability of student data from various sources such as learning management systems (LMS), educational applications, and online platforms (Siemens & Long, 2011). The analysis and interpretation of this data can support educators in shaping learning experiences to individual students, recognizing students who may be at risk, and enhancing the design of curriculum.

2. BIG DATA ANALYTICS IN EDUCATION

2.1 Sources of Big Data in Education

Educational institutions are a powerful source of big data, which is generated from a variety of sources. These sources include:

- Learning Management Systems (LMS) such as Moodle and Blackboard, which track student progress, course engagement, and test scores (Dawson, 2010).
- Additionally, Student Information Systems (SIS) store demographic information, grades, and attendance records (Romero & Ventura, 2010).
- Furthermore, social media and educational applications serve as platforms where students interact and share content, thereby generating additional valuable data (Chen et al., 2015).

2.2 Data Analysis Techniques

The analysis of educational big data often involves the application of highly developed techniques to obtain meaningful insights and improve educational outcomes. These techniques include:

- Predictive analytics: Predictive analytics is used to forecast student performance based on historical data (Baker & Yacef, 2009).
- Educational Data Mining (EDM): It is another crucial approach that involves the application of data mining techniques to educational datasets to detect patterns and trends that can inform instructional strategies and interventions (Romero & Ventura, 2010).
- Learning Analytics (LA): Additionally, Learning Analytics (LA) plays a crucial role in the assessment and analysis of learning processes to gain insights into student progress and to eventually improve educational outcomes (Siemens & Long, 2011).

These advanced techniques collectively contribute to a data-driven approach to education, enabling educators and institutions to make informed decisions and deliver required support to students.

3. APPLICATIONS OF BIG DATA ANALYTICS IN EDUCATION

3.1 Personalized Learning

Big data analytics plays a crucial role in education for personalized learning experiences. By analysing students' learning styles, strengths, and weaknesses, tutors can gain valuable insights into each student's unique necessities. This information can then be utilised to design the learning content and materials to suit individual student’s requirements. Adaptive learning technologies, driven by big data analytics, dynamically modify the educational content and pace of learning to balance the exact needs of each student. This personalized approach not only improves the learning experience but also maximizes the possibility for student success and engagement in the educational process (Johnson et al., 2013).

3.2 Predictive Analytics for Student Retention

Predictive analytics is a powerful tool utilized in educational institutions to proactively recognize students who are probably at risk of dropping out or failing courses. This approach, includes the analysis of comprehensive historical data, but not limited to attendance records, academic performance, and student engagement criterions (Arnold & Pistilli, 2012). By examining these data

points, institutions can effectively interfere at an early stage, offering suitable support to students in order to avoid dropout and ensure their academic success.

3.3 Curriculum Design and Development

In order to enhance curriculum development, educators can use the power of big data analysis to gain valuable visions into the most effective approaches for student learning. By examining various data points such as test scores, student feedback, and engagement criteria, educators can gain a deep understanding of the strengths and weaknesses of their existing course materials. This analysis can then be used to refine and optimize the curriculum, ensuring that it is tailored to meet the specific needs and learning styles of the students. This method represents a data-driven approach that can lead to continuous improvement in educational resources and practices (Greller and Drachsler, 2012).

3.4 Administrative Efficiency

In the context of education, institutions are increasingly using the potential of big data to enhance the efficiency of their administrative processes. This includes the optimization of resource sharing, careful budgeting, and strategic infrastructure planning. Through the thorough analysis of enrolment trends and patterns, educational institutions are inspired to derive valuable insights that inform and guide their decision-making processes related to resource management (Daniel, 2015).

4. CHALLENGES IN IMPLEMENTING BIG DATA ANALYTICS IN EDUCATION

4.1 Data Privacy and Security

The large amount of data stored in educational institutions has raised significant concerns regarding the privacy and security of this data (Slade & Prinsloo, 2013). It is important to prioritize the security of personal information of students as such, educational institutions must create robust data governance policies. These policies should include strong data encryption methods, secure data storage practices, access controls, and regular security audits to ensure the constant safety and privacy of student data.

4.2 Data Integration

Educational institutions often gather data from a number of sources, including student information systems, learning management systems, assessment tools, and many more. However, these data sources are often kept in isolation from each other and are not easily integrated or analysed together. This lack of integration and standardization across data systems poses a major challenge for educational institutions. The absence of regulated data schemes presents a major barrier for effectively utilising data for analysis and decision-making within educational institutions (Siemens, G., 2013).

4.3 Ethical Concerns

The use of student data arises ethical concerns, particularly regarding issues of consent and transparency. It is important for educational institutions to endorse responsible data usage practices and to ensure that students are fully informed about how their data is collected, stored, and utilized (Prinsloo & Slade, 2016). This involves obtaining explicit consent from students before collecting their data and providing clear information about the purposes for which the data will be used. Transparency in data usage is vital for building trust and maintaining ethical standards within educational institutions.

4.4 Lack of Expertise

To effectively implement big data analytics in education, institutions require skilled data scientists who can analyse and interpret the considerable volumes of data generated. However, many educational institutions currently lack the necessary expertise in this area (Daniel, 2015). Therefore, it is important for these institutions to invest in training and development programs to develop the required expertise amid their staff. By providing training in data analytics and related skills, institutions can ensure that they have the capabilities to utilize big data for improving educational outcomes and decision-making processes.

5. FUTURE DIRECTIONS AND OPPORTUNITIES

5.1 Artificial Intelligence and Machine Learning in Education

The convergence of artificial intelligence (AI) and machine learning within the domain of big data analytics holds great potential to transform the field of education. Through the utilization of AI-powered systems, educational institutions can hitch the power of continuous learning from vast educational datasets to elevate and customize the learning experiences of individual students (Luckin et al., 2016).

5.2 Real-time Data Analytics

The future of using big data in the field of education depends on the implementation of real-time analytics. Real-time analytics supports educators to rapidly adapt their teaching methods in response to live data, leading to significant enhancements in the overall responsiveness and effectiveness of educational systems (Sharma et al., 2014).

5.3 Open Educational Resources and Big Data

Open Educational Resources (OER) are increasingly gaining importance in educational domain. The examination and interpretation of data derived from OER platforms offer valuable perceptions into the ways in which learners interact with educational materials. This analysis can further help in identifying specific areas that require enhancement or modification to better satisfy the needs of the students (Weller, 2014).

5.4 Collaborative Learning Analytics

Collaborative learning analytics is a specialized field that focuses on the comprehensive analysis of group dynamics and collaboration patterns within online learning systems. It involves the thorough examination of data derived from various group projects and activities to gain insights into the particulars of how individuals interact and work together. This approach enables educational institutions to enhance their collective learning strategies by using the knowledge and information gathered from the analysis. A study emphasised the importance of this practice in encouraging more effective and efficient collaborative learning experiences (Joksimović et al., 2015).

6. CONCLUSION

In the progressive scenario of the education sector, big data analytics stands at the forefront, offering the potential to help in a transformative era. By using the power of big data, educational institutions can gain invaluable insights that have the capability to revolutionize the learning experience, elevate student achievement, and streamline administrative operations. However, amid the promise of these advancements, it is essential to acknowledge and address the significant challenges that accompany the integration of big data analytics in education.

One of the foremost concerns is the vital issue of data privacy, as educational data contains sensitive information about students, teachers, and administrative staff. Protecting this data while extracting meaningful insights is an important consideration. Additionally, the seamless integration of different data sources and systems within educational institutions challenging, requiring robust strategies for data management and interoperability.

Furthermore, the demand for skilled personnel well-versed in data analysis and interpretation is a pressing requirement. Educational institutions need to invest in the development of capable staff to leverage the potential of big data analytics to drive meaningful change. As the area continues to evolve, the convergence of artificial intelligence and real-time analytics need to collectively use to shape the future of education, offering unprecedented opportunities for personalized learning experiences and predictive interventions.

Amid all these technological advancements, it is essential for institutions to adopt a data-driven decision-making approach, while simultaneously navigating the ethical and practical complexities essential in big data analytics. By accepting these challenges and using the potential of big data analytics, educational institutions can pave the way for a future where data serves as a method for positive transformation in the sector of education.

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THE ROLE OF ARTIFICIAL INTELLIGENCE IN TRANSFORMING THE WORLD

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ABSTRACT

Artificial intelligence (AI) has been rapidly emerged as cathartic technology, reshaping the world at very large scale. This paper traverses the role of AI in transforming the world. It gives us an exposure to the impact of AI across various industries such as healthcare, education, finance and autonomous systems. It focuses on AI capabilities in improving medical diagnosis, better learning experiences, promoting financial markets and upgrading transportation with autonomous vehicles and robotics. This chapter concludes that AI will provide much better opportunities to solve problems at the global level. It must be developed with an assurance that it would benefit the society as a whole.

INTRODUCTION

Artificial Intelligence has emerged as a revolutionising technology, it has reshaped every sector from business to education, healthcare at large. It is transforming the world at unmatched pace. It has also a profound impact on social life of a person, promising the better quality of life. Along with benefitting mankind with better opportunities, It has also posed enormous challenges for human beings. Challenges such as employment, privacy, decision making, etc which are likely to be faced by the world with the emergence of AI technology need utmost attention to be paid. This paper explores various roles of AI and how it can transform the world into a better place. It includes both positive impacts and ethical challenges related with AI technology. The impacts of AI on day-to -day life have been discussed below:

1. THE ECONOMIC IMPACT OF AI

AI has making an era of completely changed global economy led to the fourth industrial revolution.AI has a vast impact on industries by increasing their productivity through its capabilities such as large datasets, automation, data driven decisions etc. It has an overall impact on various industries by reducing costs, improved efficiency, fast speed with more accuracy, led to global growth.

1.1 **AI and the 4th Industrial Revolution**

The Emergence of AI has led to the 4th Industrial Revolution. In this era, intelligent machines and automation are at the peak that has transformed the world. AI provides automation in manufacturing sector to the transportation sector which has given way to work efficiency, cost reduction and much more improvements in production of goods and services.The increase of autonomous system and Robotics has given rise to the emergence of smart processing, fast functioning etc just because of AI driven technology which has given us high productivity with easy maintenance. For example, 'General Electric' has implemented AI based predictive maintenance which monitors the systems so that AI algorithms may detect warning signs of malfunctioning at early stage.

1.2 **AI and Job Transformation**

AI is not only limited to automation but is also supplementing human capabilities. AI works as a professional in making data driven decisions in various sectors such as healthcare and finance. The

Automation creates a dilemma regarding low skill jobs facing challenges due to AI technology. A study by 'The Mckinsey Global Institute' indicates that automation will displace jobs at large. However, it also points that emergence of AI technology will create more job opportunities in some fields such as AI Engineers, Data Scientists, etc.

1.3 **AI in Financial Markets**

AI is playing an effective role in financial sector as it provides automation in trading system, risk management and fraud detection. Algorithms of AI identify the economic trends, make predictions of stock prices, currency updates etc.AI fraud detection system prevents the banking system from faulty transactions and reduce the risks.

2. AI IN HEALTHCARE

AI has a profound impact in healthcare industry. AI in healthcare sector can identify diseases, diagnose disease, manage patient care with various effective treatments. All this is possible with large data sets through AI can detect problems easily and find solutions. This AI is not only limited to diagnosis but has capable for drug discovery, surgery with robots, patient monitoring and many more.

2.1 **AI in Medical Diagnosis and Treatment**

AI is also transforming the Healthcare sector. It improves the accuracy of medical diagnosis. It can analyse the medical reports, genetic tests, X-rays to properly identify disease and also recommends effective treatments. All this is possible only with machine learning algorithms. These AI systems are being used to identify various diseases and its treatment through data analysis.

2.2 **Drug Discovery**

AI plays a major role in Drug discovery. Traditional method to discover a drug is very expensive. AI system checks chemical compounds and other related data to identify the drugs.AI algorithms discover the drug by processing various data sets to treat various diseases. During Covid pandemic, AI algorithms played an important role in discovering the vaccination.

2.3 **AI and Robotics in Surgery**

Artificial intelligence is widely used in surgical procedures, improve the safety and efficiency of surgeries. These systems can lead to lower risk rate of a patient and faster recovery rates. These AI systems use real time data like using cameras during surgery to assist surgeons.

3. AI IN EDUCATION

Integration of AI and Education helps to improve the education system through the way students learn and teachers teach. It provides various innovative tools that offer various way to enhance quality education. Machine learning, data analytics, natural language processing are some of the AI technologies that makes education system more effective.

3.1 **Personalised Learning**

AI helps both teachers to teach and students to learn in an effective manner, through AI based personalised learning platforms such as "Khan Academy" and "Physics Wallah". Personalised learning platforms work on AI algorithms to identify the student's learning pace, progress, weaknesses, etc. These platforms provide assessments and reports in real time, helping learners to achieve their goals.'Carnegie learning' is an AI based learning platform, which identifies the student's report, according to which it offers courses and contents which might improve their performance.

3.2 **AI for Special Needs in Education**

AI also helps students with special needs. Speech recognition and natural language processing play a crucial role in education as it allows disabled students to access education effectively. They can communicate and enhance their social skills. AI technology is also helping globally to improve access to education.

4. AI IN AUTONOMOUS SYSTEMS

Autonomous systems of AI has advancing industries such as transportation, defence, manufacturing etc. Autonomous systems such as self-driving cars, robots, drones are rely on technologies such as machine learning, computer vision, sensor fusion to perform automation, which enhanced efficiency in tasks.

4.1 **Autonomous Vehicles**

One of the most emerging advancements in AI is creation of autonomous vehicles. Companies like 'Tesla',' Waymo' and 'Uber' are using AI systems to make self-driven cars. These systems use techniques like computer vision, sensor fusion and machine learning algorithms to build self-driven cars as these help to navigate paths, avoid obstacles and make real time functioning. With this technology, accidents will reduce, traffic efficiency will improve and many more. However, ethical challenges will remain with emerging advancements.

4.2 **Drones and Robotics**

AI assisted robots and drones are used in various fields such as agriculture, manufacturing, defence etc. In agriculture, AI systems are used to monitor crops, detect pests, etc. AI robots do tasks like sorting products, handling tasks like packaging with great speed and efficiency. For example, Amazon's AI powered robots.

AI AND ETHICS: CHALLENGES AND CONCERNS

As we know AI is growing significantly in everyday life, ethical challenges and concerns are more likely to occur across AI. AI has revolutionising industries on a large scale and improving the quality of life, at where questions about fairness, accountability, transparency etc are raised. AI is using vast amount of data to make decisions, challenge raised if an AI made biases in algorithms. So, we need various frameworks to solve these issues.

Bias in AI

Bias is the basic issue arising with the development of AI systems. Algorithms are good at where they are well trained, otherwise it may create bias or discriminated output. For example, facial recognition systems might create errors in identifying people of different colours where they are not trained properly. To resolve the problem of bias, AI specialists are focusing on creating more data sets with more detailed information, so that AI system gives fair outcomes.

Privacy concerns

As we know, AI systems are based on large datasets. With this, we have come across privacy concerns.AI applications like advertising, social media platforms, etc, collect vast amount of data. So, there is also need to store this data and how to use this data for any system. Organisations are trying to make robust privacy laws and their key concern is to protect data. In Europe, an initiative is taken to maintain the personal data by AI systems, named GDRP (General Data Protection Regulation).

Accountability of Decision Making

In AI systems concerned regarding accountability arises. Various AI systems make various decisions like a Healthcare System identify diseases, diagnose patient, etc. It must have a proper accountable structure. If an AI system makes an incorrect decision, it might create consequences in healthcare field. To improve decision making, researchers are working on transparency and explainability of the AI systems. So that human can better understand their decisions and why a particular decision is made by an AI system.

Future Prospects of AI

Future with AI is promising to improve the lives with advancements that could transform industries and economies. Now AI is moving towards generalization which is capable of solving large complex problems like a human can .

AI and General Intelligence

Currently AI systems are doing narrow tasks. Some of those AI systems which we are using in our day-to-day life to complete our various tasks. Developing AGI is still a challenge for Researchers. AGI refers to the system which can perform like a human with more flexibility and efficiency. AGI can be achieved with advancing unsupervised learning, machine learning and reinforcement learning, which can develop more intelligent AI systems.

AI and Quantum Computing

Another important concept arriving is AI and quantum computing. Quantum computers are capable to process large amounts of data. They are much faster than classical computers. Quantum computing enables AI system to solve complex issues like Drug discovery, Cryptography and climate modelling through data processing in real time.

AI for Good: Addressing Global Challenges

AI is driving into our day to day lives. It can solve various issues like climatic conditions, diseases, improving disaster management, reduce accidents through autonomous systems, etc. For instances, AI assisted climate models have capability to make predictions regarding impact of global warming and able to solve these issues by designing various strategies.AI applications are also used to improve food security through AI driven agriculture system.

CONCLUSION

AI has been transforming the world in many ways. AI offers us various opportunities for increasing innovations, productivity and process in various fields from healthcare to education, finance and autonomous system.AI has the ability to act as a human being or perform actions which a human can also perform. However, with benefits, it also comes across various ethical challenges, privacy and accountability concerns. Issues like bias in algorithms, job displacement, data privacy and accountability should be addressed properly. AI technologies are advancing to a future where AI serves the best true humans.

Ethical frameworks must be implemented to ensure fairness, accountability and unbiased results. Looking ahead, AI is advancing in areas like Artificial General Intelligence (AGI) and quantum computing led to the more advanced AI. As AI continues to evolve, it will be necessary to manage challenges along with advancing innovations.

In conclusion, while AI offers various opportunities to solve complex global problems and improve the quality of life, its global integration requires care for its ethical impacts. So that AI technology overcome its challenges to provide a better life to humans.

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ARTIFICIAL INTELLIGENCE: SOCIAL, PSYCHOLOGICAL AND ETHICAL DILEMMAS

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ABSTRACT

The connection between humans and technology has been the foundation of human development, unfolding from the simple tools in early history to advanced technology that has shaped contemporary society. This paper considers the historical changes of the human technology and their interrelationship spotlighting key milestones, such as agrarian and industrial evolution and the ongoing digital age. Each stage presented new opportunities and challenges, notably transforming social structure and human potential.

The paper also covers psychological, social, and ethical impacts of the current technology, such as digital tool effects, developmental impacts of social media , mental health effects and the disruption caused by mechanization in the labour market. Ethical considerations, such as data privacy, AI-based systems, and the role of autonomous systems, have also been discussed in this paper. As the pace of technology and innovation accelerates, ensuring unbiased distribution and responsible use remains a pressing concern.

Ultimately, this chapter highlights the need for ethical framework and productive measures to align technological advancement with the well-being of society. The future of the human advancement interaction will depend on the balancing progress with responsible supervision to harness its potential for societal benefit.

Keyword: Humans, Technology, AI, Artificial Intelligence

I INTRODUCTION

The coalition between human beings and technology is one of the major features of our civilization, from the essential tools of early humans to the highly advanced technology utilized today. The development of technology has shaped up physical environment, societies, and even our creation . The unit analyzes the historical evolution of humans with technology and the various social, psychological impacts and ethical dilemmas that develop in the present day.

II THE EVOLUTION OF HUMAN TECHNOLOGY

The relationship between humans and technology goes back to the initial days of our species. Homo Habilis, an early human ancestor, is frequently recognized for crafting the earliest tools around 2.5 million years ago. The tools were not complex; A rock flake was used for cutting and a hammer stone for Pounding. It indicated the start of a significant shift; no longer did humans depend exclusively on physical attributes for existence; they even started to use outside items to engage and change their environment.

The invention and regulation of fire which is estimated to have happened around 1.5 million years ago, show great technological inventions. Fire helped humans to cook food, provide warmth and ward off predators, all of which were necessary to the livelihood and advancement of the human sector.

As technology developed, so did human societies. The discovery of the wheel around 3500 BCE restructured transportation and trade, enabling early civilization to raise the size and complexity.

By the time first written language was developed, a wide range of technologies had been created by humans, from tools of agriculture to systems of governance, all playing a crucial role in shaping early communities.

III THE INDUSTRIAL REVOLUTION

The Industrial revolution started in the late 18th century and indicated a change in human history this era. It changed not only the living standards of people but also their relationship with the world and their thinking power. The advancement of machining, factories, and industries changed human life.

The steam engines discovered by James watt in 1769 became a source of energy behind the uprising that leads to the development of factories, ships, mass production of goods and speedy movement of people. The outcome was that it led to growth in urbanization changes in living standards and the expansion of the global economy and connectivity.

Unfortunately, there were many disadvantages of the industrial revolution. It badly affected the environment, led to deteriorated working conditions, and exploited labour, especially women and children. The rapid growth of technology filled many people with excitement that would continue through history.

IV THE DIGITAL AGE

The 20th and 21st centuries recorded the rise of digital technologies. The discovery of computers and the Internet connected the whole global society. Even these technological developments had advances in artificial intelligence (AI), biotechnology, and many more.

The pace of personal improvement in the 1970s, with many companies like Apple and Microsoft, the innovating of the world as a whole hub also affected humans. Interaction enhanced communication and information flow today. The Internet and smartphones are so pervasive that the whole world is connected with them

This growth has raised many inquiries and concerns about privacy data security, automation and AI although technology has the strength to address these questions, it also presents new obstacles and challenges.

V COGNITIVE DEVELOPMENT

Cognitive development particularly in children has been affected by digital technology. Some researchers have also given information that this effect of digital technology leads to a decline in attention spans and critical thinking skills. Moreover a study by Sparrow Liu ,and Wegner 2011 has shown that people do not try to remember and learn information because they know they can get any information from online sources and this phenomenon is also known as the Google effect. On the other hand summary searches have shown that by offering new and modern opportunities for learning and problem solving, digital technology can improve cognitive abilities. For instance, spatial reasoning and hand eye coordination have been improved by video games (Ferguson 2011).

Educational apps and online learning platforms can also offer different learning experiences that serve individual needs.

One of the leading apparent ways technologies have transformed human life is how we communicate. The rise of social platforms such as Facebook, Twitter, and Instagram has changed the way individuals connect with one another, forming network that transcend geographical boundaries.

On one side platforms permit individuals to maintain their relationships over long distance share ideas, and put organize social causes. Gestures like the Arab Spring and #MeToo have been facilitated by social communities, highlighting the power of these technologies to drive social evolution.

However, there are drawbacks to this large connectivity. Studies have appeared that imprudent use of social communities feelings of isolation, unhappiness, and anxiety. Specifically, among juveniles. The constant pressure to present accurated and glorified version oneself online, can lead to adverse self comparison and decreased mental well-being.

Moreover, the rise of echo chambers and filter bubbles on the internet has been related to Getting bigger political polarization. By only revealing individuals to statistics that strengthen their pre- - existing faith, these rostrums can support the spread of false information and the attrition of civil discourse.

Technology has also had a deep influence on the nature of chores. The industrial revolution moved a multitude of agricultural toil to the manufacturing plant, and today, numeric technologies are transforming the workplace once again. Automation, AI, and robotics are steadily being used to execute tasks that were once done by humans, leading to worries about job displacements.

In 2013 study by Carl Benedikt Frey and Michael Osborne analyzed that up to 47% of jobs in the United States could be in the peril of automation over the two decades. Jobs in industries like manufacturing, transportation, and retail are especially vulnerable, while the write is that essential creativity, critical thinking, and emotional intelligence are less likely to be replaced by machines.

On the other hand, automation has the potential to enhance efficiency and decrease costs. It also raises questions related to income inequality and future work. Some of the specialists have called for the introduction of strategies like universal basic income to certify that people who lose their jobs caused by automation are not left behind.

VI ETHICAL CONSIDERATIONS IN TECHNOLOGY

Privacy and surveillance

One of the most vital ethical concerns in the cutting-edge technology outlook is isolation. As more of our existence transitions to the online world, worries about the collection and storage of personal data and its use have moved into the spotlight. Organizations, like Facebook and Google, gather extensive information about their users. Increasing conflicts regarding surveillance and the possibility of misuse.

The Cambridge Analytical scandal in 2018, in which personal details of millions of Facebook users were obtained as well as used for political objectives, illuminates the threats of uncontrolled data collection. (Isaak & Hanna 2018). In consequence, there has been an increasing demand for more robust data protection laws, such as the European Union's. General Data Protection Regulation (GDPR), which provides solitary users with more command over their personal data.

VII ARTIFICIAL INTELLIGENCE AND ETHICS

As AI continues to merge with everyday life, moral issues concerning its development and implementation are emerging as more significant. AI technologies are now utilized across a wide

range of sectors, such as health provision, financial management, law enforcement agencies, and territorial integrity .Increasing worries regarding bias, fairness, and accountability.

One of the primary hurdles with AI is that one of the primary challenges with AI is that it can adopt biases from the data on which it is trained. For instance, facial recognition technology has demonstrated higher error rates for individuals with darker skin tones, raising concerns about bias in law enforcement and monitoring. (Buolamwini & Gebru, 2018). As AI systems achieve more independence, there is an escalating conversation about whether they should be bound by the same ethical criteria as human agents.

Furthermore, there are discussions about the potential for AI to be used in manners that challenge human autonomy. For instance, AI-enabled algorithms are being increasingly adopted to shape the content we observe on social media sites.

Our understanding of reality and subtly influencing our conduct. There is a potential for AI to find use in armed forces applications, promoting discussions regarding the ethical implications of autonomous firepower systems.

VIII THE FUTURE OF HUMAN TECHNOLOGY

The connection between humans and technology proceed, growing in the incoming decades as quantum computing, biotechnology, nanotechnology, and many more come into existence. Technology has the power to solve various worldly problems such as climate change, disease, and politics leading to various moral and social issues. One of the major difficulties is the equal distribution of the new benefits of technology. There is a sudden gap between those who have excessive use and those who do not, increasing widely and worsening the situation. Even though the technology is strong, this leads to the development and requirement of ethical guidelines for its uses. The biggest challenge is confirming the use of technology in the well-being of humans instead of weakening society.

IX CONCLUSION

The relationship between humans and technology is likely to remain an ever-evolving one. From the earliest stone tools to the most recent advancements in AI, technology has influenced every aspects of human life. While it has the potential to enhance our lives in numerous ways. It also introduces new challenges and ethical dilemmas.

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MOBILE MARKETING TRENDS SHAPING THE FUTURE

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Mobile marketing refers to advertising and promotional activities designed to reach target audiences on their mobile devices, such as smartphones and tablets. With the widespread use of mobile devices, mobile marketing has become an essential component of many businesses' overall marketing strategies. Mobile marketing is marketing on or with the help of a mobile device, such as a smart phone. Mobile marketing can provide customers with time and location sensitive, personalized information that promotes goods, services and ideas. Mobile marketing offers unique advantages, including the ability to reach consumers anytime, anywhere, and personalize messages based on location, behavior, and preferences. However, it also presents challenges such as ensuring a seamless user experience across various mobile devices and navigating privacy concerns related to collecting and using mobile data. Mobile marketing trends were evolving rapidly with the advancement of technology and changing consumer behaviors. Customizing marketing messages and experiences based on user data and preferences remains a key trend. With the growing popularity of mobile shopping, optimizing the mobile shopping experience and implementing features like mobile wallets, one-click checkout, and mobile-first design are crucial for businesses.

Keywords: - Mobile Marketing, Buying Behaviour and Mobile phones

OBJECTIVES OF MOBILE MARKETING

The objectives of mobile marketing encompass various goals and targets that businesses aim to achieve through their mobile-focused strategies. Here are some common objectives of mobile marketing:

- **Reach a Mobile Audience:** With the increasing use of smartphones and tablets, businesses aim to reach and engage with their target audience effectively on mobile devices.
- **Increase Brand Visibility and Awareness:** Mobile marketing endeavors to enhance brand visibility and raise awareness among mobile users through mobile-friendly websites, apps, advertisements, and social media campaigns.
- **Drive Traffic to Mobile Channel:** Businesses may aim to drive traffic to their mobile websites, apps, or social media profiles to increase engagement and interactions with their mobile audience.
- **Generate Leads and Conversions:** Mobile marketing strategies often focus on generating leads and converting mobile users into customers through various tactics such as mobile advertising, optimized landing pages, and call-to-action prompts.
- **Enhance user Engagement and Interaction:** Mobile marketing aims to foster meaningful interactions and engagements with mobile users through personalized content, interactive experiences, push notifications, and messaging channels.
- **Facilitate Mobile Commerce:** Businesses may aim to promote mobile commerce by driving sales, increasing conversions, and providing a seamless shopping experience for mobile users through mobile-optimized websites, apps, and mobile payment options.

- **Build Customer Relationships and Loyalty:** Mobile marketing endeavors to build and nurture relationships with customers by delivering personalized messages, offers, and experiences, thereby fostering loyalty and encouraging repeat business.
- **Utilized Location based Marketing:** Leveraging location-based technologies, businesses aim to target mobile users based on their geographical location, delivering relevant and timely messages, promotions, and offers to drive foot traffic and increase sales.
- **Collect and Analyze Mobile Data:** Mobile marketing objectives include gathering valuable data and insights about mobile user behavior, preferences, and interactions to refine marketing strategies, improve targeting, and enhance overall performance.
- **Stay ahead in the Mobile Landscape:** Businesses aim to stay competitive by adapting to the evolving mobile landscape, embracing emerging technologies, and implementing innovative mobile marketing strategies to stay ahead of competitors and meet the changing needs of mobile consumers.

CONSUMER BUYING BEHAVIOUR REGARDING MOBILE MARKETING

Consumer behavior regarding mobile marketing is influenced by various factors, including technological advancements, user preferences, and societal trends. Here are some key aspects of consumer behavior related to mobile marketing:

Mobile Usage Patterns: Consumers are increasingly reliant on mobile devices for various activities, including browsing the internet, shopping, social media interaction, and communication. Understanding how consumers use their mobile devices and the platforms they prefer can help businesses tailor their mobile marketing strategies accordingly.

Preference for Personalization: Consumers appreciate personalized experiences and content tailored to their interests, preferences, and behaviors. Mobile marketing efforts that deliver personalized messages, product recommendations, and offers are more likely to resonate with consumers and drive engagement and conversions.

Mobile Shopping Behaviour: Mobile commerce (mCommerce) is on the rise, with more consumers using their smartphones and tablets to research products, compare prices, and make purchases. Businesses need to optimize their mobile websites and apps for a seamless shopping experience and implement features like mobile-friendly checkout and payment options to facilitate mobile transactions.

Influence of Social Media: Social media platforms play a significant role in shaping consumer behavior and purchase decisions on mobile devices. Consumers use social media channels to discover new products, read reviews, and seek recommendations from peers. Businesses can leverage social media marketing tactics to engage with consumers, build brand awareness, and drive traffic to their mobile channels.

Concerns about Privacy and Security: Consumers are increasingly concerned about their privacy and security when interacting with brands and sharing personal information on mobile devices. Businesses must prioritize data protection, transparency, and trustworthiness in their mobile marketing practices to build and maintain consumer trust.

Significance of Mobile Marketing

Mobile marketing holds significant importance in today's digital landscape due to several key reasons:

Widespread Mobile Device Adoption: Mobile devices such as smartphones and tablets have become ubiquitous, with a large portion of the global population owning and regularly using these devices. This widespread adoption makes mobile marketing an essential channel for reaching and engaging with consumers

24/7 Connectivity: Mobile devices enable constant connectivity, allowing consumers to access information, browse the internet, and interact with brands anytime, anywhere. This accessibility presents opportunities for businesses to engage with consumers in real-time through mobile marketing campaigns.

Targeted and Personalized Messaging: Mobile marketing enables businesses to deliver targeted and personalized messages to consumers based on factors such as demographics, location, interests, and past behaviors. This level of customization increases the relevance of marketing communications and enhances the overall customer experience.

Higher Engagement Rates: Mobile devices are highly personal and frequently used, leading to higher engagement rates compared to other marketing channels. Consumers are more likely to interact with mobile ads, emails, and notifications, making mobile marketing an effective way to capture and retain their attention.

Geo targeting Capabilities: Mobile marketing allows businesses to leverage geo targeting capabilities to deliver relevant and timely messages based on a user's location. This enables hyper-localized marketing campaigns, such as offering discounts or promotions to consumers in a specific area, driving foot traffic to nearby stores, or providing location-based recommendations.

Rich Media and Interactive Content: Mobile devices support various multimedia formats, including images, videos, GIFs, and interactive content. Businesses can leverage these rich media formats to create visually appealing and engaging mobile marketing campaigns that capture consumers' attention and drive interactions.

Integration with Other Channel: Mobile marketing can complement and integrate with other marketing channels such as email marketing, social media marketing, and offline advertising. By creating cohesive and multi-channel marketing campaigns, businesses can amplify their reach and maximize the effectiveness of their marketing efforts.

Future Growth Potential: As mobile technology continues to advance and consumer behaviors evolve, the significance of mobile marketing is expected to grow further. Businesses that invest in mobile marketing now are well-positioned to capitalize on future opportunities and stay competitive in the digital marketplace.

MOBILE MARKETING TRENDS TO SHAPE THE FUTURE

The future of mobile marketing is shaped by emerging technologies, evolving consumer behaviors, and industry innovations. The landscape of mobile marketing is continuously evolving, driven by advancements in technology and shifts in consumer behavior. Here are some trends that are likely to shape the future of mobile marketing:

5GTechnology: The widespread adoption of 5G networks will revolutionize mobile marketing by enabling faster download speeds, lower latency, and higher bandwidth. This will facilitate the delivery of high-quality video content, augmented reality experiences, and real-time personalized messaging.

Augmented and Virtual Reality: AR and VR technologies offer immersive experiences that enable brands to engage with consumers in unique and interactive ways. From virtual try-on experiences to AR-enhanced product demonstrations, these technologies will play a significant role in mobile marketing campaigns.

Voice Search and Voice Commerce: As voice-enabled devices become more prevalent, optimizing content for voice search and implementing voice commerce capabilities will be essential for businesses to reach consumers through voice-activated search queries and commands.

Artificial Intelligence and Machine Learning: AI-powered algorithms and machine learning models will continue to enhance personalization, automation, and predictive analytics in mobile marketing. From chatbots and virtual assistants to personalized recommendations and content optimization, AI will play a crucial role in delivering tailored experiences to mobile users.

Social Commerce: Social media platforms will continue to evolve as shopping destinations, with features like shoppable posts, in-app checkout, and live shopping events driving mobile commerce. Brands will leverage social commerce to reach and engage with consumers directly on social media platforms.

Contextual marketing: Contextual marketing strategies that deliver relevant content and offers based on real-time contextual data such as location, weather, and user behavior will become more sophisticated. This hyper-targeted approach will enable brands to deliver personalized experiences that resonate with mobile users.

Sustainability and Social Responsibility: Consumers are increasingly prioritizing brands that demonstrate a commitment to sustainability and social responsibility. Mobile marketing campaigns that highlight environmentally friendly practices, ethical sourcing, and community engagement will resonate with socially conscious consumers.

CONCLUSION

In conclusion the future of mobile marketing will be characterized by innovation, personalization, and a focus on delivering seamless and engaging experiences to mobile users. Brands that embrace these trends and adapt their mobile marketing strategies accordingly will be well-positioned to succeed in the ever-changing mobile landscape. By understanding and adapting to consumer behavior related to mobile marketing, businesses can develop more effective strategies to engage with their target audience, drive conversions, and build long-term relationships with customers in the mobile landscape. Businesses that embrace these trends and adapt their mobile marketing strategies accordingly will be well-positioned to succeed in the evolving mobile landscape.

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PROTECTION OF CROPS FROM ANIMAL INTRUSION USING DEEP LEARNING

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ABSTRACT

Agriculture is the significant component of Indian economy. The survival of a large number of people is dependent on agriculture. Still this field has been severely neglected and even in the era of rapidly increasing Technology agriculture has been facing tremendous issues which need to be solved. Technological solutions have made their mark in every field but agricultural issues are yet to be addressed. There are various challenges that farmers face everyday and one of the critical issues among them is damage of crops by entry of stray animals in the fields. In order to effectively mitigate this issue innovative technical solutions like Deep learning, Internet of things, image processing have been utilised in this paper a critical review of research work undertaken to check animal intrusion into the fields has been offered. The major advantages and loop holes of such systems have also been discussed.

Keywords: Animal intrusion, Deep learning, IoT, Smart agriculture

INTRODUCTION

Indian economy is significantly dominated by agriculture sector. There is dependency of a large chunk of Indian population on farming. Despite of this fact there are significant matters in agriculture field which need to be resolved. As the population of India is increasing at an exponential rate deforestation has also been increasing at the same pace. So wild animals have been frequently raiding residential areas. The human animal conflict has become very common nowadays which is a matter of serious concern for one and all. The intrusion of animals in agricultural land is also endangering human life and causing economic loss to agriculturists due to crop damage. The serious implications of entry of wild animals into agriculture lands have come into picture in the form of damage to crops, loss of human lives etc which is endangering sustainable survival of both humans and animals. Thus there is a strong need to protect human resources as well as financial resources from this issue. Challenging factors in agriculture like damage caused by natural calamities, unforeseen climate conditions and shooting price of inputs are already been faced by Indian farmers and the raids of stay animals in the fields is making the situation worse. The other situations are not in control but with the advent of latest technology it has become feasible to stop animal raids into the fields.

Conventional methods like trenches, fencing and barbed wires etc have not only failed in checking animal intrusion but also caused physical harm to animals and human beings. At the same time it is also not feasible to do field surveillance 24*7. Thus an automatic detection system is required in order to protect the crops from controllable factors at least as some other factors are beyond our control and cannot be tackled by human efforts. With the advent of latest technology extraction of an object from the image has become the fundamental issue to be resolved. Object extraction occupies a significant place in vision application such as object detection and classification. Deep learning is among the fastest emerging techniques in the field of computer technology as it gives effective outputs in different areas such as automobiles, defence etc. The adaptation of deep learning in the areas demanding object extraction, detection and classification has made it the hot topic of discussion nowadays[1]. The main factors behind its popularity are easily available data sets and Graphics

Processing Units (GPUs). Deep learning is an effective and efficient technique for accurate and fast identification of an object in the image.

Agriculture has been revolutionized with the introduction of Internet of Things (IoT). Integration of surveillance cameras with IoT has assigned them a better role then being passive observers. Programming can be done to identify various species of animals. As soon as an undesirable creature is identified the farmer is alerted immediately via a computer or phone[2]. The cameras integrated with IoT can be strategically placed all over the fields in order to recognise the animals and alerts the farmers about the intrusion of stray animals in the farmlands in real time based on which rapid Action can be taken by the farmer so as to protect their crops from undesirable creatures.

AGRICULTURE: PAST & PRESENT

There are four main stages of evolution of Agriculture to attain this present state as depicted in figure 1 [3].

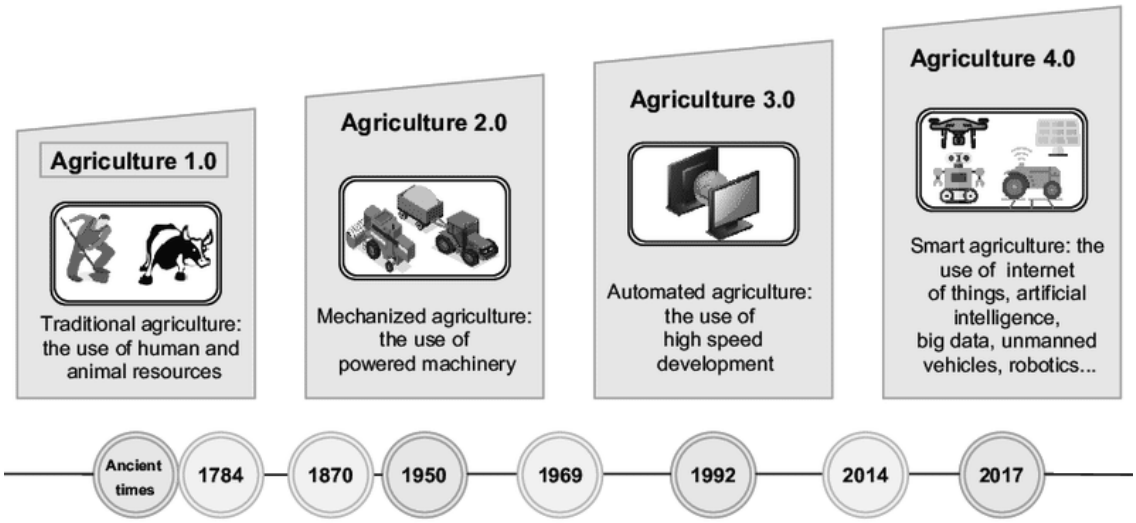

Fig. 1: The four agricultural revolutions

The stages are explained as under:
1. The traditional agriculture phase (Agriculture 1.0): This phase was dominated by use of animal and human resources for agriculture. most of the work was done manually.
2. The Mechanization phase (Agriculture 2.0): This stage can be characterized by rise of reverberant noise due to rapidly increasing use of machines.
3. The stage of automation (Agriculture 3.0): This stage was marked by exponential emergence of technical advancements.

4. Smart Farming(Agriculture 4.0): This is the present state of agriculture.It is characterized by integration of advanced technology in agriculture to obtain sustainable agriculture [4][5]. Smart agriculture utilizes technology like IoT, Deep learning, machine learning Wireless Sensor Networks (WSNs) etc to optimize agricultural practices[6]. Some of the techniques are explained below: **Internet of Things(IoT):** IoT plays a significant part in making agriculture sustainable by facilitating interchange of data between diverse components integrated through a network [7]. IoT offers solution to different problems by connecting smart devices through internet. IoT provides solution for problems like soil health monitoring, water management, protection of crops from damage etc [8].

Image processing: the use of algorithm to analyse and manipulate images to extract desired information can be defined as image processing. Application of image in diverse sectors like medical field, defence, automobile industry has made it the most talked about concept in modern era. Image processing supports in tasks like weed detection, ,crop protection, disease identification in the field of agriculture.

Deep Learning: it is a subset of machine learning which applies multilayer processing for extracting features from images by utilising artificial neural networks. Deep learning is used for jobs like disease identification in plants ,soil health monitoring, protection of crops from damage etc in the field of agriculture.

LITERATURE REVIEW

Giordano et al. [9] conducted and experiment to protect crops from animal raids in agricultural lands. He developed an IoT application to tackle this issue. The fields were continuously monitored with wireless technologies like ZigBee ,WiFi and IoT gateways to check animal raids.A sound repeller was developed which worked on solar technology to obtain effective results from this model in partial or total darkness. The loophole in this device was that on increasing the distance beyond 60 metres, the performance of this device used to deteriorate below 90% and as the distance kept increasing surpassing 100 metres, the device stopped working.

Iniyaa K K et al[10] developed a model by using Convolutional Neural Network(CNN) and machine learning to tackle the issue of animal raids in agricultural lands. The basic principle behind this model was to divert the creatures away from the fields. Integration of deep learning with neural network was used to develop a model for monitoring the animals coming near the fields by using computer vision. The movement of animals was traced by tracking the farms via a camera then neural network and detection algorithm were used to detect the animal captured in camera and pertinent sound was used to divert the stray animals away from farmlands.

Prabha et al.[11] worked on a model to track aerial and terrestrial creatures encompassing the farmlands. The model was based on sound alert. Low range of sensors was the main drawback of this model. Also it was not economical to put a vast number of sensors across the farms and the sensors were not capable of monitoring fields having wider area.

Balakrishna et al. [12] worked on a model based on Internet of Things (IoT) and machine learning to check animal raids and stop crop damage. An algorithm based on convolutional neural network was utilised to identify the animal captured in the video. This model has shown an accuracy above 80%. However the major drawback of this system was that its performance used to degrade in dim light at night.

Suchitra et al. [13] developed a model comprising of sensors to measure the value of field variables then the obtained values were verified and transferred further to the WiFi module. Cloud computing concepts were used to transmit the information from WiFi module to the agriculturist's cell phone. To control the flow of water into the fields an algorithm was developed with threshold values of temperature and moisture. The farmer could control the motor by using this model through remote access.

Santhiya et al. [14] developed a model for crop protection from animal raids by utilising Raspberry pi. Other major components of the system were Global System for Mobile communication (GSM) and Radio Frequency Identification (RFID) module. The farmers could be alerted about the entry of stray animal in the farms along with the identity and location of the approaching creature. One of the major

loopholes in the system was that the injection of RFID vaccine in animal skin might cause some serious infection and harm the animal

CONCLUSION

The research work of different scholars, based on the effect of animal raids in farmlands, has been exhaustively examined. At the same time rapidly emerging technologies for sustainability of agriculture have been thoroughly reviewed. After comprehensive analysis it has been concluded that while work done by different researchers for protection of crop from animal intrusion has given promising results still there is a need for improvement in terms of accuracy. Moreover every system had its own pros and cons. The loopholes in the developed systems must be handled effectively to develop a more efficient model for identification and tracking of stray animals intruding agricultural lands in order to save the farmers from physical harm and economical loss.

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ASSESSING THE IMPACT OF ENVIRONMENTAL DEGRADATION AND CLIMATE CHANGE ON ECONOMIC DEVELOPMENT AND HUMAN WELL-BEING IN EMERGING ECONOMIES

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ABSTRACT

Determine a balance between environmental sustainability and economic growth is a major problem for emerging economies. These countries' long-term growth is seriously threatened by environmental deterioration and climate change, which also exacerbate inequality and threaten their economic prospects. With an emphasis on the effects of natural resource depletion, climate-induced disasters, and environmental policy responses, this article explores the intricate relationship between environmental degradation, climate change, and the economic development of rising economies. It also looks at how these environmental problems affect people's quality of life, especially for disadvantaged groups. This study examines the relationship between economics, environmental science, and social welfare in the context of rising economies using a multidisciplinary approach. It makes policy recommendations to reduce adverse effects and advance sustainable development.

KEYWORDS: Climate, Environment, Economic Development And Human Well Being

INTRODUCTION

Emerging economies play a central role in the global economy, making substantial contributions to global expansion while also dealing with serious issues like climate change and environmental degradation[1]. These nations are especially susceptible to environmental hazards since they are frequently defined by fast industrialization, population expansion, and urbanization[2]. In addition to endangering their ecological stability, the interconnected problems of climate change and environmental degradation also pose a threat to their social and economic advancement[3].

The term "environmental degradation" describes how the natural environment deteriorates, including resource depletion, pollution, and biodiversity loss[4]. By changing weather patterns, increasing sea levels, and intensifying extreme weather events, climate change—which is mostly caused by human activities like burning fossil fuels and deforestation—makes these problems worse[5].

These environmental changes have a wide range of effects on emerging economies, influencing infrastructure, health, social well-being, industry, and agriculture[6]. Because they are less able to adjust to environmental shocks and are frequently reliant on natural resources for their livelihoods, low-income groups bear the brunt of the economic effects of environmental degradation and climate change[7].

This article examines the effects of climate change and environmental degradation on human well-being and economic development in emerging economies[8]. It evaluates the difficulties these problems provide as well as the chances to lessen their effects and promote more resilient, sustainable development.

1. THE LINK BETWEEN ENVIRONMENTAL DEGRADATION, CLIMATE CHANGE, AND ECONOMIC DEVELOPMENT

1.1. Economic Impacts of Environmental Degradation

In nations where agriculture, forestry, fishing, and other natural resources account for a sizable amount of the economy, environmental deterioration has a direct impact on economic performance[9]. The loss of biodiversity, decreased agricultural yields, and the demise of regional industries reliant on natural resources can all result from deforestation, soil erosion, overfishing, and water scarcity[10].

Both GDP and employment in emerging nations are frequently accounted for by these sectors[11]. For instance, agriculture employs the bulk of the workforce and contributes more than 30% of GDP in many South Asian and African nations. The loss of biodiversity, the drying up of water supplies, and the degradation of fertile soil all lead to a reduction in agricultural production[12]. Particularly in rural areas, this output decline impedes economic growth and makes poverty worse.

Additionally, the costs of environmental degradation frequently include the damage of infrastructure, the loss of ecosystem services (including clean water, pollination, and flood control), and higher healthcare costs as a result of pollution[13]. Poorer communities and the government, who must devote funds to environmental mitigation and restoration, usually bear a disproportionate share of these expenses[14].

1.2. Economic Consequences of Climate Change

Climate change, driven by global warming, is an exacerbating factor in the challenges already faced by emerging economies. Rising temperatures, erratic rainfall patterns, and increased frequency of extreme weather events such as droughts, floods, and hurricanes all have severe economic implications[15]. For instance, in regions dependent on agriculture, altered weather patterns can lead to crop failures, food insecurity, and reduced agricultural exports[16].

Climate change has an immediate effect on agriculture, but it also has an impact on other vital economic sectors including infrastructure, electricity, and water[17]. The economy and government resources are put under strain by extreme weather events, which have the potential to upend supply lines, destroy infrastructure, and force entire communities to relocate. Higher temperatures brought on by climate change may also increase the demand for energy, further taxing energy systems in nations that depend on fossil fuels or have trouble obtaining energy[18].

National budgets may be strained by the expense of climate change adaptation, including social safety nets, catastrophe preparedness, and resilient infrastructure, which would further impede economic growth[19]. Climate change's long-term effects on the economy include reduced growth rates, increased rates of poverty, and a growing divide between developed and developing Nations.

2. ENVIRONMENTAL DEGRADATION AND CLIMATE CHANGE AND HUMAN WELL-BEING

2.1. Health Issues

In developing nations, public health is seriously threatened by environmental deterioration and climate change. Both air and water pollution can cause long-term health issues like cancer as well as respiratory and waterborne ailments. One of the main causes of respiratory and cardiovascular disorders in nations that are industrializing quickly is air pollution from factories and vehicles[21]. High rates of waterborne illnesses like cholera, dysentery, and typhoid are caused by water pollution, which is caused by industrial waste, agricultural runoff, and untreated sewage contaminating rivers and lakes[22].

By raising the frequency of heat-related illnesses, broadening the spectrum of vector-borne illnesses like dengue and malaria, and causing more frequent and severe natural catastrophes, climate change exacerbates these health concerns. Furthermore, severe weather disasters like hurricanes and floods can cause long-term mental health effects for impacted communities in addition to injuries and fatalities[23]. Children, the elderly, and the impoverished are among the vulnerable populations that are most at risk from the negative health effects of environmental degradation and climate change[24]. These groups are more likely to be exposed to environmental risks including contaminated water sources and inadequate sanitation, and they frequently reside in places with little access to healthcare[25].

2.2. Social Inequality and Displacement

Social inequality is made worse by environmental deterioration and climate change, especially in developing nations. The most reliant on natural resources for their livelihoods are frequently the poor and marginalized, who are also the least able to adjust to changes in the environment[26]. Climate change, for instance, may cause crop failures for impoverished farmers in rural areas who have no access to financial resources or technology, further impoverishing them[27].

Other major worry is migration brought on by climate change. Prolonged droughts, floods, and rising sea levels can all compel people to leave their homes in quest of better living conditions. The growing number of climate refugees in regions of Asia, Africa, and Latin America is placing further pressure on social services, healthcare systems, and urban infrastructure[28].

Climate change and environmental degradation disproportionately harm indigenous groups, women, and children. Women are particularly burdened because they are frequently in charge of gathering food, fuel, and water[29]. Their time and energy are further stretched as a result of environmental stresses making these resources scarcer, which restricts their capacity to engage in economic and educational activities[30].

2.3. Livelihoods and Poverty

There is a complicated and nuanced relationship between poverty, climate change, and environmental degradation. Many people in emerging economies make their living from fishing, farming, and other activities that depend on natural resources[31]. People lose their means of subsistence when these resources are exhausted or when climate patterns become unpredictable

For instance, the livelihoods of fishermen in coastal regions are under risk due to increasing storm frequency and sea level rise. Soil erosion and shifting rainfall patterns in rural areas lower

agricultural production, increasing poverty and food insecurity[32]. Social instability and growing inequality are exacerbated by this lack of livelihood opportunities.

3. POLICY RESPONSES AND STRATEGIES FOR SUSTAINABLE DEVELOPMENT

3.1. Mitigation and Adaptation Strategies

Emerging economies must implement both mitigation and adaptation methods to address the effects of climate change and environmental degradation on economic growth and human well-being[33]. While adaptation entails preparing for the present and expected effects of climate change, mitigation refers to initiatives to cut greenhouse gas emissions and delay the process of climate change.

Making the switch to renewable energy, increasing energy efficiency, and supporting sustainable farming methods are examples of mitigation techniques. Since solar, wind, and hydropower are cleaner alternatives to fossil fuels and not only lower emissions but also open up new business prospects in the green energy sector, many emerging economies are investing more in these sources of energy[34].

Building resilience to climate impacts is the goal of adaptation techniques, which include creating climate-resilient infrastructure, strengthening disaster preparedness, and upgrading water management systems[35]. Additionally, governments need to incorporate climate change concerns into urban planning and development regulations and invest in early warning systems for extreme weather occurrences.

3.2. Strengthening Environmental Governance

Promoting sustainable growth and managing the environment effectively depend on good governance. Implementing strategies to safeguard natural resources and reduce climate risks is hampered in many emerging economies by poor governance, corruption, and a lack of enforcement of environmental laws[37].

Enhancing accountability, openness, and public involvement in environmental decision-making are all components of strengthening environmental governance[38]. To create and carry out policies that address environmental degradation and climate change, governments must collaborate closely with local communities, the commercial sector, and civil society organizations[39].

Support from developed nations and international cooperation are also essential. Initiatives for capacity-building, technology transfer, and climate finance can assist developing nations in putting into practice sensible climate policies and achieving sustainable development objectives[40].

CONCLUSION

The economic growth and well-being of rising economies are severely hampered by environmental deterioration and climate change. These environmental problems have wide-ranging effects on infrastructure, social inequality, industry, agriculture, and health. However, these nations may overcome many of the obstacles presented by climate change and environmental degradation if they adopt proactive policies and are dedicated to sustainable development.

Emerging economies need to adopt a development strategy that integrates social justice, economic expansion, and environmental sustainability. These countries may achieve long-term, equitable growth, safeguard human well-being, and increase resilience against environmental threats by implementing adaptation plans, investing in green technologies, and implementing good governance.

While there are obstacles in the way of sustainable development in emerging countries, there are also plenty of chances to innovate, start new businesses, and raise the standard of living for coming generations. In order to assist these countries in addressing the twin concerns of environmental degradation, the international community must cooperate.

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POST-COVID EMERGENCE OF REGIONAL OTT PLATFORMS IN INDIA: A DESCRIPTIVE ANALYSIS

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ABSTRACT

This descriptive analysis explores the significant emergence of Over-The -Top (OTT) platforms in India in the aftermath of the Covid-19 pandemic. The research aims to provide an in-depth understanding of the factors and dynamics contributing to the rapid growth of these platforms and their impact on Indian media and entertainment industry. The present study utilizes a qualitative research approach to provide an in-depth review of industry reports, market data and scholarly articles.

The research revealed diverse factors for the emergence of these platforms in India; such as increasing digital adoption during pandemic, socio-cultural and economic implications of the content in regional languages.

Keywords: OTT platforms, Regional OTTs, Digital Media, COVID-19, Socio-cultural impact, Media industry.

1. INTRODUCTION

The covid-19 pandemic has reshaped various aspects all over the world, including the media and entertainment industry. The lockdowns and restrictions on traditional forms of entertainment gave a major setback to film and television industry. Cinema halls and other businesses were shut down. The shootings of movies and Tv serials were cancelled. It was a time of uncertainty and every business organization was unsure about what would happen next for any venture. Due to lack of entertainment options, there was a sudden increase in demand for online content during this period. These online platforms or Over-The-Top platforms became very popular because they are convenient, flexible and have vast content libraries. They deliver both audio and video over the internet without the involvement of traditional communication technology like cables. They also offer diverse genres at a reasonable cost and compatibility with multiple devices like smartphones, tablets, gaming console and smart tv.

India, with its vast and linguistically diverse population also witnessed a remarkable surge in regional OTT platforms during this period. The rise of OTT platforms in India has been a subject of scholarly interest in recent years. The increasing digital penetration in the country, driven by affordable smartphones, widespread internet connectivity and decreasing data cost also have led to the immense popularity of these platforms. According to the reports, India is the world's fastest growing OTT market and is projected to become the world's 6th largest by 2024.Over the next four years, the Indian OTT market is expected to reach revenues of 2.9 $ billion. (Daily News, 2020).Experts suggests that the Covid-19 has served as a catalyst for the OTT industry as massive investments are being made by leading OTT platforms like Netflix, Amazon, Disney + Hot star and others.

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This exponential surge in the demand for online entertainment paved a way for the emergence of new players in the OTT space, particularly those focusing on regional content. The objective of this paper is to provide an in-depth analysis of the factors that contributed to the rise of this phenomenon and assess its impact on India media and entertainment industry.

2. METHODOLOGY

This paper adopted a qualitative approach to establish a comprehensive understanding of the factors behind this phenomenon. For this purpose, in- depth structural interviews of industry experts and content analysis of industry reports, market data and scholarly articles, has been done.

3. A BRIEF HISTORY OF OTT PLATFORMS IN INDIA

The evolution of history of OTT platforms in India can be traced back to the 2000s when internet usage and broadband connections witnessed a significant growth in the country. The arrival of the OTT platforms began in India in 2008 when Reliance entertainment launched its very own OTT platform called 'BIGFLIX' Following the suit, Digivive-Media Matrix Group introduced "NexGTv" in 2010, which became India's premier OTT app by offering live streaming of IPL matches on smartphones(news4masses,2021). The momentum continued to grow in 2016 with the entry of global giant Netflix into the Indian market. However, despite its global success, Netflix struggled initially in India due to its high subscription fees and limited regional content (Sull & Turconi,2021).

In 2015 Disney Hotstar made its debut offering a mix of live streaming of sports, TV shows and movies (DisneyStar.com). Its popularity soared during the streaming of IPL cricket matches as the country's cricket obsession is immense. In the same year, Amazon prime enters the Indian market offering a wide range of international and regional content *(The Economics Times, 2021)*. Between 2016-2023, several other Indian companies and telecom operators also launched their own OTT platforms such as:

- Voot (owned by Viacom18)
- SonyLiv (owned by Sony Pictures Networks India)
- Zee5 (owned by Zee Entertainment Enterprises)
- JioCinema (owned by Reliance Jio)
- Eros now (owned by Eros international)

The influx of diverse streaming options not only transformed the way Indians consume entertainment but also sparked a fierce competition among OTT platforms seeking for the attention of Indian audience.

4. FACTORS CONTRIBUTING TO THE EMERGENCE OF OTT PLATFORMS IN INDIA

- **Unprecedented digital growth**

  In recent years, the emphasis of Indian government on **Digital India** has led the country towards a greater dependence on digital infrastructure. This increasing penetration of internet in India has also revolutionized the way in which entertainment is consumed. The present data clearly speaks volume of country's remarkable progress in information and technology sector over the years. India is one of leading countries with the highest number of internet users in the world with the internet penetration rate of 47%(CNBCTV18,2022). The statistics indicates that in the year 2023,the number of smartphone users in the country exceed over 1 billion.

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The catalyst for India's digital revolution, especially in terms of accessibility, was the introduction of affordable data plans, with the advent of **Reliance Jio.** This development proved to be a game changer, resulting in a widespread digital adoption in the country. Other telecom providers like Airtel and Vodafone also followed the same suit leading to the momentum of this digital transformation (Sundaravel & Elangovan,2020). It should be noted that India's internet data are the most economical in the world; with an average cost of $0.16 per 1 GB of data. This affordability has further fuelled India's revolution and established it as a major player in the global digital landscape. Increasing internet penetration in rural areas and popularity of affordable smartphones has also created opportunities for both domestic and international OTT players.

According to the report by PricewaterhouseCoopers or PWC, *a multinational professional services network of firms,* India is the world's fastest growing OTT market and is projected to become the world's 6th largest by 2024. In 2023, there were 46 OTT service providers in India with over 45 million subscribers.

Over the next four years, the Indian OTT market is expected to reach revenues of 2.9 $ billion. (Daily News, 2020). Experts suggests that the Covid-19 has served as a catalyst for the OTT industry as massive investments are being made by leading OTT platforms like Netflix, Amazon, Disney + Hot star and others. These investments, both in originals as well as in acquired content, are expected to drive subscription video-on-demand which is forecasted to contribute 93% of the total OTT revenue (as compared to 87% globally). This segment is projected to grow at a CAGR of 30.7% between 2019-20, increasing from $708 million in 2019 to $ 2.7 billion (Daily News, 2020*)*.

5. Digital adoption during Pandemic affected OTT platform growth

The growth of OTT platforms in India has been significantly impacted by digital adoption during Covid -19 pandemic. With the strict lockdown measures, the consumers turned to OTT platforms as a primary source of entertainment resulting in a significant surge in online content consumption. Moreover, the shift to a work-at-home environment had further led to the consumption of new direct-to-consumer apps and other user generated content formats.

Studies have revealed that there was a significant increase in household's screen time during the lockdown. One of the primary reasons behind this surge was growing entertainment choices facilitated by OTT platforms, offering a wide range of content. Furthermore, the flexibility of work from home environment blurred the boundaries between personal and professional life, which resulted in an increased screen-based activities (Nijhawan & Dahiya, 2020). This surge in viewership has not been limited to mainstream media but has also given rise to the popularity of regional OTTs (Times of India (2023).

The popularity gained by these platforms during the pandemic has also created new opportunities for innovation and investment in the digital content space (Times of India, 2023)The pandemic crisis has accelerated the digitalization of Indian media industry .More than 200 films have been released on digital platforms during recent times, with 75 of them debuting directly on digital platform without theatrical release (Newsdrum,2024).This shift highlights that industry is adapting to the changing landscape and emphasizing the role of digital platforms in the distribution of content during challenging times.

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6. Socio-cultural and economic implications of regional content

The social and cultural implications of regional content in India are significant and cannot be overlooked. The OTT platforms have abundance of opportunities in India due to its vast linguistic and cultural diversity. These platforms cater to a wide range of audience linguistic and cultural preferences. Today the viewership of online streaming has expanded well beyond metro cities and millennials, to homemakers and senior citizens. As a result, the demand for regional streaming apps have increased which cater to the non-Hindi and non-English markets. This demand for content tailored to specific linguistic and cultural preferences has led to an immense popularity of regional OTT platforms like **Oho Gujrati, Hoichoi, Planet Marathi, Nine Rise, Neestream and Chaupal** which have been offering content in Marathi, Bengali, Malayalam, Telugu, Kananda and Punjabi. This demand has also created a golden opportunity for creators who may not find space in mainstream services (Mint, 2021).

The growth of the OTT industry is not only driving it to new heights but also reshaping the economic landscape by creating job opportunities, nurturing local talents and promoting investment in culture and arts. According to *Thinkwithniche*, the market share of regional OTT platforms in India is expected to rise from 30% to 45% by 2023. In an interview, the Co-founder of **Hoicho**i emphasizes that today's consumer demand hyper localized content. Therefore, this surge is not merely limited to translating content into different dialects but also producing and delivering stories which are culturally relevant (Cnbctv18, 2023). The demand for partnership with local production companies that specializes in regional storytelling, indicates the significant economic potential of that regional content (Times of India, 2023).This focus on regional specificity not only caters to the 70-75% of Indians who consume content in Hindi and regional languages but also nurtures a more inclusive society which appreciates cultural diversity (Times of India; The Statesman, 2023). Therefore, the rise of regional OTT platforms in India is not just a trend but a social-cultural and economic phenomenon which is reshaping the entertainment industry and also the societal narrative (Cnbctv18,2023; Medioum,2024).

7. Impact on Indian Media and Entertainment Industry

Amidst the challenges faced by traditional media during the pandemic due to shutting down of cinema and decline in advertisement revenues, OTT platforms emerged as a beacon of resilience, adapting to the new normal in the midst of global economy uncertainty (Variety, 2024). This increasing dominance of OTT platforms has catalysed a boom for job opportunities as the demand of skills in journalism, advertising, digital marketing and public relations has risen to meet the industry's need for digital strategies (Variety, 2024). Now the industry has embraced the OTT space as a viable space for direct-to-digital releases, indicating a paradigm shift in distribution strategies that aligns with the evolving consumption patterns of audiences who prefer the convenience to access the content from the comfort of their home (Variety, 2024). Furthermore, the growing preference for regional content has played a significant role in the popularity of OTT in India(The Economics Times.2023)The influence of these OTT platforms can also be seen in India's regulatory sphere as the Ministry of Information and Broadcasting has recognized their impact and aims to bring digital audio-video content under its preview by November 2023 (IBEF, 2023)This regulatory inclusion highlights the significant role of OTT platforms in the Indian media ecosystem. However, the paradigm shift in media landscape has also brought challenges to regional media producers who are striving to make their presence in this evolving media ecosystem (IBEF,2023). Their ability to sustain in this environment will promote diverse tapestry of local languages and cultures to a boarder audience.

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IMPACT OF ENVIRONMENTAL POLLUTION ON LUNG: FROM PATHOPHYSIOLOGY TO ECONOMIC BURDEN

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ABSTRACT

Lung cancer is among the leading causes of morbidity and mortality worldwide, while air pollution has emerged as one of the critical risk factors along with smoking. The study discusses the multidimensional relationship between air pollution and lung cancer, such as biological mechanisms, health effects, and economic impacts, and identifies key contributors to be fine particulate matter (PM2.5), nitrogen oxides (NOx), sulfur dioxide (SO2), and VOCs. These pollutants initiate carcinogenesis through oxidative stress, chronic inflammation, and DNA damage. Indoor pollutants, including biomass fuel emissions and radon, alongside occupational exposures to asbestos and heavy metals, further exacerbate the risk. The economic burden of lung cancer is examined, encompassing direct healthcare costs, indirect productivity losses, and psychological impacts on patients and families. The findings call for stronger environmental policies, public awareness programs, and sustainable health strategies to curb the effects of pollution on lung cancer and improve global health outcomes.

Keywords: Lung Cancer, Nitrogen oxides (Nox), Sulfur dioxide (SO_2), Economic burden, health cost, Particulate matter (PM2.5).

1. INTRODUCTION

Lung Cancer is among the most common and life-threatening cancers worldwide, with approximately 2.2 million new cases and 1.8 million deaths every year (Sung et al., 2021) While smoking has long been considered the leading cause of lung cancer, more and more evidence indicates that environmental pollution has become a significant and rapidly increasing risk factor. The major contributors to lung cancer include fine particulate matter (PM 2.5 and PM 10), nitrogen oxides (NOx), Sulfur dioxide (SO_2), and Volatile organic compounds (VOCs). The pervasive exposure in urban and industrial areas accelerates the onset of carcinogenesis and aggravates respiratory health risks.

PM2.5 has a small microscopic size that allows it to deeply penetrate lung tissues and pose severe health risks. Once it is inhaled, the PM2.5 interacts with lung epithelial cells, and it has the potential to trigger oxidative stress, inflammation, and DNA damage; thus, all these have the potential to initiate carcinogenesis processes Pollutants such as NOx and SO_2, mostly produces by vehicular emission and industrial processes, can inflame the respiratory system, and chronic inflammation contributes to an environmental that may trigger the development of cancer because the chronic inflammatory response is supposed to release cytokines and growth factor to promote abnormal cell growth and angiogenesis (Cohen et al., 2017).

Indoor pollution also remains a very vital issue and is largely neglected. In developing and middle-income nations, the use of biomass fuels, like wood, coal, and dung for cooking and

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heating adds a huge contribution to indoor pollutant loads. Exposition to carcinogens, including PAHs released due to poorly ventilated living space in addition to other carcinogenic factors contributes to lung cancer more among women and children (Shields et al., 2021). In addition, occupational exposure to asbestos, silica, and heavy metals poses significant risks to specific populations, especially in industries with inadequate safety regulations.

The biological mechanisms connecting pollution to lung cancer are multifaceted. After inhalation, pollutants produce ROS, which causes oxidative stress and DNA damage in lung cells. This damage, if unrepaired, leads to genetic mutations that drive cancerous transformations. Chronic exposure to pollutants also results in continuous inflammation, which compromises immune surveillance and allows for the proliferation of malignant cells (Liu et al., 2019). In addition, epigenetic changes induced by pollutants through DNA methylation and histone modifications can suppress tumor-suppressing genes or activate oncogenes, thus promoting carcinogenesis (Herbst et al., 2018).

The effects of lung cancer through pollution go beyond health; there are high economic costs on people and society. The cost of expenditure has been divided into direct costs including drugs, treatments, and hospital stays, and indirect costs including lost productivity and premature death. The patient's and their family's psychological and emotional impacts have also created a burden to this complex burden. Such challenges only emphasize the urgent need for policy interventions such as stricter environmental regulations, improved healthcare access, and public awareness campaigns.

The chapter tries to explore the complex relationship between pollution and lung cancer, focusing on the biological mechanisms underlying this association and any form of economic and health impact. This chapter integrates environmental science, epidemiology, and health economics insights to focus on the urgent need for sustainable strategies for mitigating pollution and its adverse health outcomes.

2. PROCESS OF LUNG CANCER DEVELOPMENT DUE TO POLLUTION

Lung cancer due to pollution is a polyfactorial process in which environmental toxins interact with the biological systems of the body. The process therefore involves mechanisms that are not solely simple, such as exposure through airborne pollutants, cellular damage, and eventual malignancy. The mechanism describing how pollution leads to the growth of lung cancer is expounded upon below:

2.1 Inhalation of Pollutants

Airborne pollutant exposures include particulate matter (PM2.5 and PM10), nitrogen oxides (NOx), sulfur dioxide (SO2), ozone (O3), and volatile organic compounds (VOCs), all of which enter through the respiratory system. Of these fine particles, PM2.5 is particularly deleterious, as its small size allows it to penetrate deep into the lung tissue up to the alveoli, the main site for gas exchange.

These pollutants, when inhaled, do not use the natural defense mechanism of the respiratory system, which comprises mucus and cilia, and thus directly get deposited into the lungs (Pope et al., 2019).

2.2 Induction of Oxidative Stress

Once in the lung tissue, pollutants generate ROS. ROS are highly reactive molecules that cause oxidative stress. They damage cellular components, such as DNA, proteins, and lipids. This destruction disrupts normal cellular functions, thus creating an environment friendly to cancer development.

For example, NO2 interaction with lung cells has shown an increase in ROS levels leading to DNA strand breaks and mutations (Kim et al., 2018).

2.3 Chronic Inflammation

Pollutants provoke the immune system, inducing chronic inflammation in the respiratory tract. Inflammatory cells release cytokines and growth factors that promote cell proliferation and suppress normal apoptosis. Such chronic inflammation eventually leads to structural alterations in lung tissue, fibrosis, and hyperplasia - all precancerous conditions.

Long-term exposure to PM2.5 has been found to increase the levels of interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α), which are inflammatory mediators linked to tumorigenesis (Crouse et al., 2015).

2.4 DNA Damage and Mutations

The known carcinogens include PAHs and heavy metals, such as arsenic and cadmium. They cause direct damage to DNA by forming DNA adducts or indirect damage by producing ROS. The damage caused leads to mutation in key genes that govern cell growth and repair, which include the following:

- **Tumour Suppressor Genes:** Mutations in the TP53 gene impair the cell's ability to control abnormal growth.
- **Oncogenes:** Activation of oncogenes, like KRAS, results in unchecked cell division. This instability allows normal lung cells to be transformed into malignant cells (de Kok et al., 2018).

2.5 Disruption of Cellular Repair Mechanisms

Pollutants also disrupt natural repair mechanisms in the body. DNA damage is, under normal circumstances, rectified by repair enzymes. However, exposure to carcinogens such as benzo[a]pyrene, a PAH component, disrupts DNA repair pathways, allowing mutations to accumulate.

This disruption forms a fertile ground for mutated cells to proliferate erratically, resulting in tumor formation (Hecht, 2020).

2.6 Angiogenesis and Tumour Formation

Since mutation in cells leads to continued growth, they later accumulate and form a tumor. A cancerous cell creates or maintains new blood vessels called angiogenesis; they secrete a secretor of vascular endothelial growth factor, VEGF to give nutrients and oxygen into their metabolism to allow the continued enlargement as well as metastasize it from part to another in the body system.

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2.7 Influence of Indoor and Occupational Pollutants

Indoor Air Pollution: Radon gas is a naturally occurring radioactive substance that is a leading indoor pollutant and the second cause of lung cancer next to smoking. Radon decays into radioactive particles which, upon inhalation, give off alpha radiation, leading to localized DNA damage in lung cells (Darby et al., 2005).

Occupational Exposure: Prolonged exposure to industrial pollutants such as asbestos, silica, and heavy metals leads to chronic inflammation and genetic mutations, thereby increasing the risk of lung cancer.

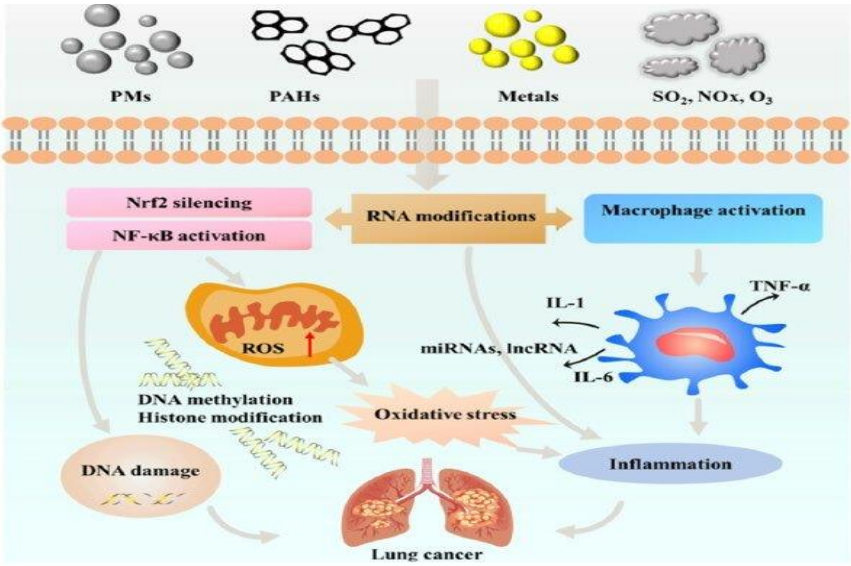

Figure 1: Pathways Through Which Air Pollution Contributes to Lung Cancer Development.

Source: (Kusumawardani et al., 2023)

3. Pollution and Lung Cancer: Pathophysiological Mechanisms

Primarily, lung cancers arising from pollution are accredited to the entry of harmful chemicals into the respiratory system leading to inflammation, oxidative stress, and DNA mutations. These result in a biological environment to trigger carcinogenesis.

- **Fine Particulate Matter of Air Pollution**

Fine particulate matter (PM2.5) is one of the most prominent contributors to the causation of the disease due to pollution. Because of its microscopic size, which measures less than 2.5 microns in diameter, PM2.5 can sneak past the body's natural barriers and penetrate deep into the alveoli in the lungs. Once lodged in lung tissue, these particles begin to produce reactive oxygen species (ROS), leading to oxidative stress and DNA damage. ROS disrupts cell repair mechanisms, resulting in mutations that disrupt normal cell cycle regulation. Chronic exposure to PM2.5 also induces inflammation through the stimulation of macrophages and epithelial cells, releasing pro-inflammatory cytokines, such as IL-6 and TNF-α. This caused inflammation promotes a

microenvironment where tumor development becomes enhanced as it promotes the proliferation of inappropriate cells and angiogenesis (Xing et al., 2016; Lelieveld et al., 2020).

There is a class of carcinogens within PM2.5: the polycyclic aromatic hydrocarbons (PAHs). PAHs will form adducts that bend DNA, thus inducing instability. There is a direct linkage between long-term exposure to PM2.5 and lung cancer, especially within urban and industrial settings in areas with high pollution rates (Cohen et al., 2017).

- **Indoor Pollution**

It is a fact that indoor air pollution accounts for a major proportion of lung cancer cases, particularly in developing regions where biomass fuels, such as wood, charcoal, and dung, are used for cooking and heating. The combustion of these fuels emits harmful pollutants, such as VOCs, carbon monoxide, and PAHs, into poorly ventilated living spaces. These materials can cause chronic respiratory inflammation and increase lung cancer risk, especially in women and kids who spend most of their day indoors (Smith et al., 2016). Radon is another indoor pollutant that is a naturally occurring radioactive gas. It enters homes through cracks in walls and floors, and its decay products emit alpha particles that damage lung epithelial cells. Long-term exposure to elevated radon levels significantly increases lung cancer risk, even among non-smokers (Darby et al., 2005).

- **Occupational Exposure**

Industrial pollutants such as asbestos, silica, and heavy metals encountered in occupational settings significantly exacerbate lung cancer risk. Asbestos fibers, for instance, directly damage lung tissue by inducing chronic inflammation and fibrosis, leading to mesothelioma and other lung cancers. Silica exposure, common in mining and construction industries, generates ROS and pro-inflammatory cytokines, amplifying the risk of carcinogenesis (Laney & Attfield, 2010). This contributes to the mechanism of lung cancer from prolonged exposure to heavy metals including cadmium and arsenic that work through mechanisms involving oxidative stress and epigenetic changes (Lelieveld et al., 2020).

4. Economic Spending on Lung Cancer

Spending on lung cancer ranges from direct, and indirect to intangible costs significantly challenging healthcare systems, household income at the individual level and, national economies.

- **Direct medical costs**

The management of lung cancer involves high direct medical costs such as imaging diagnosis, biopsy procedures, chemotherapy, radiation therapy, and novel immunotherapies. Advanced treatments, including targeted therapies such as tyrosine kinase inhibitors and immune checkpoint inhibitors, have transformed the management of lung cancer but at a significant cost. For example, the immunotherapy drug pembrolizumab can reach an annual cost of more than $150,000 per patient (Mariotto et al., 2020). Moreover, palliative care for patients with advanced-stage lung cancer also increases the cost, usually at a high level for pain management and supportive care.

- **Indirect Costs**

Indirect costs are productivity losses because of morbidity and premature mortality. Lung cancer, often diagnosed at the advanced stage, causes extensive attrition in the workforce. The loss in terms of human capital can be tens of billions of dollars a year. For example, in the United States,

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it has been estimated that lung cancer deaths translate to a loss of over $36 billion in productivity annually (Bradley et al., 2011). The same economic impacts occur worldwide, especially in developing countries with a high burden of lung cancer and few healthcare facilities.

- **Intangible Costs**

  The psychological and emotional impact of lung cancer on patients and their families is enormous. In addition to direct and indirect financial costs, other intangible costs include emotional stress and anxiety from disease progression, uncertainty over the treatment outcome, and loss among family members. While these are hard to monetize, they impact the quality of life for the patients and caregivers significantly. Such a component of the burden should be addressed through fully developed psychosocial support mechanisms within cancer care packages.

5. HEALTH COSTS AND BURDEN ON THE HEALTH SYSTEM

Lung cancer, exacerbated by environmental pollution, imposes immense health and economic challenges on individuals and societies. The financial burden arises from high healthcare costs, unequal access to care, and societal impacts like productivity losses and psychological distress.

- **Healthcare Utilization**

  In most instances, advanced lung cancer detection requires intense medical interventions. Due to this, patients tend to receive costly tests like images or CT and PET scans alongside biopsy tests to prove their malignancies. The treatment calls for extended periods of chemotherapy radiation therapy or immunotherapy. However, others must undergo surgical procedures, meaning that patients with metastasis and existing respiratory disorders require prolonged admission in hospitals. The chances are that some will necessitate ICU admittance.

  For example, treatments such as tyrosine kinase inhibitors (TKIs) and immunotherapy (for example, pembrolizumab) have greatly increased survival rates but are priced at more than $100,000 per year in developed economies. Such expenses make lung cancer one of the most expensive malignancies to treat. On the other hand, palliative care for advanced cases entails other expenses such as home care services, hospice support, and pain management therapies, among others (Mariotto et al., 2020).

- **Economic Inequalities**

  In low- and middle-income countries (LMICs), the mortality due to lung cancer is proportionally higher because of a lack of health infrastructure. Screening programs for early detection, such as low-dose computed tomography (LDCT), are not very common in these regions. The majority of people cannot access advanced treatments, including immunotherapies and precision medicine, because of high costs and supply chain barriers.

  For instance, in sub-Saharan Africa and parts of South Asia, less than 10% of cancer patients have access to radiotherapy services. In these regions, the reliance on out-of-pocket payments leads many patients to either delay seeking treatment or discontinue care mid-course, resulting in poorer health outcomes (WHO, 2021).

- **Insurance and out-of-pocket Expenses**

  The lack of universal healthcare in most countries worsens the economic burden of lung cancer. Even in the United States, a country with an insurance system, patients who are covered may still face gaps in coverage, with certain therapies being excluded or benefits limited for advanced

treatments. Lung cancer patients may have to pay for co-pays on consultations, diagnostic tests, medications, and travel to specialized care centers.

The situation is even more alarming in LMICs. Most families end up depleting their savings or liquidating other assets to manage the expenses. In a study from India, families reported spending over 40% of their annual income on managing cancer care; many families' catastrophic health expenditures pushed them below the poverty line (Pramesh et al., 2014). Many who cannot access care remain on the sidelines of life with higher rates of mortality and suffering.

6. POLICY AND PREVENTIVE MEASURES

Mitigating the dual challenges of lung cancer and pollution requires a multifaceted approach combining policy reforms, public awareness, and healthcare improvements.

6.1 Air Quality Standards

Stringent regulations of pollution sources are needed in order to reduce exposure to carcinogenic pollutants. For instance:

- **Industrial Emissions:** Policies that enforce cleaner production technologies and stricter limits on PM and gaseous pollutants can significantly curtail the industrial contribution to air pollution.
- **Vehicular Pollution:** Transitioning to electric vehicles (EVs) and implementing congestion pricing in urban areas can reduce emissions. Countries like Norway, which heavily subsidize EV adoption, have shown marked improvements in air quality (Lelieveld et al., 2020).
- **Urban Air Quality Monitoring:** Expanding air quality monitoring networks provides real-time data, enabling targeted interventions in high-pollution zones. Public reporting of air quality indices (AQIs) raises awareness and encourages behavioral changes.

6.2 Public Awareness Campaigns

Public education is critical for minimizing exposure to pollution and health-enhancing behaviors. Information campaigns should be tailored to:

- **Indoor Air Quality:** Encouraging the use of radon detection kits, proper ventilation, and non-toxic cleaning agents that minimize exposure to VOCs and other indoor pollutants.
- **Community Engagement:** Grassroots will be able to develop the local solutions, such as the adoption of clean cooking fuels in rural areas to replace biomass fuels that emit carcinogens, such as polycyclic aromatic hydrocarbons, and PAHs.

The World Health Organization's "BreatheLife" initiative is one of the global efforts through which people and policymakers have been educated on the dangers of air pollution and how clean environments are required to avoid the risks (WHO, 2021).

6.3 Healthcare Policies

Healthcare systems should move to respond to the dual burden of pollution and lung cancer with efficiency. Among the areas where interventions would be most needed are:

- **Subsidizing treatment:** Governments should subsidize lung cancer diagnostic tests and treatment, especially among the poor.
- **Integrating healthcare strategies:** Policies would have to incorporate air pollution control measures into greater public health strategies focusing on the prevention approach.

- **Research Funding:** The investment in research towards the development of cost-effective diagnostic tools and treatments is crucial, especially for LMICs where financial and technological resources are limited.

CONCLUSION

In the light of growing evidence, the connection between pollution and lung cancer has become increasingly undeniable. Long-term exposure to airborne toxins such as particulate matter (PM2.5), nitrogen oxides (NOx), sulfur dioxide (SO2), and other harmful airborne pollutants drives the biological mechanisms of carcinogenesis through oxidative stress, DNA damage, and chronic inflammation. These mechanisms underscore the need for addressing pollution at its source, to protect public health. However, indoor pollution and occupational hazards fall unequally on vulnerable populations and thus increase the need for focused intervention to address health disparities. The societal impact of lung cancer extends beyond health consequences. Economic burden, which includes the direct costs of medical treatment and indirect costs of lost productivity, weighs on the individual, family, and national economies. These costs underscore the need for preventive measures that promote prevention, early detection, and access to healthcare.

Comprehensive and coordinated action to the problem is necessary. Tighter regulations to cut back on emissions, with clean energy technologies and working environment safety measures, need to be adopted to reduce exposure to pollutants. Public health policies in the form of an awareness campaign and infrastructure should help educate communities about potential dangers and encourage healthier behaviors. In addition, developing advanced early diagnosis techniques and targeted treatment methods can aid the outcomes of those already exposed to lung cancer.

By prioritizing pollution mitigation and lung cancer prevention as public health imperatives, we can reduce the prevalence of this devastating disease by fostering sustainable development. Our efforts to combat pollution as well as its health effects will increase the quality of life among generations now but also better the environment for generations then, leading to a much more equitable and sustainable future.

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ETHICAL CONSUMPTION: A STEP TOWARDS AN ETHICAL SPACE

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ABSTRACT

Ethical consumption involves making purchasing decisions that are guided by moral values, environmental sustainability, social equity, and economic fairness. This concept has become increasingly significant in addressing global challenges such as climate change, labour rights, and consumer responsibility. Ethical consumption encourages practices that prioritize local, sustainable, and fair-trade products, aiming to align consumer habits with the principles of sustainability and fairness. Ethical consumption in India is influenced by a unique blend of cultural, social, and economic factors. It reflects a growing awareness of sustainability, fair trade, and social equity among consumers. With a population rich in diversity and a rapidly growing middle class, India presents a dynamic landscape for understanding ethical consumption practices. Key drivers include environmental consciousness, social responsibility, and traditional values emphasizing minimalism and sustainability.

Keywords: Consumption, Ethics, Moral values, Sustainability,

INTRODUCTION

Ethical consumption is the practice of making purchasing decisions that align with moral, ethical, and environmental values. It considers the impact of consumer choices on people, animals, and the planet. This concept has gained global significance as individuals become increasingly aware of the consequences of their consumption patterns. In India, the idea of ethical consumption is rooted in the country's cultural, spiritual, and philosophical traditions, such as *ahimsa* (non-violence) and *sustainable living*, which promote harmony with nature and social responsibility.

India's large and diverse population creates a unique consumer landscape where traditional practices coexist with modern consumerism. With rapid urbanization, a growing middle class, and rising disposable incomes, Indian consumers have access to a wider variety of products than ever before. However, this has also led to an increase in environmental degradation, exploitation of labour, and resource depletion.

In recent years, ethical consumption in India has gained momentum, driven by growing awareness of issues like climate change, fair trade, and animal welfare. Movements such as promoting organic farming, zero-waste lifestyles, and cruelty-free products reflect the shift towards more conscious consumption. Social media, government policies, and advocacy by non-governmental organizations (NGOs) play a significant role in encouraging ethical practices.

While the concept of ethical consumption is evolving in India, it faces challenges, including lack of awareness, higher costs of ethical products, and accessibility. Nonetheless, as consumers, businesses, and policymakers work together, the potential for fostering a culture of ethical consumption in India is promising, aligning with global sustainable development goals (SDGs) and the nation's traditional ethos.

CONCEPT OF ETHICAL CONSUMPTION

Ethical consumption refers to the practice of making purchasing decisions based on moral, ethical, and environmental considerations. It involves choosing products and services that align with values such as sustainability, fairness, and social responsibility. Ethical consumers consider the broader impact of their choices on the planet, people, and animals, striving to support practices that promote positive outcomes while avoiding those that cause harm.

Key aspects of ethical consumption include:

1. **Environmental Sustainability**: Preferring products that are eco-friendly, biodegradable, or have a lower carbon footprint.
2. **Fair Trade**: Supporting businesses that provide fair wages and safe working conditions to workers, particularly in developing regions.
3. **Animal Welfare**: Avoiding products tested on animals or derived from unethical treatment of animals.
4. **Minimalism and Conscious Living**: Consuming less and focusing on quality rather than quantity to reduce waste.
5. **Social Justice**: Choosing brands that promote inclusivity, equity, and ethical labour practices.

Ethical consumption challenges consumers to move beyond price and convenience and consider the origin, production, and societal impact of the products they buy. It reflects a shift toward responsible consumer behaviour, aiming to create a sustainable and equitable future.

Definition:

"Ethical consumption is the conscious and deliberate choice to make certain consumption decisions due to personal moral beliefs and values."

Harrison (2005)

Broadly defining Ethical Consumption from different perspectives:

1. **General Definition**:
   Ethical consumption is the act of making purchasing decisions based on moral, ethical, and environmental values, emphasizing the impact of consumption on society, the environment, and animals.
2. **From an Environmental Perspective**:
   Ethical consumption refers to choosing goods and services that minimize harm to the environment and promote sustainability, such as opting for eco-friendly, biodegradable, or renewable products.
3. **From a Social Justice Perspective**:
   Ethical consumption involves supporting businesses that ensure fair wages, equitable treatment, and safe working conditions for their workers, especially in supply chains.
4. **Academic Definition:**
   "Ethical consumption is the conscious and deliberate choice to make certain consumption decisions due to personal moral beliefs and values." (Harrison et al., 2005)

5. **Consumer Advocacy Perspective**:
   Ethical consumption is the practice of using one's buying power to influence ethical practices in industries, such as avoiding companies with exploitative practices or supporting those with ethical certifications like Fair Trade or cruelty-free labels.
6. **Cultural Definition**:
   Ethical consumption is rooted in values like non-violence and sustainability, which are aligned with cultural traditions that emphasize harmony with nature and social responsibility.

These definitions highlight how ethical consumption encompasses various dimensions, including environmental care, social equity, animal welfare, and individual responsibility.

REVIEW OF LITERATURE

- ***Barnett et al. (2005)*** **and** ***Harrison et al. (2005)*** Ethical consumption is rooted in values such as sustainability, fairness, and social justice. Studies like those emphasize the role of individual moral beliefs in influencing consumption choices.
- ***Shaw & Clarke, (1999*****)*** Research highlights that ethical consumption integrates ecological, social, and economic considerations into purchasing decisions.
- ***Narayanan (2010)*** discusses how principles of Gandhian philosophy, such as simplicity and environmental harmony, influence ethical consumption practices.
- ***Goyal & Gupta, (2018*****)*** With increasing concerns about climate change and pollution, urban consumers are showing interest in eco-friendly products

KEY FEATURES OF ETHICAL CONSUMPTION

Ethical consumption is characterized by decisions that prioritize the well-being of society, the environment, and future generations. Ethical consumption integrates environmental sustainability, social justice, and individual responsibility into everyday purchasing decisions. It seeks to create a balance between consumer needs and the planet's well-being, encouraging a more equitable and sustainable world. Below are its key features:

1. Sustainability

- Focuses on minimizing the environmental impact of production, consumption, and disposal.
- Encourages the use of renewable resources, energy efficiency, and sustainable practices like recycling and upcycling.

2. Fair Trade and Labor Rights

- Supports products that ensure fair wages, safe working conditions, and ethical labour practices.
- Opposes exploitation, child labour, and modern slavery in supply chains.

3. Animal Welfare

- Promotes cruelty-free products and opposes practices that harm or exploit animals.
- Encourages veganism, vegetarianism, and the use of alternatives to animal-derived products.

4. Environmental Responsibility

- Includes preferences for eco-friendly products, such as biodegradable, organic, or low-carbon footprint items.
- Advocates reducing consumption, waste, and reliance on non-renewable resources.

5. Consumer Awareness and Activism

- Involves making informed choices about the origins, production processes, and impact of goods and services.
- Encourages boycotting unethical brands and supporting companies with responsible practices.

6. Local and Small-Scale Production

- Supports local artisans, farmers, and small businesses to strengthen communities and reduce transportation emissions.
- Encourages the use of traditional, handcrafted, and indigenous methods.

7. Minimalism and Conscious Living

- Prioritizes quality over quantity, encouraging people to buy less and use resources efficiently.
- Advocates for reducing clutter and avoiding overconsumption.

8. Certification and Transparency

- Encourages the use of certifications like Fair Trade, Organic, FSC (Forest Stewardship Council), and cruelty-free labels to verify ethical practices.
- Demands corporate transparency about sourcing, production, and environmental impact.

9. Social Justice and Equity

- Promotes inclusivity, diversity, and equitable opportunities in business and consumer practices.
- Focuses on reducing inequalities and empowering marginalized communities.

10. Long-Term Perspective

- Recognizes the importance of choices that benefit future generations by preserving natural resources and ecosystems.
- Advocates for a shift in consumption patterns toward a circular economy.

Forms of ethical consumption:

Ethical consumption can take various forms, depending on the values and priorities of the consumer. Here are the main types of ethical consumption and examples of how they are practiced:

1. Sustainable Consumption

Focus: Minimizing environmental harm by choosing eco-friendly products.

- **Examples**:
  - Purchasing products with minimal or recyclable packaging.

- Supporting brands that use renewable energy or sustainable materials.
- Opting for second-hand, upcycled, or repairable items to reduce waste.

2. Fair Trade

Focus: Ensuring fair wages and good working conditions for producers.

- **Examples**:
- Buying fair trade-certified coffee, tea, or chocolate.
- Supporting brands that promote worker-owned cooperatives.
- Avoiding goods produced in exploitative working conditions.

3. Cruelty-Free and Animal Welfare

Focus: Avoiding harm to animals in product testing or sourcing.

- **Examples**:
- Choosing cruelty-free cosmetics and household products.
- Buying plant-based or vegan alternatives to reduce demand for factory farming.
- Supporting businesses committed to humane treatment of animals, such as free-range or pasture-raised meat and eggs.

4. Local and Small-Scale

Focus: Supporting local economies and reducing carbon footprints from transportation.

- **Examples**:
- Shopping at farmers' markets or local artisans.
- Choosing locally-sourced ingredients to reduce "food miles."
- Favouring small businesses over large multinational corporations.

5. Minimalism and Conscious Consumption

Focus: Consuming less and choosing quality over quantity.

- **Examples**:
- Buying fewer but longer-lasting products to reduce waste.
- Borrowing or renting items instead of buying (e.g., renting clothes for events).
- Practicing "zero-waste" or "low-waste" lifestyles.

6. Ethical Investment

Focus: Aligning financial decisions with ethical values.

- **Examples**:
- Investing in socially responsible or green funds.
- Avoiding companies involved in industries like fossil fuels, tobacco, or weapons.

- Supporting crowdfunding for ethical projects or startups.

7. Human Rights Focus

Focus: Avoiding products associated with exploitation or abuse.

- **Examples**:
  - Avoiding fast fashion brands with poor labour practices.
  - Checking supply chains to ensure no forced or child labour.
  - Supporting movements advocating for ethical labour standards, such as "No Sweat" campaigns.

8. Ethical Technology

Focus: Supporting companies that prioritize privacy, sustainability, and fair labour in tech production.

- **Examples**:
  - Buying electronics from brands committed to reducing e-waste.
  - Supporting open-source software and ethical tech initiatives.
  - Avoiding products made with conflict minerals.

9. Ethical Food Choices

Focus: Promoting health, sustainability, and fair practices in agriculture.

- **Examples**:
  - Choosing organic or non-GMO food.
  - Reducing meat consumption to lower environmental impact.
  - Supporting community-supported agriculture (CSA) programs.

10. Activism-Oriented Consumption

Focus: Using purchasing power to influence corporate and social behaviour.

- **Examples**:
  - Participating in boycotts of unethical companies.
  - Supporting brands that align with social justice causes.
  - Choosing "B Corporations" or companies committed to balancing profit with purpose.

Ethical Consumption Models

Ethical consumption models provide frameworks that guide consumer behaviour, enabling individuals to make purchasing decisions aligned with ethical, social, and environmental values. Below are some of the key ethical consumption models that have been developed and applied:

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1. The Fair Trade Model

- **Focus**: Promotes fair wages, safe working conditions, and equitable treatment of producers in developing countries.
- **Core Principles**: Ensures that producers receive a fair price for their goods, guarantees decent working conditions, and fosters long-term relationships between producers and consumers.
- **Impact**: This model aims to reduce poverty, promote gender equality, and support community development.
- **Example**: Fair Trade Certified products, such as coffee, chocolate, and handicrafts, which guarantee ethical production and transparent supply chains.

2. The Sustainable Consumption Model

- **Focus**: Encourages consumers to choose products and services that have minimal environmental impact, promote resource conservation, and support sustainability.
- **Core Principles**: Reducing waste, choosing eco-friendly products, and opting for renewable resources. It often emphasizes the importance of circular economy principles, such as recycling and reusing.
- **Impact**: Aims to minimize the depletion of natural resources, reduce pollution, and combat climate change.
- **Example**: Brands offering biodegradable packaging, reusable goods, and products made from sustainable materials like bamboo or recycled plastic.

3. The Green Consumption Model

- **Focus**: Consumers choose environmentally friendly products that reduce harm to the planet.
- **Core Principles**: Prioritizes energy-efficient, low-carbon, and zero-waste products. It encourages reducing personal carbon footprints through mindful consumption.

- **Impact**: Aims to protect ecosystems, reduce greenhouse gas emissions, and lower the impact of consumer choices on biodiversity.
- **Example**: Purchasing electric vehicles, choosing energy-efficient appliances, and using solar-powered products.

4. The Vegan/Vegetarian Consumption Model

- **Focus**: Promotes plant-based diets and cruelty-free products to reduce harm to animals and minimize the environmental impacts of animal farming.
- **Core Principles**: Avoiding animal products, both in food and non-food items (e.g., leather, fur, wool). This model also often extends to cosmetics and household goods that are not tested on animals.
- **Impact**: Reduces animal cruelty, supports animal rights, and decreases the environmental footprint associated with animal agriculture, including land use and greenhouse gas emissions.
- **Example**: Vegan food products, cruelty-free cosmetics, and plant-based leather alternatives.

5. The Localism and Slow Consumption Model

- **Focus**: Supports locally-produced goods and services, as well as slow and mindful consumption.
- **Core Principles**: Encourages purchasing from local artisans, farmers, and producers, minimizing the environmental impact of long-distance transportation, and supporting local economies. Also advocates for thoughtful, deliberate consumption rather than fast-paced, disposable culture.
- **Impact**: Reduces carbon emissions related to transportation, strengthens local economies, and promotes sustainable, community-based practices.
- **Example**: Buying organic produce from local markets, supporting local artisans, or purchasing handmade goods.

6. The Circular Economy Model

- **Focus**: Promotes the reuse, recycling, and upcycling of products to create a closed-loop system that minimizes waste.
- **Core Principles**: Designing products with longer life cycles, encouraging repair and refurbishment, and reusing materials to reduce waste. This model moves away from the traditional "take-make-dispose" approach.
- **Impact**: Reduces waste, conserves resources, and fosters sustainable production and consumption practices.
- **Example**: Brands that offer products designed for repair, such as electronics that can be easily upgraded or clothes made from recycled fibres.

7. The Conscious Consumer Model

- **Focus**: Involves consumers who prioritize the ethical, environmental, and social impact of their purchases, integrating their values into their consumption habits.

- **Core Principles**: These consumers research and carefully select brands based on the ethical practices behind them, such as environmental sustainability, fair labour practices, and corporate transparency.
- **Impact**: Promotes a shift in consumer demand toward businesses that align with social and environmental values, encouraging companies to adopt ethical practices.
- **Example**: Consumers who prefer brands like Patagonia (known for sustainability) or The Body Shop (promoting ethical sourcing and animal welfare).

8. The Ethical Fashion Model

- **Focus**: Ethical consumption within the fashion industry, advocating for fair labor practices, sustainable materials, and eco-friendly production.
- **Core Principles**: Promotes clothing brands that source their materials ethically, ensure fair wages for workers, and reduce environmental harm by using organic, biodegradable, or recycled fabrics.
- **Impact**: Reduces waste and environmental harm caused by fast fashion, supports ethical labour standards, and encourages more responsible fashion production.
- **Example**: Sustainable fashion brands like Stella McCartney, Reformation, and People Tree.

Ethical consumption models provide diverse pathways for consumers to make choices that align with their values, whether they prioritize environmental sustainability, social justice, or animal welfare. Each model emphasizes a different aspect of ethical living, but collectively, they contribute to a more sustainable, fair, and conscientious consumer culture.

BENEFITS OF ETHICAL CONSUMPTION

The benefits of ethical consumption extend far beyond individual satisfaction, creating a ripple effect that positively impacts society, the environment, and the global economy. By fostering sustainability, fairness, and responsibility, ethical consumption offers a pathway to a more equitable and sustainable world.

1. Environmental Benefits

- **Reduces Pollution and Waste**: By prioritizing eco-friendly and biodegradable products, ethical consumption minimizes environmental degradation.
- **Promotes Sustainability**: Supports practices like renewable energy, organic farming, and sustainable resource use, which preserve ecosystems for future generations.
- **Mitigates Climate Change**: Encourages low-carbon products and reduces the environmental footprint through conscious consumer choices.

2. Social and Economic Benefits

- **Improves Labor Conditions**: Ethical consumption supports fair trade and companies that provide safe working environments and fair wages, particularly in developing countries.
- **Empowers Communities**: Encouraging local and small-scale production strengthens communities, creates jobs, and promotes economic self-sufficiency.

- **Reduces Inequality**: Focuses on equitable distribution of wealth and opportunities, supporting marginalized groups.

3. Health Benefits

- **Encourages Natural Products**: Promotes the use of organic, non-toxic, and chemical-free products, contributing to better health outcomes for consumers.
- **Fosters Healthy Eating Habits**: Ethical consumption often includes choosing sustainably grown and organic food, which is healthier and free from harmful pesticides.

4. Promotes Animal Welfare

- **Supports Cruelty-Free Practices**: Advocates for products that are not tested on animals and avoids industries involving animal exploitation.
- **Encourages Plant-Based Diets**: Reduces the demand for meat and dairy, leading to lower rates of animal farming and associated ethical concerns.

5. Consumer Empowerment

- **Aligns with Personal Values**: Enables individuals to make choices consistent with their ethical beliefs, creating a sense of purpose and fulfilment.
- **Promotes Conscious Living**: Encourages consumers to think critically about their consumption habits and make informed decisions.

6. Encourages Corporate Responsibility

- **Incentivizes Ethical Practices**: By supporting ethical brands, consumers pressure businesses to adopt fair, transparent, and sustainable practices.
- **Improves Product Innovation**: Drives companies to develop eco-friendly, sustainable, and innovative products to meet the demands of conscious consumers.

7. Global Impact

- **Addresses Global Issues**: Ethical consumption helps combat pressing global challenges such as climate change, poverty, and deforestation.
- **Supports Sustainable Development Goals (SDGs)**: Aligns with the United Nations SDGs, contributing to a sustainable and equitable future.

8. Economic Resilience

- **Encourages Circular Economies**: Promotes reuse, recycling, and minimal waste, reducing dependency on finite resources.
- **Stimulates Green Industries**: Increases demand for environmentally responsible businesses, fostering the growth of the green economy.

THE IMPACT OF ETHICAL CONSUMPTION ON MARKETING PRACTICES

There has been profound, reshaping how companies engage with consumers, develop products, and communicate their values. With a growing number of consumers prioritizing sustainability, social responsibility, and ethical practices, businesses have had to adapt their marketing strategies to meet these expectations. Here's how ethical consumption has influenced marketing practices:

1. Emphasis on Transparency and Authenticity

- **Impact**: Ethical consumers demand honesty and openness from brands about their sourcing, production, and environmental impact.
- **Marketing Response**:
  - Providing detailed information about supply chains and sustainability initiatives.
  - Using storytelling to highlight the ethical journey of products.
  - Publishing sustainability reports and certifications.

2. Growth of Purpose-Driven Branding

- **Impact**: Consumers increasingly seek brands that align with their values and support social or environmental causes.
- **Marketing Response**:
  - Highlighting a company's mission and values in campaigns.
  - Aligning with causes like climate action, gender equality, or fair trade.
  - Partnering with NGOs or social enterprises to enhance credibility.

3. Rise of Green and Ethical Labels

- **Impact**: Certifications and labels (e.g., Fair Trade, USDA Organic, B-Corp) have become critical tools for building consumer trust.
- **Marketing Response**:
  - Promoting products with recognized ethical certifications.
  - Incorporating eco-labels and sustainability seals into packaging and advertisements.
  - Educating consumers about the significance of these certifications.

4. Avoidance of Greenwashing

- **Impact**: Increased consumer awareness has made greenwashing (false sustainability claims) a significant risk for brands.
- **Marketing Response**:
  - Shifting focus from vague claims to measurable, verified impacts (e.g., carbon reduction metrics, water savings).
  - Avoiding overstatement and ensuring marketing aligns with actual business practices.
  - Engaging third-party audits and transparency tools to validate claims.

5. Incorporation of Ethical Storytelling

- **Impact**: Ethical consumers value the story behind products, including the people and processes involved.
- **Marketing Response**:
  - Sharing narratives about artisans, workers, and communities benefiting from ethical practices.

- Highlighting small-scale, local, or handmade production methods.
- Creating emotional connections with consumers through relatable stories.

6. Focus on Minimalism and Sustainability

- **Impact**: Consumers are shifting away from overconsumption toward quality, durability, and sustainability.
- **Marketing Response**:
- Promoting longevity and repairability of products instead of disposability.
- Using minimalist packaging and highlighting reduced environmental footprints.
- Encouraging responsible consumption (e.g., "buy less, buy better" campaigns).

7. Leveraging Social Media and Influencers

- **Impact**: Social media has amplified ethical consumption trends, enabling consumers to hold brands accountable and spread awareness.
- **Marketing Response**:
- Partnering with influencers who genuinely advocate for ethical practices.
- Using social platforms to share behind-the-scenes looks at sustainability efforts.
- Encouraging user-generated content that highlights consumers' ethical purchases.

8. Market Segmentation Based on Values

- **Impact**: Ethical consumers are diverse, with varying priorities such as environmentalism, social justice, or animal welfare.
- **Marketing Response**:
- Customizing campaigns to resonate with specific ethical concerns (e.g., veganism, zero-waste living).
- Creating product lines or services targeting niche ethical markets.
- Utilizing data to understand and target eco-conscious demographics effectively.

9. Demand for Circular Economy Marketing

- **Impact**: Ethical consumers value brands that support recycling, upcycling, and waste reduction.
- **Marketing Response**:
- Promoting take-back programs, product recycling, or refurbishing services.
- Highlighting closed-loop processes where waste becomes a resource.
- Marketing reusable or multi-functional products.

10. Competitive Differentiation

- **Impact**: Ethical consumption provides an opportunity for brands to stand out in crowded markets.

- **Marketing Response**:
  - Differentiating through strong commitments to sustainability and ethical practices.
  - Competing on values rather than just price or convenience.
  - Building loyalty by fostering a community around the shared ethical principles.

CONCLUSION

Ethical consumption empowers individuals to align their purchasing choices with their values, fostering a positive impact on the environment, society, and the economy. By prioritizing sustainability, human rights, animal welfare, and transparency, consumers can drive meaningful change at both personal and systemic levels.

While challenges like affordability, accessibility, and greenwashing exist, the growing awareness and demand for ethical alternatives encourage companies to adopt responsible practices. Ethical consumption, when combined with advocacy and policy support, has the potential to create a more equitable and sustainable global economy.

Ultimately, ethical consumption is not just about what we buy but about rethinking our relationship with consumption itself—moving towards mindful, responsible, and impactful choices that benefit people and the planet.

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ASSESSMENT OF PERSONALITY TRAITS AMONG FEMALE SPORTSPERSON AND NON-SPORTSPERSON AT PUNJABI UNIVERSITY PATIALA

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ABSTRACT

Study Objective
The primary objective of this study was to assess the personality traits of female sportspersons and non-sportspersons at Punjabi University, Patiala.

Methodology
The study sample comprised 40 females: 20 sportspersons who had participated in inter-university and intercollege competitions, and 20 non-sportspersons from various university departments. Data collection was conducted using the Ten Item Personality Inventory (TIPI), which evaluates five key personality factors:

- Extroversion
- Conscientiousness
- Agreeableness
- Emotional Stability
- Openness to Experience

The data were analyzed by calculating the mean and standard deviation (SD) for each variable across the 40 participants. A t-test was employed to determine significant differences between the sportsperson and non-sportsperson groups.

Results
The analysis yielded the following findings:

- Significant differences were observed in the traits of agreeableness, conscientiousness, and openness to experience.
- No significant differences were found in extroversion and emotional stability.

All significant results were reported at $p<.05$.

Keywords: Personality Traits, Sportsperson and Non-Sportsperson

INTRODUCTION

Personality is a dynamic and organized set of characteristics that uniquely influence an individual's behaviors, thoughts, and emotions in various situations. It encompasses the enduring patterns of behavior and internal processes that define a person's individuality and interaction with the world. Over time, personality has been a key area of study in psychology due to its significance in understanding human differences and predicting behavior.

Allport (1937) was among the first to define personality as "the dynamic organization within the individual of those psychophysical systems that determine his characteristic behavior and thought." This definition highlights the integrative and adaptive nature of personality. Later, Eysenck (1947) proposed a trait-based approach to personality, emphasizing the biological and genetic bases of traits such as extroversion, neuroticism, and psychoticism.

The Five-Factor Model (FFM), proposed by **McCrae and Costa (1990)**, is one of the most widely accepted frameworks for understanding personality. It identifies five core dimensions:

1. **Extroversion**: The tendency to be outgoing, energetic, and sociable.
2. **Agreeableness**: The quality of being compassionate, cooperative, and empathetic.
3. **Conscientiousness**: The attribute of being organized, dependable, and self-disciplined.
4. **Emotional Stability (Neuroticism)**: The ability to remain calm and stable in stressful situations.
5. **Openness to Experience**: The inclination towards creativity, curiosity, and a preference for novelty.

Personality is influenced by both genetic and environmental factors, making it a complex interplay of innate predispositions and life experiences (**McCrae & Costa, 2008**). It is also a crucial determinant in various domains of life, such as academic success, career development, interpersonal relationships, and sports performance.

In the context of sports psychology, personality plays a significant role in influencing an athlete's performance, motivation, and resilience. Studies suggest that certain personality traits, such as conscientiousness and emotional stability, are associated with higher levels of performance and stress management in athletes (**Allen, Greenlees, & Jones, 2013**). Understanding the personality differences between sportspersons and non-sportspersons can provide insights into how participation in sports may shape or reflect distinct personality profiles.

OBJECTIVES OF THE STUDY

The primary objective of this study was to examine and compare the personality traits of sportspersons and non-sportspersons at Punjabi University, Patiala.

SIGNIFICANCE OF THE STUDY

This study aims to provide valuable insights into the personality traits of sportspersons and non-sportspersons at Punjabi University, Patiala. It seeks to explore the relationship between personality and participation in sports, shedding light on how personality traits may differ between these groups. The findings could contribute to identifying distinct personality traits associated with sportspersons compared to non-sportspersons.

Additionally, this research may assist psychologists and educators in understanding the behavioral patterns and similarities between sportspersons and non-sportspersons, potentially informing strategies for personality development and mental well-being in both groups.

REVIEW OF RELATED LITERATURE

Raghvendra Singh, Dr. Shri Krishna Patel (2023) studied to compare the personality characteristics of players who engage in combative games with those who engage in team games better to comprehend the distinctions between the two categories of players. The study examined 96

male athletes aged 21–26 who competed in intercollegiate competitions in their combative sport. The data was collected with the Big Five Personality Questionnaire by Oliver, P. John & Sanjay Srivastava was used to gather data (1999). The independent samples t-test compared combative game players and team game players. The significance threshold was 0.05. The results showed that combative and team sports differed in Extraversion, Agreeableness, Conscientiousness, and Openness to experience ($p<0.05$) but not in Neuroticism ($p>0.05$).

Ravinder Kumar (2022) studied to compare selected big - five personality traits and physiological parameters between sportsperson and non – sportsperson of New Delhi India. The researcher had randomly selected 35 non-sportsperson and 35 national level players. To complete this research, the subjects were divided into two groups, in which sportspersons were kept in experimental and non - sportsperson in controlled group. The age of subjects between 15 – 25 years. The selected all subjects were the natives of New Delhi. Standardized BIG FIVE Questionnaire was used to test personality traits among Sportsperson and Non-Sportsperson. BIG Five personality traits such as Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism. Other hand side Physiological Parameters such as Body composition, Vital capacity and Heart rate were used to assess. The result of the current study suggests that there are only two selected Big – five personality traits Extraversion and Agreeableness was found statistically significant on both Experiment and control group. $P \leq 0.05$, and it was evident from the table 3 that there are two selected Physiological parameters namely Body Composition and Vital Capacity was found statistically significant on both Experiment and Control group $P \leq 0.05$.

Shivani Nishad and Monika Gwalani (2021) conducted a study to compare emotional intelligence, personality, and mental health among sportspersons and non-sportspersons. The sample included 100 participants (50 sportspersons and 50 non-sportspersons). The study used Pethe and Hyde's Emotional Intelligence Test, the NEO Five-Factor Inventory, and Jagdish and Srivastava's Mental Health Inventory. The results revealed statistically significant differences in emotional intelligence (self-awareness, self-motivation, emotional stability, managing relations, and altruistic behavior), personality traits (extraversion, openness, and conscientiousness), and mental health dimensions (positive self-evaluation, perception of reality, personality integration, autonomy, group-oriented attitudes, and environmental mastery). The findings highlighted that sportspersons exhibited higher emotional intelligence and mental health levels than non-sportspersons. The study underscores the role of physical activity in enhancing both psychological and mental well-being, particularly in adolescence.

DESIGN AND PROCEDURE

The primary objective of the current study was to examine the personality traits of sportspersons and non-sportspersons at Punjabi University, Patiala. The sample consisted of 40 females, including 20 sportspersons who had participated at intercollege and interuniversity levels, and 20 non-sportspersons from various departments of the university. Data collection was carried out using the Ten Item Personality Inventory (TIPI) questionnaire, developed by Samuel Gosling, S.D., Rentfrow, P.J., and Swann, W.B. (2003).

METHODOLOGY

After data collection, appropriate statistical tools were applied to describe and interpret the results. The mean and standard deviation (SD) were calculated for each item across the 40 female participants (20 sportspersons and 20 non-sportspersons from Punjabi University). The data were analyzed using a t-test.

ANALYSIS OF DATA

The data collected using various parameters in the investigation were recorded, statistically analyzed, and graphically presented in this chapter in alignment with the study's objectives. Tabular and graphical representations of the data are provided, accompanied by discussions, results, and conclusions.

TABLE NO. 1 - Descriptive statistics of Extroversion Personality of Sportspersons and non-Sportspersons.

Subjects	N	Mean	SEM	S.D.	p-value	t-value
Sportsperson	20	4.175	0.286	1.280	0.3424	0.9614
Non-sportsperson	20	4.575	0.302	1.350		

***p>0.05, df 38, table 't' value 1.686**

Table 1 presents the descriptive statistics for sportspersons and non-sportspersons (total respondents). For the extroversion dimension of the Big Five Personality traits, the mean score for sportspersons was 4.175, with a standard deviation of 1.280 and a standard error mean of 0.286. Non-sportspersons had a mean score of 4.575, a standard deviation of 1.350, and a standard error mean of 0.302.

The analysis revealed no significant difference in the extroversion dimension between the two groups. However, comparing mean values shows that non-sportspersons scored higher on extroversion than sportspersons, indicating that non-sportspersons from Punjabi University exhibit stronger extroversion traits.

TABLE NO. 2 - Descriptive statistics of Agreeableness Personality of Sportspersons and non-Sportspersons.

Subjects	N	Mean	SEM	S.D.	p-value	t-value
Sportsperson	20	4.250	0.239	1.070	0.0038	3.0803
Non-sportsperson	20	5.375	0.276	1.234		

***p>0.05, df 38, table 't' value 1.686**

Table 2 presents the descriptive statistics for sportspersons and non-sportspersons (total respondents). For the agreeableness dimension of the Big Five Personality traits, the mean score for sportspersons was 4.250, with a standard deviation of 1.070 and a standard error mean of 0.239. Non-sportspersons had a mean score of 5.375, a standard deviation of 1.234, and a standard error mean of 0.276.

The analysis revealed a significant difference in the agreeableness dimension between the two groups. Comparing the mean values indicates that non-sportspersons scored higher on agreeableness than sportspersons, suggesting that non-sportspersons from Punjabi University exhibit stronger agreeableness traits.

TABLE NO. 3 - Descriptive statistics of Conscientiousness Personality of Sportspersons and non-Sportspersons.

Subjects	N	Mean	SEM	S.D.	p-value	t-value
Sportsperson	20	4.289	0.292	1.273		

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Non-sportsperson	20	5.700	0.327	1.464	0.0028	3.2043

***p>0.05, df 38, table 't' value 1.686**

Table 3 provides the descriptive statistics for sportspersons and non-sportspersons (total respondents). For the conscientiousness dimension of the Big Five Personality traits, sportspersons had a mean score of 4.289, with a standard deviation of 1.273 and a standard error mean of 0.292. Non-sportspersons had a mean score of 5.700, a standard deviation of 1.464, and a standard error mean of 0.327.

The analysis identified a significant difference in the conscientiousness dimension between the two groups. Comparing the mean values reveals that non-sportspersons scored higher on conscientiousness than sportspersons, indicating that non-sportspersons from Punjabi University exhibit stronger conscientiousness traits.

TABLE NO. 4 - Descriptive statistics of Emotional Stability Personality of Sportspersons and non-Sportspersons.

Subjects	N	Mean	SEM	S.D.	p-value	t-value
Sportsperson	20	4.100	0.210	0.940		
Non-sportsperson	20	4.525	0.403	1.803	0.3558	0.9349

***p>0.05, df 38, table 't' value 1.686**

Table 4 presents the descriptive statistics for sportspersons and non-sportspersons (total respondents). For the emotional stability dimension of the Big Five Personality traits, sportspersons had a mean score of 4.100, with a standard deviation of 0.940 and a standard error mean of 0.210. Non-sportspersons had a mean score of 4.525, a standard deviation of 1.803, and a standard error mean of 0.403.

The analysis revealed no significant difference in emotional stability between the two groups. However, the mean value comparison shows that non-sportspersons scored higher on emotional stability than sportspersons, suggesting that non-sportspersons from Punjabi University exhibit slightly better emotional stability traits.

TABLE NO. 5 - Descriptive statistics of Openness to experience Personality of Sportspersons and non-Sportspersons.

Subjects	N	Mean	SEM	S.D.	p-value	t-value
Sportsperson	20	4.575	0.308	1.379		
Non-sportsperson	20	5.600	0.311	1.392	0.0247	2.3396

***p>0.05, df 38, table 't' value 1.686**

Table 5 presents the descriptive statistics for sportspersons and non-sportspersons (total respondents). For the openness to experience dimension of the Big Five Personality traits, sportspersons had a mean score of 4.575, with a standard deviation of 1.379 and a standard error mean of 0.308. Non-sportspersons had a mean score of 5.600, a standard deviation of 1.392, and a standard error mean of 0.311.

The analysis revealed a significant difference in openness to experience between the two groups. Comparing the mean values indicates that non-sportspersons scored higher on openness to experience

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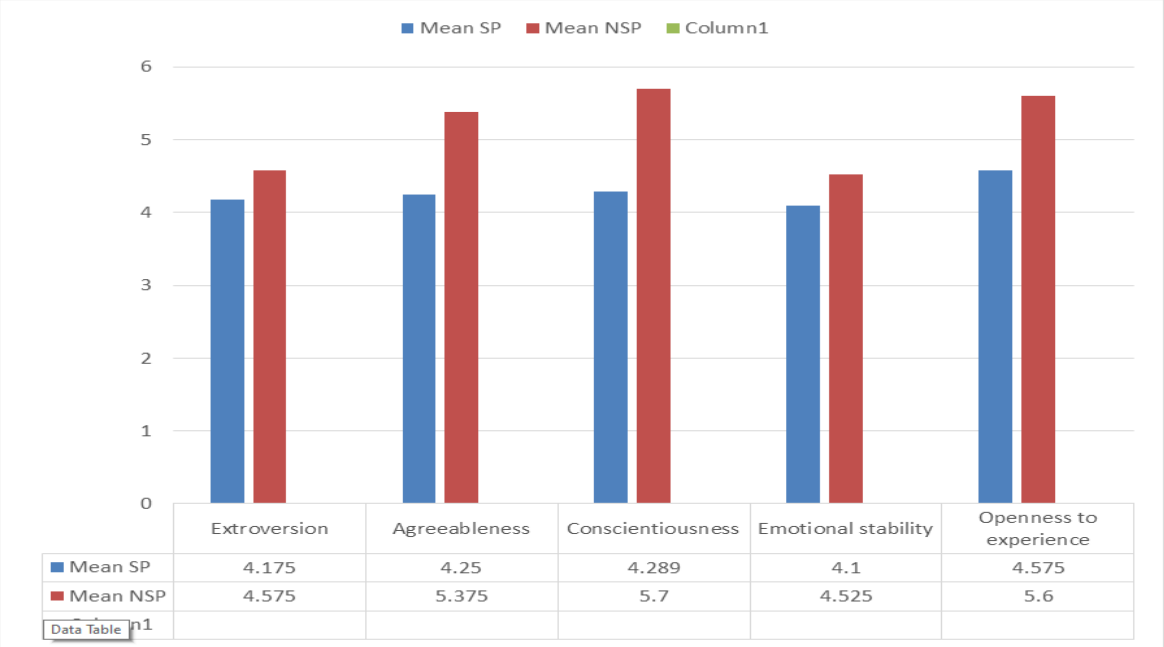
than sportspersons, suggesting that non-sportspersons from Punjabi University exhibit stronger traits in this dimension.

TABLE NO. 6 - Descriptive Statistics on big-five personality of Sports persons and non-sports persons.

S. No.	Variables	t-value	Df	Significance	Mean Difference	Std. Error Difference
1.	Extroversion	0.9614	38	0.3424	-0.400	0.416
2.	Agreeableness	3.0803	38	0.0038	-1.125	0.365
3.	Conscientiousness	3.2043	38	0.0028	-1.411	0.440
4.	Emotional Stability	0.9349	38	0.3558	-0.425	0.455
5.	Openness to Experience	2.3396	38	0.0247	-1.025	0.438

Table 6 provides the descriptive statistics for sportspersons and non-sportspersons, including the t-value, degrees of freedom, significance level (2-tailed), mean difference, and standard error difference for the variables of the Big Five Personality traits.

FIGURE NO. 1 - Graphical Presentation of the Mean of Personality of Sportsperson and Non-Sportsperson.



SUMMARY

The study aimed to examine differences in personality traits between sportspersons and non-sportspersons at Punjabi University, Patiala. The research problem was stated as: **"Assessment of Personality Among Sportspersons and Non-Sportspersons of Punjabi University Patiala."**

Data were collected using the Ten Item Personality Inventory, and the age of participants ranged from 20 to 25 years. The sample consisted of 20 sportspersons and 20 non-sportspersons. The t-test was applied to analyze the computed scores for both groups.

The results for the Big Five Personality traits were as follows:

- **Extroversion**: t-value = 0.9614 (not statistically significant)
- **Agreeableness**: t-value = 3.0803 (statistically significant)
- **Conscientiousness**: t-value = 3.2043 (statistically significant)
- **Emotional Stability**: t-value = 0.9349 (not statistically significant)
- **Openness to Experience**: t-value = 2.3396 (statistically significant)

The findings were evaluated at a 0.05 level of confidence, highlighting significant differences in agreeableness, conscientiousness, and openness to experience, while no significant differences were observed in extroversion and emotional stability.

CONCLUSION

Based on the limitations and scope of the study, the following conclusions have been drawn:

1. The results of the study indicate that some selected psychological variables showed statistically significant differences between sportspersons and non-sportspersons, while others did not.
2. The study revealed significant differences in the psychological variables of agreeableness, conscientiousness, and openness to experience between sportspersons and non-sportspersons. These differences were statistically significant at the 0.05 level.
3. The study also found no statistically significant difference in the psychological variables of extroversion and emotional stability between sportspersons and non-sportspersons at the 0.05 level.

Testing Hypothesis

Hypothesis: Based on the findings, the following conclusions were made regarding the hypotheses:

- "There is no difference found in the extroversion factor of personality between sportspersons and non-sportspersons at Punjabi University, Patiala." Hence, the null hypothesis is accepted.
- "There is a significant difference in the agreeableness factor of personality between sportspersons and non-sportspersons at Punjabi University, Patiala." Hence, the alternative hypothesis is accepted.
- "There is a significant difference in the conscientiousness factor of personality between sportspersons and non-sportspersons at Punjabi University, Patiala." Hence, the alternative hypothesis is accepted.
- "There is no significant difference in the emotional stability factor of personality between sportspersons and non-sportspersons at Punjabi University, Patiala." Hence, the null hypothesis is accepted.
- "There is a significant difference in the openness to experience factor of personality between sportspersons and non-sportspersons at Punjabi University, Patiala." Hence, the alternative hypothesis is accepted.

RECOMMENDATION

Based on the conclusions drawn from the present study, the following recommendations are made:

1. The findings of this research can be valuable for coaches and trainers in enhancing the performance of athletes.
2. Similar studies can be conducted to explore other psychological and physiological variables.
3. Further research can be undertaken across different sports and games to gain a broader understanding of personality traits in various contexts.
4. Future studies could focus on male participants, as this study was limited to females.
5. I personally recommend that sportspersons also focus on their academic pursuits and continue to explore their potential in various areas.

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A SURVEY ON SCRAP WASTE MANAGEMENT IN ATTINGAL MUNICIPALITY- INNOVATIVE PERSPECTIVES

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ABSTRACT

The creation and handling of scrap waste is a concern as properly managing solid waste. This comprehensive study using data from 100 respondents near 10 scrap collection units in Attingal municipality, examines awareness, perceptions, concerns, and solutions related to scrap waste management and evaluates satisfaction with services and views on scrap waste management systems and current state prevailing in the study area. The effectiveness of scrap collection systems, public awareness of recycling and segregation, and the negative social and environmental effects of inappropriate scrap waste management are some of the main conclusions. In addition, the research highlights deficiencies in community involvement, infrastructure, and upkeep while offering doable suggestions for enhancement. This study intends to aid in the creation of a more inclusive, sustainable, and successful scrap trash management plan for Attingal Municipality by evaluating the advantages and disadvantages of the current system. Very few studies been done focusing on this issue so this study helps to further studies for analysis of Environmental Impact.

Keywords: Scrap Waste Management, Heavymetals, Scrapdealers

INTRODUCTION

Many countries are attempting to strike a balance between improving the built environment and protecting the natural ecosystem in their pursuit of sustainable development. By switching from the traditional linear production model to a circular strategy that emphasizes material waste prevention, reuse, and recycling, this balance can be reached (Al-Hajj & Hamani, 2011; Chikarmane et al., 2000; Moreno-Sánchez & Maldonado, 2006). A percentage of solid trash that is isolated from mixed waste and undergoes additional processing for recycling and reuse is referred to as scrap waste (Jones et al., 2021; Luitel & Khanal, 1970) That are no longer usable in their original form but may frequently be used for other purposes. It usually results from building, production, or the disposal of tools, machinery, or equipment because of wear and tear, damage, or the end of their useful lives (Orisadare et al., 2020). Scraps are wastes that are separated from the mixed garbage and used for recycling and reuse and they are a type of solid waste (Chikarmane et al., 2000; Luitel & Khanal, 1970). Solid waste bothers most people, especially if it smells and no one gives scrap waste more importance. Many contaminants leak out since most of the discarded items are kept outdoors, unprotected. Significant differences in the influence of scrap metal on soil quality were found through the investigation of various criteria.

Scraps consist of recyclable materials, usually metals, left over from product manufacturing and consumption, such as parts of vehicles, building supplies, and surplus materials. Once a product completes its useful product life, it becomes old scrap. (Thompson et al., 2019). The leaching of heavy metals from scrap metal dumpsites could contaminate soil, groundwater and vegetation. (Angaye & Seiyaboh, 2019) Heavy metal contamination from anthropogenic sources is one of the most dangerous pollutants in different environmental compartments. (Briffa et al., 2020). The heavy

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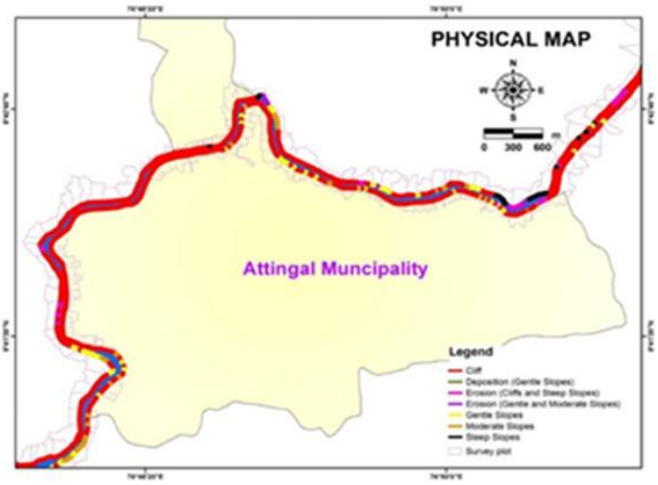
metals in waste or scraps are primarily a consequence of the intended use of heavy metals in industrial products. At the end of their useful life all products will end up in waste to the extent they are not attractive for recycling or in the scrapyard for recycling (Duffus, 2002; Orosun et al., 2016; Pathania, 2016). Heavy metals may, however, also be lost to waste during production, use phases and storage for recycling in scrapyard (Dhayalan & Kanimozhi, 2015). There is a growing concern about the possibility of contaminated soil resulting in the introduction of metals in food chains through uptake by plants grown on contaminated soil and thereby affecting food safety (Pujar et al., 2012) Polycyclic aromatic hydrocarbons (PAHs), are common contaminants in the environment that can threaten the populace living close to contaminated soil. (Alegbeleye et al., 2017). Common pollutant (chemical oxygen demand (COD), nutrients (i.e., nitrogen and phosphorous), suspended solids as well as potentially toxic metal, phthalates, polyaromatic hydrocarbon (PAH) and polychlorinated biphenyl (PCB) concentrations can be high and frequently exceed the imposed discharge limits. (Blondeel et al., 2015). In most developing countries, the urban authorities, such as municipalities are responsible for waste management. Waste management is one of the most visible urban services whose effectiveness serves as an indicator for good local governance, sound municipal management and successful urban reforms. Scarp waste management (SWM) is one of the major environmental issues in cities of many developing countries, there is lack of proper management of scarp wastes, and this problem has remained static as there is no growth of public awareness about the adverse effect in public health and environment as well as effort of the people for its control (Cowi, 2002; Jones et al., 2021)

MATERIALS AND METHODS:

Study Area

Attingal Municipality is situated at Chirayinkeezh taluk, Thiruvananthapuram district. Total number of wards 31 and the population of the Municipality is 38,838.(Nazeemudeen Sabah et al., 2021). The latitude of Attingal is 8.695034, and the longitude is 76.817879. Attingal is located at the towns place category with the GPS coordinates of 8° 41' 42.1224" N and 76° 49' 4.3644" E. (Anjana et al., 2018).



Source: (Gopal et al., 2014)

Data Collection

Primary data collection by direct observation and preparing a questionnaire for collecting data from scrap dealers and from people living near the scrap collection unit to know the current situation in scrap dealing and to understand the current state prevailing. Surveys and informal discussions were carried out to gather more data, creating three separate questionnaires: one for the municipality, one for scrap traders, and one for residents living close to scrap collection units. Prior to distributing the questionnaires to the targeted respondents based on age difference, education, and employment, a pilot test was carried out. The questionnaire for peoples living near the area has three sections: the first gathers respondent details (gender, race, tenancy, employment, education); the second assesses awareness, perceptions, concerns, and solutions related to scrap waste management; the third evaluates satisfaction with services and views on scrap waste management solutions. The scrap dealers' questionnaire to comprehend business practices, the scrap garbage collected, how to prevent environmental damage, and the role of the municipality in monitor to managing scrap waste.

a) Sample Size - The sample consisted of 100 respondents, peoples near scrap collection units in Attingal Municipality and 10 respondents of scrap dealers.

b) Tools for Data Collection - The primary data were collected through direct observation or field visits, questionnaires and interview schedules. Secondary Data collection including studies, reports and data collected by government and non-governmental organizations.

RESULTS AND DISCUSSIONS:

According to the collected data there is relatively little research has been done on this area mainly the scrap waste management. Therefore, in order to create efficient scrap trash management systems, one must first be knowledgeable about the pace at which scrap waste is generated and how to handle it before sending it for recycling. The objective of the present study is to determine type, nature, and estimate volume of scrap at its scrap collection units and understand the current status in the study area.

A) Observation of Field Visit and Data Collection from Scrap Dealers

From this study most of the scrap waste collected by door-to-door collection system by waste pickers and cycle hawkers, especially they collect paper, plastics and metals. Sometimes scrap traders collect scrap waste from municipality by auction. Mainly scrap dealers transfer the scrap materials to recycling based on definite quantity and according to increase rate of materials. Based on interview scrap traders giving employment opportunity to lots of people and they are facing lots of challenges mainly health problems and license renewal issues from Concerned authority, from that, understand lots of unauthorised scrap collection system done in the municipality area.

Table 1 shows quantity of scrap wastes collection in tonnes per day (tpd) from different institutions in Attingal Municipality

(Source: Action Plan on Municipal Solid Waste Management of the Municipality 2018-19,Nazeemudeen Sabah et al., 2021).

Sl.No.	Type of Institutions	Nos.	Expected Generation Rate (tpd)
1	Households	15633	1.2
2	Schools	19	0.209
3	Colleges	5	0.055
4	Offices	46	0.506
5	Halls	8	0.088
6	Hotels	40	0.44

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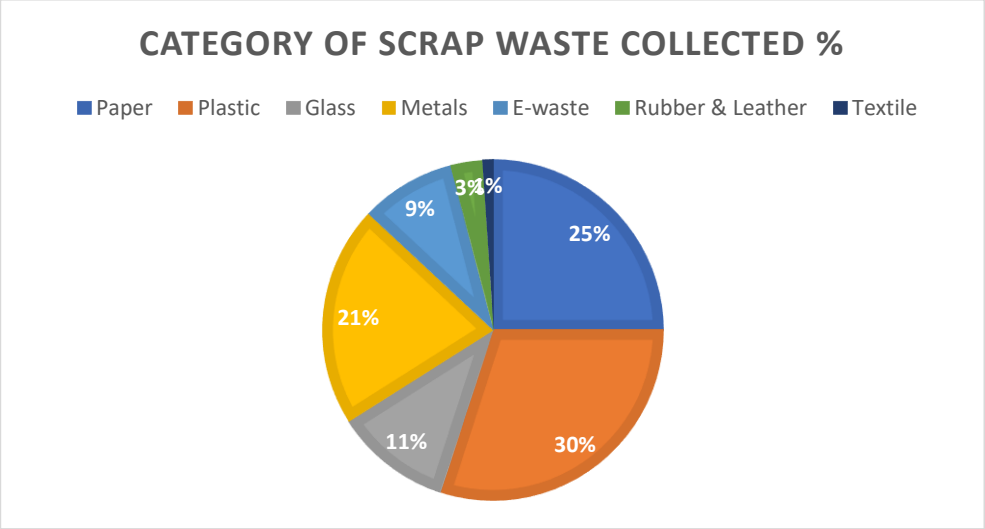
7	Hostels	5	0.044
8	Hospitals	11	0.121
9	Restaurants	15	0.165
10	Markets	6	2.83
11	Shopping malls	6	3.00
12	Housing Colonies	7	0.5
13	Housing Towers	2	0.5
14	Slums	5	1
TOTAL SCRAP WASTE COLLECTION (TPD)			10.658

Table 2: Category of Scrap waste collected by scrap dealers in Attingal Municipality

Sl.No.	Category of Scrap	Percentage (%)	Collected Scrap by dealers (TPD)
1	Paper	25	0.82
2	Plastic	30	1.39
3	Glass	11	0.27
4	Metals	21	0.78
5	E-Waste	9	0.21
6	Rubber and Leather	3	0.07
7	Textile	1	0.09
TOTAL		100	3.63

Graph 1 shows Category of scrap waste



Graph 2 shows Collected scrap by scrap dealers

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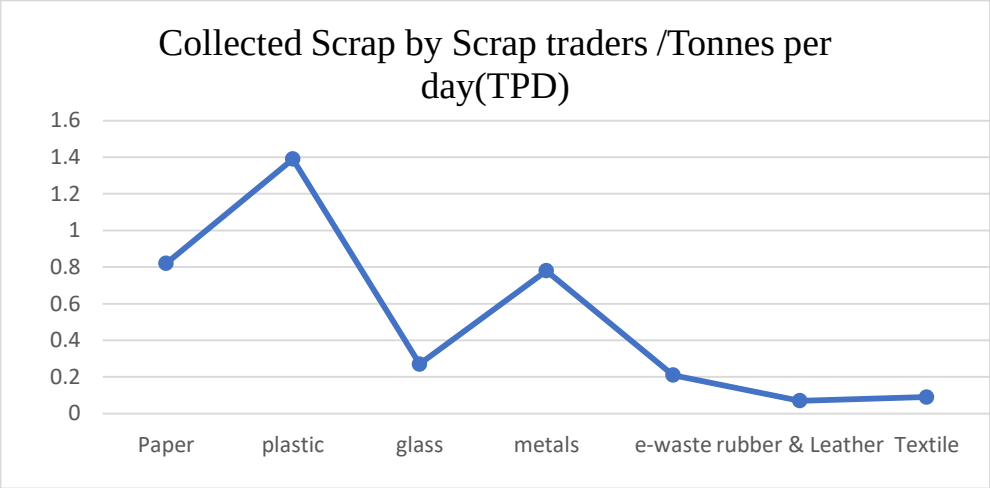

B) Data Analysis by peoples near scrap collection units

According to collected demographic data from the responses of a peoples near scrap collection units, 63% respondents were aware of the scrap waste collection services in their area, 37% peoples had little to no awareness about the schedule or type of waste collected, 90% people not bothered because there have no smell and 70 % bothered about producing sound. 20% of respondents highly satisfied with scrap waste collection services, 50% moderately satisfied and 30% dissatisfied by the reason of irregular collection schedules (30%), lack of proper segregation of recyclable and non-recyclable materials (30%) and impact on collection unit near populated area. 60% believe that proper scrap waste management can reduce Environmental pollution and 50% think it encourages recycling and reusable habits within the community, 70% concern raised about soil pollution from improperly handled and dumbed prolonged period of scrap materials. 40% expressed concern about the long-term health impact of living near poorly managed scrap units mainly due to heavy metals contamination. 40% people worried about there have no proper growth in plants, instead of that 70% peoples gives important in economic benefit through get revenue from scrap waste. 90% peoples not aware about concern authority visit scrap site for proper monitoring.

C) Role of Attingal Municipality in Scrap waste Collection and Processing

Direct interview through questionnaire, concerned authority members take effort to manage scrap materials management with that Solid Waste Management. The municipality works with authorized scrap merchants and recycling facilities. The town makes money by selling recyclable scrap materials to approved organizations, which it can then use to fund waste management initiatives and they conduct an auction for licensed scrap dealers to sell scrap materials they collected. Based on rules and regulation they give license to scrap collection units.

Kerala must register garbage pickers and dealers in accordance with Rule 11(m) of the SWM Rules 2016; the PCB/HO/SEE-3/TECH/130/2021 contains recommendations for scrap collection facilities. Kerala still has low recycling rates despite having over 10,000 centers that employ 3.5 lakh people. Items like thermocol and rexine are rejected, but paper, plastics, metals, rubber, and e-waste are recyclable. Under Rule 15(b), local governments are required to identify and integrate waste pickers and make sure that centres are housed in covered structures with fire safety precautions and authorized equipment (such as balers, shredders, and hand cutters). With the

exception of auto scrapping, which is supervised by CPCB standards, centers are required to report storage capacity, keep thorough records, and gather data in order to comply with SWM Rules 2016 and related regulations (Kerala State Environment Plan, 2022,).

With a clear responsibility for each stakeholder, the Kerala government developed the institutional framework for solid waste management in the state that are the Local Self Government Department (LSGD) of the Kerala government houses the Suchitwa Mission (SM), a technical body. It is the State's principal agency for carrying out Swatch Bharat Mission initiatives and supporting waste management and sanitation projects carried out by local self-government institutions (LSGIs). In this context, SM offers technical guidance and allocates the state government's portion of funding to waste management and sanitation initiatives carried out by Haritha Karma Sena (HKS). Haritha Sahaya Sthapanam (HSS), an organization designated by Suchitwa Mission to offer managerial and technical assistance at the local level to local self-government organizations like corporations, municipalities, and gram panchayats in order to successfully execute their decentralized waste management initiatives, trains its members. (Booklet on Waste management and best practices, 2024; Kerala State Environment Plan, 2022; The State of Decentralised Solid Waste Management in Kerala Report 2021; Nishad A, 2024; Shameerdas T, 2024).

ROLE OF HARITHA KARMA SENA (HKS) FOR SCRAP WASTE COLLECTION IN ATTINGAL MUNICIPALITY:

In Kerala, the Haritha karma Sena is a community-based organization and micro entrepreneurial initiative under kudumbasree mission that works to advance sustainable environmental practices and efficient waste management. The Sena, which is made up of women and unofficial waste collectors as well as trained volunteers, is essential to making sure that waste from homes, businesses, and institutions is separated, collected, and recycled. HKS appoints 2 persons in each ward for door-to-door collection of non-biodegradable waste such as paper, plastic, medicine covers, etc., at regular intervals commonly monthly basis, and also assists in biodegradable waste management and for these services collects monthly user fee which varies from household (Rs.50 – Rs.75) to institutions (Rs.100-150). More over Municipality directly collected scrap waste (metals and e-waste) through Haritha karma sena at definite intervals without revenue based on the quantity handed over. Therefore, mostly people chose scrap traders based on the money they make.

Households in the Attingal municipality separate biodegradable and non-biodegradable wastes at the source of generation. While biodegradable waste is composted in a central plant, some households with large land areas manage it onsite and non-biodegradable waste is stored and collected twice a week by workers. Although the market produces a large amount of organic waste, only one of two biogas plants with a capacity of 300 kg is currently in service. Additionally, several schools' biogas plants aren't working. Three vehicles and Kudumbashree employees gather waste from homes, marketplaces, lodging facilities, and public areas in 31 wards. A solid waste processing plant at Chudukkadu manages segregation, composting, and biogas production using 21 workers, vermi-compost tanks, and windrows. Non-biodegradable waste goes to a Material Recovery Facility. The old dumpsite near the plant holds 10,584 m^3 of waste, including pre-2005 deposits and plant rejects. A 10-year sanitary landfill, designed per CPHEEO guidelines, handles 4 tonnes of daily landfill waste, with a base liner raised by 2.5 m (Nazeemudeen Sabah et al., 2021).

CONCLUSION

The generation of substantial volume of scrap materials such as plastics, glass, aluminium, e-waste, cardboard, metal, wire, copper, brass, steel, paper, wood, construction and demolition materials, vehicles parts, lead, leather, rubber, and more, is a significant environmental concern.Despite the presence of numerous of metals, e-waste and plastic scrap collection units within municipality and cooperation in densely populated areas, the improper disposal of these materials remains a critical issue. Nobody is worried or nobody is bothered. So, this study is crucial to make sure the scrap is not dumped for prolonged period and it's a relevant subject due to its environmental impact and very limited research focusing specifically on this issue.

RECOMMENDATION

- Further study helps to develops awareness about problems related to scrap collection units in densely populated areas.
- Ensure the scrap collection units are cleaned and maintained to prevent health hazards.
- Upgrading existing collection points as totally closed and concreted area to reduce soil pollution.
- Launches new projects for recycling facility near the site and ensure not dumbed prolonged period.

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INNOVATION THROUGH INTEGRATION: HOW MERGING DISCIPLINES SPARKS NEW IDEAS

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ABSTRACT

In an increasingly interconnected and complex world, innovation often arises from the integration of knowledge across disciplines. This chapter explores the transformative power of merging distinct fields of expertise and how it drives groundbreaking ideas and solutions. It discusses the intersection of knowledge from different domains, highlighting the creativity, adaptability, and effectiveness that emerge when disciplines are combined. Through real-world examples such as bioinformatics, sustainable architecture, and electric vehicle development, this chapter demonstrates how interdisciplinary collaboration breaks down traditional boundaries and fosters innovation. This chapter examines the role of technology in facilitating integration, the organizational structures needed to encourage cross-disciplinary collaboration, and the importance of diverse perspectives in generating novel solutions. The chapter also presents case studies, such as the Human Genome Project and renewable energy innovations, to illustrate the tangible outcomes of interdisciplinary integration. Finally, it offers strategies for organizations and educational institutions to cultivate an environment where innovation through integration can thrive. By embracing diversity in knowledge and perspectives, this approach offers a promising path for addressing global challenges and achieving sustainable progress.

Keywords: Interdisciplinary collaboration, innovation, integration, cross-disciplinary knowledge, design thinking, global challenges

1. INTRODUCTION

Innovation thrives when ideas collide and merge, often leading to breakthroughs that no single discipline could achieve on its own. The concept of merging knowledge from diverse fields is not new, but its importance has grown as global challenges become more complex. This chapter explores how interdisciplinary collaboration sparks new ideas and drives innovation by leveraging the strengths of various disciplines. We will examine real-world examples, frameworks, and strategies that show how integrating distinct perspectives can lead to novel solutions.

2. THE INTERSECTION OF KNOWLEDGE

Innovation at the crossroads of disciplines is driven by the intersection of ideas, methodologies, and perspectives that may not traditionally be aligned. By blending different expertise, the resulting hybrid solutions often offer greater creativity, adaptability, and effectiveness. The notion of a "cross-pollination" of ideas emphasizes that the real value comes from seeing problems through multiple lenses.

- **Example: The Rise of Bioinformatics** The field of bioinformatics combines biology, computer science, and statistics to solve complex problems related to genetic data. The fusion of computational tools with biological insights has revolutionized fields such as personalized medicine and genomics, enabling the rapid decoding of the human genome and the development of tailored therapies.

- **Example: Sustainable Architecture and Environmental Engineering** By integrating disciplines like engineering, design, and environmental science, sustainable architecture has emerged as a powerful force for eco-friendly building solutions. Collaboration between architects, engineers, and environmental scientists results in structures that are not only aesthetically pleasing but also energy-efficient, reducing carbon footprints and optimizing resource usage.

3. OVERCOMING TRADITIONAL BOUNDARIES

One of the key challenges to fostering innovation through integration is the inherent boundaries that exist between disciplines. Whether in academic institutions, organizations, or industries, silos of knowledge often restrict free-flowing collaboration. Breaking down these barriers requires a mindset shift—embracing ambiguity, uncertainty, and the blending of often incompatible languages or methods.

3.1.Collaboration Over Competition Many disciplines, especially in academia and research, can operate in isolated silos, competing for resources and recognition. However, cross-disciplinary collaboration involves creating a shared vision that transcends personal or institutional boundaries. Successful integration hinges on valuing diverse viewpoints and recognizing that no one discipline holds the ultimate answer.

- **Case Study: The Development of Electric Vehicles (EVs)** The development of electric vehicles exemplifies how cross-disciplinary innovation leads to technological advancements. Engineers, designers, environmental scientists, and policy experts work together to develop more sustainable transportation systems. The result is not just a technical innovation in vehicle design but also policy shifts that encourage the widespread adoption of electric vehicles.

4. THE ROLE OF TECHNOLOGY IN FOSTERING INTEGRATION

Technology plays a pivotal role in facilitating interdisciplinary collaboration. Advances in data analytics, artificial intelligence, and digital platforms make it easier to integrate diverse knowledge, enabling the synthesis of new ideas. The explosion of open-source platforms and collaborative tools has also allowed for the seamless sharing of research, data, and insights across disciplines.

- **Example: Data Science and Artificial Intelligence** The integration of machine learning and data science with fields like healthcare, finance, and education has led to significant innovations. AI-powered diagnostic tools, predictive analytics, and automated financial advice are examples of how merging computational expertise with domain-specific knowledge can generate groundbreaking outcomes.
- **Example: Crowdsourcing Solutions** Platforms like Innocentive and Kaggle bring together individuals from different disciplines to solve complex problems. By tapping into a diverse pool of thinkers—scientists, engineers, entrepreneurs, and even hobbyists—innovative solutions to problems ranging from disease outbreaks to product development have been accelerated.

5. ORGANIZATIONAL CULTURE AND STRUCTURES THAT FOSTER INNOVATION

For innovation to thrive, organizations must cultivate a culture that promotes cross-disciplinary collaboration. Traditional hierarchical structures, which often compartmentalize departments and expertise, may inhibit the free exchange of ideas. Organizations that prioritize flexibility, inclusivity,

and open communication are more likely to nurture an environment where interdisciplinary innovation can flourish.

- **Example: Google's** "20% Time" and Innovation Google's practice of allowing employees to dedicate 20% of their time to passion projects has led to the development of new products, such as Gmail and Google Maps. This culture of autonomy and cross-disciplinary interaction has proven to be a successful model for fostering innovation across teams with diverse expertise.
- **Building Cross-Functional Teams** Encouraging collaboration between teams from different backgrounds—such as marketing, technology, and customer service—can lead to more holistic solutions. Cross-functional teams often bring fresh perspectives to problem-solving, enabling the identification of opportunities that would be overlooked by a single discipline.

6. HARNESSING THE POWER OF DIVERSE PERSPECTIVES

Innovation often arises from seeing a problem from an unexpected angle. When experts from different fields collaborate, they can combine their distinct approaches to produce more comprehensive solutions. By bringing together individuals with different ways of thinking, it becomes possible to challenge assumptions, discover new opportunities, and create transformative outcomes.

- **Example :** The Integration of Neuroscience and Marketing The field of neuromarketing, which blends neuroscience and consumer behavior, has led to innovative strategies for advertising and product design. Understanding how the brain responds to various stimuli has allowed businesses to tailor their marketing strategies more effectively, enhancing customer engagement and increasing sales.
- **Example :** Design Thinking and Social Impact The design thinking process, which integrates design, empathy, engineering, and business, has been successfully applied to solving social issues such as homelessness and education. By working together, designers, social workers, and policy experts have crafted solutions that are user-centered and sustainable.

7. REAL-WORLD CASE STUDIES OF INNOVATION THROUGH INTEGRATION

To truly understand the power of interdisciplinary collaboration, it is helpful to explore real-world examples where merging disciplines has resulted in breakthrough innovation.

- **Case Study 1: The Human Genome Project** The Human Genome Project (HGP) is one of the most ambitious interdisciplinary efforts in scientific history. It brought together experts from genomics, computer science, and ethics, among others, to map the entire human genome. The integration of these fields enabled a global research effort that has transformed healthcare and biotechnology.
- **Case Study 2: Renewable Energy Solutions** Innovations in renewable energy, such as solar panels and wind turbines, result from the integration of physics, engineering, environmental science, and economics. Researchers, engineers, and policymakers are working together to make renewable energy solutions more cost-effective and scalable, contributing to a cleaner future.

8. STRATEGIES FOR ENCOURAGING INNOVATION THROUGH INTEGRATION

Innovation through integration thrives when organizations, universities, and governments take proactive steps to encourage collaboration across disciplines. These strategies not only help in

overcoming the barriers created by siloed knowledge but also facilitate the creation of new, transformative solutions. Below are detailed approaches to encouraging interdisciplinary collaboration and sparking innovation:

8.1. Facilitate Cross-Disciplinary Education

Educational institutions are at the forefront of fostering innovation, and one of the most effective ways to promote interdisciplinary collaboration is by encouraging cross-disciplinary learning. This can be achieved through:

- **Joint Courses and Collaborative Projects:** Universities can offer courses that combine subjects from multiple disciplines. For example, a course that integrates engineering, environmental science, and economics could focus on designing sustainable urban infrastructure. Collaborative projects between students from different departments or faculties can bring diverse perspectives, pushing students to solve complex problems using methods and knowledge outside their usual scope.
- **Interdisciplinary Research Opportunities:** Schools can create research programs that encourage faculty and students from different departments to work together on common themes. Funding interdisciplinary research grants and providing platforms for collaboration are effective ways to integrate knowledge across fields. For example, a research project focused on healthcare could involve collaboration between medical science, technology, psychology, and ethics departments.
- **Interdisciplinary Academic Centers:** Establishing centers of excellence that focus on cross-disciplinary studies helps consolidate efforts across departments. Examples include centers for climate change research, which often combine environmental sciences, engineering, political science, and business studies. These centers offer both formal education and informal environments conducive to spontaneous collaboration.

  By encouraging students to explore subjects outside their primary field of study, educational institutions can foster creativity, broaden problem-solving abilities, and prepare students to tackle multifaceted global challenges.

8.2. Create Innovation Hubs

Innovation hubs serve as physical or virtual spaces where individuals from different fields come together to work on innovative projects. These hubs, often referred to as incubators, accelerators, or innovation labs, offer key advantages in stimulating interdisciplinary collaboration:

- **Cross-Sector Collaboration:** Innovation hubs attract entrepreneurs, researchers, industry professionals, and even government representatives from a range of sectors. The interaction between these diverse groups sparks creative thinking and encourages the development of breakthrough products and services. For instance, a tech hub might bring together software developers, healthcare professionals, and business leaders to work on digital health solutions.
- **Rapid Prototyping and Testing:** These hubs often provide access to resources, equipment, and technology that would otherwise be difficult for small startups or research teams to access. This enables fast prototyping of new ideas, allowing for iterative development and testing of new products. By creating spaces that encourage trial, error, and rapid innovation, hubs foster an environment where ideas can evolve quickly and efficiently.

- **Networking and Mentorship:** In addition to providing physical resources, innovation hubs offer valuable networking opportunities, mentorship, and guidance from experienced professionals. Startups, researchers, and entrepreneurs can interact with experts from various industries, gaining insights and support that push their ideas forward. Mentorship from seasoned professionals with diverse expertise helps ensure that the projects being developed are innovative and feasible in the real world.
- **Examples:** Successful innovation hubs such as Silicon Valley in the United States, Station F in France, or the Cambridge Innovation Center in the UK showcase how shared spaces for diverse minds can lead to significant breakthroughs in technology, business, and science. These hubs are not just physical locations; they embody a culture of integration and shared expertise that encourages innovation on a global scale.

  By facilitating the exchange of ideas, providing access to resources, and promoting collaboration between diverse professionals, innovation hubs are essential in accelerating the development of new solutions to complex problems.

8.3. Incentivize Collaborative Research

One of the most impactful strategies to encourage interdisciplinary innovation is to provide incentives for collaborative research. Research funding bodies, government agencies, and private institutions play a critical role in shaping how interdisciplinary research is supported. Specific strategies include:

- **Interdisciplinary Research Grants:** Governments and organizations should create funding programs that prioritize projects involving collaboration across multiple disciplines. These grants can cover various sectors, such as health, technology, and the environment, and should require teams from different fields to apply together. Such grants encourage researchers to step out of their disciplinary comfort zones and seek out new ways to address problems from multiple perspectives.
- **Performance-based Incentives:** Research institutions can incentivize interdisciplinary work by linking funding, career progression, or prestige to collaborative projects. For example, giving more weight to joint publications and patents that result from cross-disciplinary work can motivate researchers to pursue collaborative opportunities. Institutions can also provide funding to departments or individuals who demonstrate effective teamwork across disciplines.
- **Fostering Public-Private Partnerships (PPP):** Governments and academic institutions can create opportunities for public-private partnerships that enable researchers to work with industry experts. These partnerships offer funding, technical expertise, and access to resources that help turn research into real-world innovations. For instance, collaborative research between universities and tech companies has led to advancements in fields like artificial intelligence, where academic expertise is paired with industry applications.
- **Case Study: The Development of CRISPR Technology:** The breakthrough in gene-editing technology, CRISPR, is an example of how collaborative research across disciplines can lead to transformative innovations. The development of CRISPR technology involved molecular biologists, geneticists, and chemists working together to develop this precise gene-editing tool. Collaboration across these fields has not only revolutionized genetics but also sparked discussions on ethics, policy, and the potential applications in medicine, agriculture, and beyond.

- **Facilitating Long-term Collaboration:** Encouraging long-term partnerships between research institutions can promote sustained innovation. Regularly convening researchers from different disciplines, hosting cross-departmental conferences, and offering collaborative fellowships will deepen these relationships and ensure continued interdisciplinary work. This also helps to build a culture of collaboration within academic and research environments.

  By providing tangible financial and career incentives for interdisciplinary research, organizations can build bridges between disciplines and create a fertile ground for groundbreaking discoveries that span multiple fields.

CONCLUSION

Innovation through integration represents a powerful way forward for tackling the complex, interconnected challenges of the modern world. By breaking down silos, embracing diverse perspectives, and fostering collaborative environments, we unlock the potential for new ideas and transformative solutions. As we continue to navigate an increasingly complex global landscape, the ability to merge disciplines will be key to driving sustainable, impactful change.

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BEYOND BOUNDARIES: BUILDING A FRAMEWORK FOR THE FUTURE

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ABSTRACT

The rapidly evolving global landscape calls for innovative solutions that cannot be confined to the boundaries of traditional academic or professional disciplines. The challenges humanity faces today—such as climate change, public health crises, technological disruption, and socio-economic inequalities—are multifaceted and interconnected. These challenges demand a shift from isolated problem-solving approaches to interdisciplinary collaboration that can generate comprehensive, sustainable solutions. This chapter outlines a robust framework for fostering such interdisciplinary collaboration, aiming to break down the silos that often hinder creativity, innovation, and progress. The framework emphasizes the need for a holistic understanding of complex problems, the integration of diverse perspectives, and the promotion of collaboration across sectors and expertise. The principles outlined include adaptability, inclusivity, and the importance of building a collective intelligence where multiple fields intersect. The chapter also provides actionable strategies for individuals, organizations, and institutions to foster interdisciplinary collaboration. This chapter envisions a world where innovation flourishes beyond traditional disciplinary boundaries.

Keywords: Interdisciplinary Collaboration, Innovation, Sustainability, Collective Intelligence

1. Introduction: The Need for a New Framework

The challenges of the 21st century—climate change, technological disruptions, global health crises—demand integrated approaches. Traditional boundaries between disciplines, sectors, and cultures often hinder innovation. To overcome this, we must reimagine how knowledge is generated, shared, and applied.

2. Objectives of the Framework

- Facilitate collaboration across disciplines.
- Promote adaptive and inclusive practices.
- Leverage emerging technologies to foster innovation.
- Build systems resilient to dynamic global challenges.

3. Principles of the Framework

3.1. Systems Thinking

Understanding complex systems holistically is central to interdisciplinary work. This involves identifying relationships and feedback loops that influence outcomes and leveraging these insights for strategic interventions.

3.2. Interdisciplinary Literacy

Promoting a foundational understanding of various disciplines enables individuals to engage effectively in collaborative efforts. This literacy bridges gaps and fosters mutual respect among diverse contributors.

3.3. Inclusivity and Equity

An inclusive framework recognizes the value of diverse voices and ensures equitable participation. This principle extends to cultural, geographic, and socioeconomic dimensions, enriching the quality of collaboration.

3.4. Iterative Adaptation

The framework emphasizes the importance of learning from successes and failures. Iterative adaptation ensures continuous improvement in strategies and outcomes.

4. THE ROLE OF TECHNOLOGY IN BRIDGING BOUNDARIES

In an increasingly interconnected world, technology plays a pivotal role in breaking down the barriers that once limited collaboration, knowledge sharing, and innovation. From enabling global teamwork to integrating vast datasets, technological advancements are fostering new opportunities for growth and development across borders.

4.1. Enabling Collaboration

Technology has revolutionized how we collaborate, making it possible for teams to work together, regardless of geographical location, time zone, or even language.

- **Cloud-based platforms** like Google Workspace, Microsoft 365, and Dropbox allow users to store, access, and collaborate on files in real-time. Cloud infrastructure facilitates seamless sharing of resources and data, ensuring that individuals or teams can work together without the need for physical proximity. This has especially proven invaluable in the face of global challenges such as the COVID-19 pandemic, where businesses, educators, and governments turned to virtual collaboration as an essential lifeline.
- **AI-driven analysis tools** empower teams by providing intelligent insights into data and trends. For example, predictive analytics powered by artificial intelligence allows businesses to forecast market trends or customer preferences, enabling teams to make informed decisions quickly. Additionally, AI chatbots and natural language processing (NLP) systems facilitate smoother communication across linguistic divides, allowing multilingual teams to communicate effortlessly.
- **Virtual meeting platforms** like Zoom, Microsoft Teams, and Slack have further enabled remote work and collaboration. These tools support video conferencing, instant messaging, file sharing, and screen sharing, helping teams work synchronously or asynchronously across vast distances. Virtual reality (VR) and augmented reality (AR) are beginning to enhance these platforms, creating immersive collaboration experiences, such as virtual offices or meeting spaces, that simulate in-person interactions.

4.2. Data Integration

In the modern world, data is a powerful resource, and its integration from diverse sources is a key enabler of informed decision-making.

- **Big data analytics** refers to the use of advanced analytics techniques to process and analyze large volumes of structured and unstructured data. These technologies help businesses, governments, and research institutions extract meaningful insights that can drive innovation, efficiency, and growth. For example, big data allows scientists to analyze vast amounts of genomic information to understand diseases better, or it helps marketers predict customer behavior by analyzing online interactions.
- **Machine learning (ML)** is one of the most significant breakthroughs in data integration. By applying algorithms to large datasets, ML can uncover hidden patterns, detect anomalies, and make predictions without explicit programming. This technology can be used across industries, from predicting climate changes to improving healthcare outcomes through personalized medicine. Machine learning's ability to handle vast amounts of data in real time enables the rapid integration of diverse data sources, creating a comprehensive understanding of complex systems.
- **Data lakes** and **data warehouses** serve as central repositories where massive amounts of data from various sources can be integrated and analyzed. These tools allow companies and organizations to unify disparate datasets, making it easier to extract actionable insights. For example, a retail company might integrate data from online and offline sales channels, customer feedback, and inventory systems to improve product recommendations and inventory management.

4.3. Open Knowledge Networks

Open access to information and knowledge is a transformative shift that has been propelled by technology..

- **Open-source software** has empowered millions of developers around the world to contribute to projects, regardless of their location or background. Platforms such as GitHub allow developers to collaborate, share code, and improve software in ways that were previously unimaginable. Open-source communities have created software that powers everything from web servers to scientific research tools, fostering innovation and collaboration across borders.
- **Open science initiatives** have made research more accessible to the public, encouraging collaboration between researchers from different disciplines and geographical regions. The open-access movement, which promotes the publication of research articles and datasets without subscription or paywall barriers, ensures that knowledge is freely available to anyone with an internet connection. Initiatives like the Open Researcher and Contributor ID (ORCID) and the Directory of Open Access Journals (DOAJ) make it easier for researchers to access and share their findings globally.
- **Public data repositories** and knowledge networks such as Data.gov, Europeana, and the World Bank's Open Data Initiative provide free access to governmental, economic, and environmental data, allowing researchers, policymakers, and businesses to tap into a wealth of information. This access democratizes knowledge, enabling the public, particularly in developing regions, to make informed decisions about everything from urban planning to health policy.

5. BUILDING BLOCKS OF THE FRAMEWORK FOR BRIDGING BOUNDARIES

To leverage technological advancements effectively, a robust framework incorporating education, institutional transformation, and cultural shifts is essential.

5.1 Educational Initiatives

Interdisciplinary Curricula

- Integrates multiple disciplines (e.g., computer science, sociology, ethics) to address complex global challenges.
- Promotes innovative solutions and creativity by combining diverse knowledge areas.

Problem-Based Learning (PBL)

- Engages students in real-world challenges, fostering practical, hands-on problem-solving.
- Encourages teamwork and integrative thinking, e.g., designing AI-powered health solutions for underserved populations.

5.2 Institutional Transformation

Flexible Structures

- Adopts agile and matrix structures for cross-functional collaboration and adaptability.
- Encourages interdisciplinary research centers in universities to drive innovation.

Cross-Sector Partnerships

- Facilitates collaboration among academia, industry, and government to pool resources and expertise.
- Enables breakthroughs in areas like AI, healthcare, and climate solutions through public-private initiatives.

5.3 Cultural Shifts

Embracing Uncertainty

- Cultivates a mindset that views uncertainty as an opportunity for growth.
- Encourages experimentation, risk-taking, and learning from failure in organizations and education.

Rewarding Collaboration

- Prioritizes collective achievements over individual success.
- Recognizes and celebrates diverse, inclusive teamwork to inspire broader collaborative efforts.

This framework fosters innovation, adaptability, and cross-disciplinary collaboration to address global challenges.

6. SUCCESS STORIES: FRAMEWORKS IN ACTION

Many institutions and initiatives around the world have embraced frameworks that foster collaboration, innovation, and cross-sector integration. These success stories showcase how the

principles of interdisciplinary collaboration, data integration, and global partnerships are being realized in action today.

6.1. The MIT Media Lab: Pioneering Interdisciplinary Innovation

The **MIT Media Lab** has long been a leader in pushing the boundaries of interdisciplinary collaboration. The Lab continues to be at the forefront of groundbreaking research, integrating diverse fields such as artificial intelligence (AI), biotechnology, urban planning, and social sciences. The Lab's ability to blend technologists, designers, artists, and scientists into cohesive teams is a model for fostering creativity and innovation.

- **Example**: One of the most notable projects emerging from the Media Lab is its **AI for Social Good** initiative, which seeks to leverage artificial intelligence to address pressing social challenges like climate change, healthcare access, and social inequality. The interdisciplinary team, consisting of AI researchers, healthcare professionals, and urban planners, is working to create scalable solutions to predict environmental disasters, optimize public health interventions, and redesign urban spaces to be more sustainable and inclusive.
- Another project that exemplifies the Media Lab's success is the **Open Agriculture Initiative** which uses machine learning to improve agricultural practices by providing farmers with real-time data on environmental factors like soil health and weather conditions. This effort integrates technology, agriculture, and community development to address global food security challenges.

6.2. CERN's Global Collaboration: Advancing Fundamental Physics

CERN (European Organization for Nuclear Research) remains one of the most impressive examples of global collaboration in the scientific community. The **Large Hadron Collider (LHC)** at CERN has brought together thousands of scientists, engineers, and technicians from over 100 countries to explore the most fundamental questions of physics. CERN's collaboration model continues to produce remarkable results in physics and beyond, as researchers push the boundaries of human knowledge.

- **Example**: CERN has advanced its work on the **High-Luminosity LHC (HL-LHC)**, a major upgrade that promises to increase the collision rate of particles, leading to more detailed data on phenomena like the Higgs boson and dark matter. This project involves close collaboration between CERN, research institutions, and industries worldwide to enhance technology and scientific knowledge, which will not only drive fundamental physics but also have applications in areas like medical imaging and quantum computing.
- CERN's collaborative framework also plays a significant role in fostering open science. The data generated by the LHC is publicly available, allowing scientists across the world to analyze it and build upon CERN's discoveries. This open-access model has accelerated scientific progress and fostered a global community of researchers working together toward common goals.

6.3. The United Nations Sustainable Development Goals (SDGs): A Global Framework for Collective Action

The **United Nations SDGs**, adopted in 2015, represent a shared global framework that integrates economic, social, and environmental goals aimed at creating a more equitable and sustainable world. The SDGs continue to serve as a guiding framework for collaborative efforts across nations, industries, and organizations, driving progress on the most critical challenges facing humanity.

- **Example**: One notable success story is the global collaboration on SDG 13: Climate Action. Countries, NGOs, and private sector entities have come together under initiatives like the Climate Finance Accelerator to fund and scale clean energy solutions, promote sustainable practices in agriculture and urban development, and assist developing nations in adapting to climate change. In particular, the Climate Finance Accelerator has facilitated over $2 billion in funding for green technologies and climate resilience projects in regions most vulnerable to climate change.
- Another example of SDG collaboration is in SDG 3: Good Health and Well-being, where organizations like the Global Fund and GAVI, the Vaccine Alliance have joined forces to ensure equitable access to healthcare. They have expanded their efforts to address both the aftermath of the COVID-19 pandemic and other global health challenges, such as mental health, maternal health, and non-communicable diseases. The partnership between the private sector (pharmaceutical companies), public sector (governments), and NGOs has been crucial in ensuring that vaccines and treatments reach underserved populations.
- SDG 4: Quality Education has seen significant progress, particularly through the Education Cannot Wait initiative, which coordinates humanitarian response to ensure that children in crisis zones have access to education. This initiative has mobilized significant funding to build digital learning platforms that enable education to continue in remote or conflict-affected areas, further demonstrating the importance of cross-sector partnerships in achieving the SDGs.

7. CHALLENGES AND STRATEGIES FOR OVERCOMING THEM IN BRIDGING BOUNDARIES

As interdisciplinary collaboration and cross-sector partnerships become increasingly essential for addressing global challenges, organizations face several obstacles in implementing and sustaining these frameworks. Overcoming these challenges requires proactive strategies that address resource constraints, cultural resistance, and the complexity of coordination among diverse teams. Below are some of the key challenges and the strategies that can be employed to address them effectively.

Challenges

7.1. Resource Allocation

- **Challenge**: Ensuring adequate funding and access to tools for interdisciplinary projects is a persistent challenge. Many interdisciplinary initiatives require a blend of expertise, equipment, and technologies that fall outside the typical funding structures of traditional disciplines or departments.
- **Impact**: Without sufficient resources, such projects may struggle to gain momentum or fail to produce meaningful results. Additionally, traditional funding models may be slow to adapt to the needs of projects that span multiple disciplines or sectors, leaving interdisciplinary research underfunded and unsupported.

7.2. Cultural Resistance

- **Challenge**: Traditional academic and organizational structures often prioritize specialization, which can create resistance to interdisciplinary collaboration. People may be reluctant to move beyond their areas of expertise or adopt approaches that challenge established methods.

- **Impact**: This resistance can stifle creativity, limit the scope of projects, and slow down the adoption of new ideas or approaches. A lack of understanding between disciplines can also lead to friction, miscommunication, and inefficiencies in collaborative efforts.

7.3. Coordination Complexity

- **Challenge**: Managing diverse teams that come from different disciplines or sectors can be incredibly complex. Each team may have different priorities, methodologies, work styles, and communication practices. This lack of uniformity can lead to misunderstandings, delays, and inefficiencies in collaborative efforts.
- **Impact**: Without effective coordination, interdisciplinary projects risk fragmentation, where team members work in silos or fail to integrate their contributions, undermining the project's overall success. Managing diverse stakeholders with varying expectations can also complicate decision-making processes.

8. STRATEGIES FOR OVERCOMING CHALLENGES

8.1. Policy Support

- **Strategy**: Advocating for policies that encourage interdisciplinary research and provide adequate funding is essential for overcoming resource allocation challenges. Governments and funding bodies need to recognize the value of cross-disciplinary initiatives and adjust funding criteria to support projects that span multiple fields of study.

  Example: Governments and academic institutions can establish funding pools or grant programs specifically for interdisciplinary work. These programs can include flexible requirements that allow teams from different disciplines to apply for joint funding. For instance, a project combining AI research with environmental science could apply for grants that cover both technological development and ecological studies.

  Example: Public-private partnerships can also play a critical role in supporting interdisciplinary projects. Collaborations between government agencies, corporations, and research institutions can pool resources, allowing for larger-scale projects that require diverse expertise and technology. Policy frameworks that encourage collaboration between these sectors will ensure that interdisciplinary initiatives have the necessary financial and technological support.

  Outcome: This strategy ensures that projects have the resources needed to thrive, and that funding structures evolve to meet the challenges of interdisciplinary work. It also provides a mechanism for sustained investment in long-term innovation across diverse sectors.

8.2. Training Programs

- **Strategy**: To address cultural resistance and promote effective collaboration, training programs can be implemented to equip leaders and team members with the necessary skills to navigate and mediate cross-disciplinary collaborations. These programs can focus on communication, conflict resolution, and project management across diverse teams.

  Example: Universities and research institutions can offer interdisciplinary leadership courses that provide skills for managing teams composed of experts from different fields. Such programs could emphasize key skills such as negotiation, mediation, and systems thinking, which are crucial for reconciling different perspectives and methodologies.

Example: Industry-specific training could help professionals develop a more interdisciplinary mindset. For example, a course focused on AI researchers might also include modules on understanding social impacts, ethics, and environmental sustainability, enabling them to consider these factors when designing technology.

Outcome: These programs foster a culture of collaboration and adaptability, where leaders and team members are better equipped to manage the complexities of interdisciplinary work. They can reduce resistance by increasing mutual understanding and respect among professionals from different disciplines.

8.3. Technology Solutions

- **Strategy**: Utilizing project management and collaboration tools is critical for managing coordination complexity. Tools that streamline workflows, facilitate communication, and integrate data can help ensure that interdisciplinary teams stay organized and focused on their common goals.

  Example: Tools like Trello, Asana, or Jira are widely used in project management to organize tasks, set timelines, and track progress across teams. These tools can be customized for interdisciplinary teams to ensure all members are on the same page and that deadlines are met efficiently.

  Example: Collaborative platforms like Slack, Microsoft Teams, or Miro facilitate communication between teams, allowing them to share ideas, documents, and real-time updates. These tools make it easier for individuals from different sectors to collaborate without physical boundaries, especially in remote or hybrid working environments.

  Example: Data integration platforms like Tableau or Google BigQuery enable teams to combine data from multiple sources, ensuring that all team members have access to the same information, regardless of their field of expertise. This reduces the risk of miscommunication and enables more effective decision-making.

  Outcome: The use of technology solutions helps overcome logistical barriers and ensures smooth, efficient collaboration. By centralizing tasks, data, and communication, these tools reduce friction and make it easier for interdisciplinary teams to stay coordinated, even when they are geographically dispersed.

8.4. Fostering a Collaborative Culture

- **Strategy**: To combat cultural resistance, institutions and organizations can create incentive structures that reward collaborative success rather than individual achievement. Shifting the focus from personal accomplishments to collective achievements helps reinforce the value of collaboration.

  Example: Performance reviews could incorporate criteria that measure an individual's ability to work within cross-functional teams, demonstrating how well they collaborate with people from different disciplines. A culture of team-based rewards can be implemented where the entire team shares in the success of a project, fostering a sense of shared responsibility and achievement.

  Example: Hackathons and innovation challenges can be used to create opportunities for team-based problem-solving, where individuals from different backgrounds come together to

tackle real-world problems. These events foster collaboration by encouraging participants to bring their unique expertise to the table.

Outcome: Rewarding collective achievements over individual success helps shift institutional cultures toward collaboration. As individuals see that their collaborative efforts are valued, they are more likely to embrace interdisciplinary work and contribute their knowledge and skills to broader projects.

9. Actionable Roadmap for Implementation

9.1.Individual Level

- Cultivate curiosity about fields outside your expertise.
- Participate in interdisciplinary workshops and events.
- Build networks with professionals from diverse backgrounds.

9.2.Organizational Level

- Invest in training programs that promote cross-disciplinary skills.
- Create interdisciplinary task forces to address specific challenges.
- Provide funding and resources for collaborative projects.

9.3.Societal Level

- Advocate for policies that support interdisciplinary research and education.
- Foster public-private partnerships to tackle societal challenges.
- Promote open access to research and knowledge-sharing platforms.

CONCLUSION: A VISION FOR THE FUTURE

A future beyond boundaries is one where collaboration is the norm, not the exception. By adopting this framework, individuals, organizations, and societies can harness collective intelligence to address global challenges and create a sustainable, innovative, and inclusive world. The path forward requires bold action, but the rewards are immeasurable: a thriving planet enriched by the power of integrated knowledge.

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GENDER JUSTICE DICHOTOMY: FEMALE DIRECTORS ON TOP NSE COMPANIES' BOARDS

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ABSTRACT

Purpose: The current study investigates how many men and women acquire the board of directors of the top ten NSE companies. The researcher has made an effort to investigate the representation of women in important roles within the chosen organizations.

Research Methodology: In the present study, secondary data was used to fulfill the goals of the study, the data was collected from the official websites of the selected companies in to investigate the proportion of women serving on the boards of directors of the selected companies. The top 10 NSE companies were selected on the basis on market capitalization and the collected data was analyzed by using descriptive statistics.

Findings: The study's findings demonstrated a noteworthy disparity in the proportion of men and women holding board of director positions. The results of the study also indicate that men made up a larger percentage of the board of directors. According to the study's findings, gender inequalities can be utilised to explain why certain organisations have gender-biased hiring procedures for their top board of director's positions.

Limitations: Researcher has only studied the top 10 NSE companies, the study can be further extended to other NSE listed companies, or other listed companies, or on an international level as well.

Keywords: board of directors, gender difference, gender justice, NSE, women directors.

INTRODUCTION

One of the key components that make a company the best place to work is gender equality. While many metropolitan corporations are working to eliminate prejudice inside their workplaces, the World Economic Forum's Gender Gap study indicates that, at the current rate, women may need to wait around 135 years for this gap to be totally closed.

This implies that it may take more than three to five generations for women to finally receive what they are due, which is too slow. Because of this, businesses that value gender equality and work to alleviate the difficulties of those who experience challenges, injustices, and discrimination as a result of their gender identity stand out from those that don't.

Such businesses are successful at providing their staff with a safe work environment that fosters innovation and personal development. The leading Indian businesses that support gender equality and diversity are:

1. Info Edge

One of the leading internet businesses in India, Info Edge, is an equal opportunity employer. The company is concentrating its efforts to promote gender inclusion and building an environment that is conducive to everyone in the notion that gender-diverse staff can help them establish greater connections with their clients.

This is probably why the overall gender diversity ratio of women to men is 41% to 59%.

Here are a few initiatives by Info Edge directed toward promoting gender equality in the workplace:

- ✓ A creche to assist its staff by offering a secure, supervised place for kids to play
- ✓ Prolonged health insurance that covers benefits for infertility treatment;
- ✓ 26 weeks of paid maternity leave for new mothers and 12 weeks of paid maternity leave for female employees choosing to give birth through adoption or surrogacy;
- ✓ POSH training and other similar benefits to create a safe and creative work environment for all employees

2. HCL(Hindustan Computers Limited)

One of the leading tech firms in India is HCL. It is the company that job seekers all around the nation want to work with. HCL offers its staff a diverse and inclusive workplace that is welcoming to people of all gender identities.

Here are some awards and recognition HCL has received for its inclusivity efforts:

2022
For the second year in a row, HCL was listed in the Bloomberg Gender-Equality Index (GEI) in 2022.

2020
The Working Mother &Avtar Conference's DivHersity Awards, given by jobsforher.com, honour the Top 5 Most Innovative Practices that are acknowledged as the Top 100 Best Companies for Women in India.

2019
The NASSCOM Corporate Award for Excellence in Gender Inclusion was given to HCL.
2017
The 'ASCEND' programme at the Brandon Hall Awards brought HCL the Gold Award for Best Advance in Women Leadership Development Programme.

HCL is undertaking several initiatives to create an equal, inclusive and safe environment, some of which include:

- ✓ ASCEND, a platform that helps women of tomorrow with peer coaching and consultancy designed to help them to identify and navigate through their career aspirations
- ✓ The next generation of women can be inspired by the STEM (Science, Technology, Engineering, and Mathematics) women who have made a difference. This program is called She Inspires.

- ✓ In order to guarantee gender equality at work, HCL has introduced a thorough programme called "Cultural Empathy and Dexterity" that promotes inclusivity and cultural expertise within the company.

3. PepsiCo

PepsiCo, one of the biggest beverage producers in the world, is a company that values diversity in the workplace.In 2018, there were 20% of women serving as executive officers, 23% of women on the board, and 40% of women in managerial roles.⎫

In 2021, Pepsico made it to the list of best companies for women to advance in the large companies category.

Here are some ways in which Pepsico is dealing with the issue of gender parity:

- ✓ Sensitization toward all genders to make the workplace a safe environment
- ✓ The intentional recruitment of female staff members to advance gender parity in the work environment
- ✓ Benefits and arrangements that facilitate female employees' capacity to focus on their work without distractions.
- ✓ The creation of new positions to enable women to find employment.
- ✓ A diverse & inclusive workplace that is capable of fostering inclusion

4. Nestle

Nestle is among the greatest companies for people of both genders. For the fourth consecutive year, Nestle was listed in the Bloomberg Gender-Equality Index (GEI) ranking for 2022. 43.9% of Nestle's managerial roles are occupied by women. The company aims to have 30% of women in senior executive positions by the end of 2022.

Nestle has also made a step by adopting a gender-neutral Global Parental Help Policy, where the firm offers new parental leave policies to support its employees, regardless of their gender. This is part of Nestle's effort to create a diverse and inclusive workforce.

Here are some initiatives introduced by Nestle to promote gender diversity:

- ✓ Sensitization training of hiring managers
- ✓ Market research to identify safe areas and assess travel entitlements
- ✓ Unconscious bias and gender sensitization awareness programs
- ✓ Pregnancy benefits programme that offers a special travel allowance, ergonomic seating, and preferential parking for the mother and child.
- ✓ 26 weeks of paid maternity leave with benefits
- ✓ Secure and personal spaces for nursing
- ✓ Dairy farming training for women to increase employment at the grassroots
- ✓ Launch of the "Attract-Retain-Develop" framework to launch inclusivity and diversity in talent

- ✓ Nestle focuses several efforts to establish a sense of gender equality in the workplace. It boasts of having one of the highest number of women employees in the FMCG sector.
- ✓ This reflects that the special initiatives taken to hire and retain women employees are working positively for the company, and that gender diversity is truly a part of the organization.

5. **Zomato**

In today's society, startups are extremely popular, and companies like Zomato frequently find themselves in the spotlight for all the right reasons. The food aggregation company advocates for gender equality in the workplace and spearheads the push for inclusivity and diversity in the Indian startup scene. It stands out as an equal employer and thoughtful initiative for people of all genders.

These are some initiatives that Zomato has introduced to bring about a sense of gender inclusivity and diversity:

- ✓ 50% of directors at Zomato are women as an initiative toward cognitive diversity
- ✓ The leave policy now allows women and transgender employees to use 10 menstrual leaves in a year
- ✓ Equal leave policies for parents through birth, surrogacy, and adoption;
- ✓ mindful hiring of women across all roles, from delivery partners to board members
- ✓ By the end of 2022, aim to raise the percentage of women in the delivery fleet from 0.5% to 10%.

6. TCS (Tata Consultancy Services)

Regarded as one of the leading companies actively fostering a diverse and inclusive work environment, TCS is included in the Bloomberg Financial Services Gender-Equality Index. TCS is an equal opportunity employer that supports gender diversity. With 44% of women in junior management, 30% in middle management, and 13% in senior leadership, the company is striving to become a completely inclusive workplace.

The organisation is dedicated to the notion that diversity and inclusion in the workplace may enhance performance, and it operates by the simple tenet of "Inclusion without exception."

TCS created the Network of Outstanding Women (TCS-NOW) as a response to this, providing a safe space for women to engage, create, learn, seek both personal and professional help, and resolve any problems they may be having.

Initiatives like TCS NOW make way for an equal and creative environment that increases creativity in professionals and influences people to have a shift in behavior and thought processes.

7. Tech Mahindra

Tech Mahindra has retained its status as a gender-neutral employer and has put in place a number of initiatives to advance gender equality at work. The company's belief in diversity and inclusivity in the workplace has worked well for them and helped them generate value and success, as evidenced by the Bloomberg Gender-Equality Index's recognition of them for three years running.

This quote from Harshvendra Soin, Global Chief People Officer & Head of Marketing gives the perfect idea about the company’s take on gender equality in the workplace,

We at Tech Mahindra have created a number of programmes, policies, and efforts to support diversity because we value variances in age, ethnicity, race, lifestyle, and socioeconomic status.

Our goal has been to establish a human-centered ecology that fosters psychological safety among associates.

Our proactive policies regarding Diversity, Equity, and Inclusion empower our associates to bring their true selves to work and flourish in a purpose-driven environment.

The fact that Tech Mahindra has been recognised in the Bloomberg GEI Index for three consecutive years is evidence of our "intentionally diverse and naturally inclusive" philosophy, which enables everyone to succeed.

8. Dr. Reddy's laboratories

One of the most gender-inclusive businesses in India today, Dr. Reddy's Laboratories has spearheaded numerous programs to hire and support women in the workplace. The number of women working for the company increased from 778 in 2015 to 2,349 as a result of efforts to promote gender equality in the workplace.These are some initiatives and projects that have resulted in Dr. Reddy's laboratories becoming a gender-diverse company:

- ✓ Conscious hiring of women in sales force and manufacturing, which makes up 60% of their workforce across all levels
- ✓ SHE (Special Hospital Executives), an initiative involving an all-women sales team of medical representatives.
- ✓ Extended support to women transitioning back into the workforce after a career break by assembling a team of SHEs with women looking for a second chance.
- ✓ Part-time working hours, limited workload, and single-client management for SHEs, compared to regular medical representatives who work long hours and deal with multiple clients and products.
- ✓ Women employed in roles like R&D, engineering, and warehouse management that are otherwise not open to them
- ✓ 'Career Comeback for Women', a platform that enables the hiring of women who are on career breaks
- ✓ Pregnant women were given extended support at work through maternity counselling and buddy mothers, which resulted in a decrease in maternity resignations.
- ✓ Women-operated pick-and-drop taxis

Bloomberg announced that the 2022 Bloomberg GEI, which increases the scope and depth of environmental, social, and governance (ESG) data available to investors, includes 418 companies with a combined market capitalization of USD16 trillion and headquarters spread across 45 countries and regions. The Bloomberg GEI aims to bring transparency to gender-related practices and policies at publicly-listed companies worldwide.

This year's GEI includes Tata Consultancy Services and Firstsource Solutions for the first time, while Dr. Reddy's Laboratories has been featured for five years running, Tech Mahindra and Wipro for three years running, and HCL and WNS Holdings have been included for two years running. A record number of companies released their data for this year's GEI using the GEI.

This year's GEI saw a record number of companies reveal their data utilising the GEI Framework—a 20% increase from the previous year. This shows a rising dedication to gender equality and an understanding that the corporate sector worldwide can drive significant change by pledging to monitor and disclose social statistics more transparently.

SIGNIFICANCE OF GENDER EQUALITY IN THE WORKPLACE

Workplace gender equality is essential for the development of businesses and workers. Because employees are less concerned with masking their gender identification in a hostile work environment, they are more creative and productive. Gender equality in the workplace is equally important since it gives people of both genders equal chances.

Workplace gender equality is essential to the expansion of businesses and the development of employees. Employee creativity and productivity are enhanced in an atmosphere free from stereotypes, disparities, and criticism because workers are less concerned with concealing their gender identity. Since it gives people of both genders equal chances, gender equality in the workplace is equally essential.

A discrimination-free work environment is beneficial for both employers and employees and can be attained by keeping the following things in mind:

- Equal salaries for people across all genders
- Strict policies and practices to ensure there is no room for discrimination against anyone, irrespective of their preferences
- Amenities and incentives for marginalized genders to enable equal employment and participation opportunities
- Open access to people of all genders in all occupations and job roles

GLOBAL GENDER GAP REPORT 2022

The Global Gender Gap Index measures the progress of gender parity across four important parameters (Economic Participation and Opportunity, Educational Attainment, Health and Survival, and Political Empowerment). It has been the longest-running index that examines improvements in closing these disparities over time since its launch in 2006. This year's Global Gender Gap Index examines 146 countries, providing a starting point for in-depth cross-national research. Since 2006, 102 countries, representing a subset of them, have been included in every index release, providing an even bigger constant sample for time series analysis. The proportion of the gender gap or the amount of progress achieved towards parity is shown by the Global Gender Gap Index scores, which are calculated on a scale from 0 to 100.

A multitude of factors, such as persistent institutional barriers, technological advancements and socioeconomic shifts, as well as economic shocks, impact and exacerbate gender disparities in the workforce. The availability of childcare, employer policies, the legal system, and societal expectations all continue to have a big influence on the educational and career paths that women choose, even though more of them are joining the workforce and assuming leadership roles. Ten years of austerity following the 2008 Global Financial Crisis increased regulations on the core social infrastructure sectors, impacting the performance of families and primary carers, who are typically women, during the pandemic. Geopolitical conflict and climate change disproportionately affect women. It is also possible that women will be more affected than males when the current cost-of-living issue continues to worsen as predicted.

Industry-specific gender disparities in leadership: From 33.3% in 2016 to 36.9% in 2022, the proportion of women employed in executive roles has progressively increased. In addition to data from the Global Gender Gap Index, high-frequency data from LinkedIn for 22 countries offers an insight on the representation of women in leadership in 2022: There are relatively few industries with leadership levels that are near to gender parity, such as education (46%), personal services and welfare (45%), and non-governmental and membership organisations (47%). On the other end of the spectrum are Manufacturing (19%), Infrastructure (16%), and Energy (20%). Even while the percentage of women in leadership roles has increased over time, hiring rates for women remain unequal across all industries. In domains where women are already well-represented, more of them have generally been nominated to leadership roles.

By 2022, 68.1% of the gender gap in the world had been closed. At the current pace of development, full parity will not be reached for 132 years. This report indicates that gender parity is not getting better. The deeper the crises get, the worse the situation is for women in the workplace, and the likelihood of a global decline in gender parity is increasing.

WOMEN ON BOARD

Women are still underrepresented in the workforce, on corporate boards, and in leadership roles in India, despite the country's rising literacy rate.

The Companies Act of 2013 has certainly upped the bar for governance, requiring female directors to be on the board for a certain class or classes of companies. Women run about 17% of the 500 Fortune Companies, and throughout the last three years, the proportion of female directors has tripled. It should also be highlighted that women bring distinct perspectives, experiences, attitudes, and ideas to the boardroom compared to men, as evidenced by the 475 female directors on the boards of the 500 Fortune businesses.

Compared to their male colleagues, female directors are "more likely to engage in meaningful intra-board deliberations" because they ask more probing questions that delve deeper into the issues at hand. In order to reach a just and moral judgment, they also weigh the interests of many stakeholders while making decisions. Having more women on staff not only increases output and revenue but also improves the company's reputation. In addition to generating more media attention, it also increases financial return.

At the entry level of most organisations, gender diversity is relatively high; nevertheless, as one climbs the corporate ladder, the ratio begins to tilt more in favour of men. Coincidentally, the World Economic Forum's Global Gender Gap Report 2022 shows that there are only 8.9% of Indian enterprises with female management. Even among companies where women own the majority of shares, just 2.8% are headquartered in India.

METHODOLOGY

Reliance Industries, Infosys, HDFC Bank, ICICI Bank, Hindustan Unilever Limited, Bajaj Finance, Bharti Airtel, Indian Conglomerate Company (ITC), Adani Enterprises, and Life Insurance Corporation (LIC) were the top 10 (market capitalization) NSE-listed companies that the researcher examined in this study. Examining the representation of women on the boards of directors of the chosen corporations was the study's goal. Secondary data was gathered from numerous sources, including the official websites of the chosen companies, in order to meet the study's purpose. The current study looks at how many men and women are employed by the chosen companies' boards of

directors. Each company's board of directors profile was looked at to gather the necessary data, and descriptive statistics were used to analyze the information that was gathered.

FINDINGS & DISCUSSION

The researcher assessed the boards of directors of the top 10 NSE companies based on market value. The distribution of male and female directors on the boards of the chosen companies is shown in the table below.

Table no. 1

Number of the Board of Directors of Selected Companies

Name of the company	**Women**	**Men**	**Total Directors**
Reliance Industries	2	9	11
HDFC bank	3	8	11
Infosys	2	6	8
ICICI Bank	2	10	12
HUL	1	3	4
Bajaj Finance	1	8	9
Bharti Airtel	2	9	11
ITC	2	10	12
Adani enterprises	1	7	8
LIC	2	10	12

Source- compiled from various sources

From the collected data, it was observed that HDFC Bank has the highest number of females on their board among the other selected companies, they have 27% female directors on their board, i.e., 3 female directors out of a total of 11 directors.

Reliance Industries, Infosys, ICICI Bank, Bharti Airtel, ITC, and LIC, all companies were having 2 female directors, while HUL, Bajaj Finance, and Adani Enterprises were having only 1 female director on their boards.

Men have filled more positions on the boards of directors of the chosen corporations, as can be seen from the above table. The number of female directors on the board is solely there to meet the Companies Act's minimal requirement. There is a significant disparity in the number of men and women holding important positions within the company. As a result, there is still gender discrepancy on the board of directors. The study reveals that there is no gender equality in the number of board of directors of the selected companies and thesegender differences can be used to explain gender-biased employment practices for the top positions of the board of directors in the selected companies.

Why Businesses Need Women at the Top

More women than ever before are employed, have greater educational attainment, and are assuming managerial roles. However, in contrast to men, women are still underrepresented in management positions despite these improvements.

Where women stand

Globally, about 50% of women of working age are employed, compared to 75% of men. Still, these numbers don't provide the complete picture. In addition, women are outperforming men in third-level

education. The only continent in the world where women currently earn somewhat fewer third-level degrees than males is Africa.

Cracking the glass ceiling

Since 1991, women have occupied management roles more quickly than men, especially in high-income countries. However, the statistics also show that there is still a long way to go before the proportion of women in these positions equals that of men.

Furthermore, there is still a long way to go before there is parity between the sexes in executive roles and boardrooms at the highest echelons of the economy. Furthermore, women are less likely to hold senior roles in larger corporations.

The benefits of gender balance

Two-thirds of companies surveyed by the International Labor Organizations (ILO Enterprise Survey 2018), agreed that diversity initiatives improved their business outcomes.

Businesses with inclusive company cultures and inclusive policies are estimated to have a 63% chance of generating greater productivity and profitability.

- ✓ Higher creativity, originality, and openness are 59%
- ✓ Improved capacity to draw and keep talent is 60%.
- ✓ A stronger brand for the company is 58%
- ✓ An improved capacity to determine customer interest and demand is 38%

Companies are roughly 20% more likely to see improved business outcomes when their boards are gender-balanced.

CONCLUSION

Even while a lot of companies are actively working to encourage gender diversity and create a welcoming, inclusive environment, the journey has only just begun. Businesses are putting a lot of emphasis on gender equality, but it's crucial to remember that everyone needs to feel safe and at ease at work.

Similarly, to this, when developing a gender equality policy, businesses must take into account the diversity and inclusiveness of all genders.

Future economic ramifications would be dire if gender diversity wasn't addressed. Women are underrepresented in a number of other nations. Such legislation will provide clarity in defining the rights of different genders and so prevent impasses in a country like India, where the possibility of litigation is expected to be thriving in the domain of business and intellectual property conflicts, where the future would depend. This improves commercial transparency.

The present study is limited only to a few top NSE companies, the results of the study might not be generalized for all the NSE listed companies, as the present research only took the top 10 NSE companies. Further research can be made on other NSE listed companies or other listed companies or on women in other executive roles at a global scale.

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ILO Enterprise Survey 2018

REVOLUTIONIZING INDIAN EDUCATION THROUGH DESIGN THINKING: INTEGRATING DIVERSE INNOVATIONS FOR 21ST-CENTURY LEARNING

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ABSTRACT:

The integration of Design Thinking (DT) into the Indian education system offers a significant opportunity to foster creativity, critical thinking, and problem-solving skills among students. This research explores the potential of DT as an innovative pedagogical framework, particularly in relation to interdisciplinary learning. With the National Education Policy (NEP) 2020 emphasizing the enhancement of education quality, vocational skills, digital literacy, and inclusivity, this study investigates how DT can complement these reforms by contributing to curriculum development, teacher training, and creating an enabling environment for learning.

The research objectives are multifaceted: first, to examine how DT can be integrated into Indian education, particularly through project-based learning (PBL) and interdisciplinary approaches, to foster creativity and problem-solving. Second, it explores the role of teacher training in ensuring the successful implementation of DT in classrooms. Third, the study evaluates the impact of DT on student engagement and the development of essential 21st-century skills, such as communication, collaboration, and empathy. Finally, the research identifies challenges in implementing DT, such as resource limitations, resistance to change, and assessment issues, and proposes strategies to address these barriers.

A significant part of the research involves analyzing secondary data, including academic journals, policy reports, and case studies, to synthesize knowledge on DT's role in education. The findings highlight that DT fosters creativity and innovation through real-world problem-solving and interdisciplinary learning, which aligns with NEP 2020's goals. The study also emphasizes the need for flexible school infrastructures, collaborative learning environments, and teacher professional development. Furthermore, new assessment frameworks are necessary to evaluate the iterative, problem-solving nature of DT projects effectively.

Despite its potential, the research identifies barriers such as resource constraints and resistance to change. Strategies like mentorship programs, collaborative communities, and enhanced teacher training are suggested to overcome these challenges. The study advocates for DT integration into the Indian education system to foster 21st-century skills, increase student engagement, and prepare students for future challenges. Further empirical studies are needed to assess the long-term impact of DT on educational outcomes

Keywords: Design Thinking, Interdisciplinary Learning, Indian Education, Teacher Training, 21st-Century Skills, National Education Policy

INTRODUCTION

The Indian education system is at a pivotal juncture, with the National Education Policy (NEP) 2020 heralding a shift towards inclusivity, innovation, and skill-based learning. Design Thinking (DT), a problem-solving methodology emphasizing empathy, ideation, and iterative solutions, offers

transformative potential to address the challenges and opportunities in this evolving landscape. By fostering creativity, collaboration, and critical thinking, DT aligns seamlessly with the objectives of NEP 2020, which advocates for interdisciplinary learning, vocational education, and equitable access to quality education.

The relevance of Design Thinking lies in its ability to address systemic gaps, such as limited access to resources and traditional teaching methods that hinder creativity and innovation. By incorporating DT, the Indian education system can better equip students for the demands of a rapidly changing global workforce while fostering a culture of inclusivity and lifelong learning. Furthermore, the methodology offers an empathetic lens to address student and parent perspectives, emphasizing the importance of personalized and impactful educational experiences.

Design Thinking has shown promise in advancing educational reforms by introducing project-based and experiential learning frameworks that encourage interdisciplinary approaches. By integrating subjects like science, technology, arts, and humanities, DT enables students to tackle complex real-world problems holistically. Teacher training and professional development are critical in this regard, empowering educators to effectively guide students through iterative problem-solving processes.

From a stakeholder perspective, parents and students view education reforms through the prism of aspirations and challenges. While they welcome innovative approaches like DT for fostering creativity and skill-building, concerns about access to resources and teacher readiness persist. This research explores how DT can address these concerns, providing actionable strategies for inclusive and impactful education reforms in India.

RESEARCH OBJECTIVES:

To investigate the impact of integrating Design Thinking with interdisciplinary learning on students' ability to solve real-world problems and develop a holistic understanding of subjects in the Indian education system.

To examine the role of Design Thinking in transforming teacher training programs, with an emphasis on fostering collaboration, creativity, and adaptability among educators in Indian schools.

To evaluate alternative assessment frameworks that align with the iterative and creative processes of Design Thinking, focusing on evaluating interdisciplinary projects in Indian education.

RESEARCH DESIGN:

The research will adopt a descriptive and analytical design using secondary data to understand the implementation, impact, and challenges of integrating Design Thinking and interdisciplinary approaches in the Indian education system. This methodology will focus on synthesizing existing literature, academic articles, research papers, case studies,government reports, educational policies, and studies conducted by academic institutions and NGOs.

LITERATURE REVIEW:

Li and Zhan (2022) conducted a systematic review of 43 studies, identifying the growing adoption of DT in STEM-related K-12 curricula. They highlighted core DT components like prototyping, ideation, and empathy as essential to fostering 21st-century competencies. Similarly, Panke (2019) emphasized DT’s role in engaging students with "wicked problems," enhancing creativity and problem-solving abilities.In higher education, Wang (2024) examined the integration of DT into interdisciplinary curriculum design, demonstrating its efficacy in fostering student collaboration and

co-creation. Practical tools such as visual communication aids and on-site observations emerged as critical enablers.

Sandhyavi and Lalitha (2020) discussed how DT addresses disruptions in management education by fostering innovations in pedagogy and curricula. DT methods, such as divergent and convergent thinking, have been instrumental in aligning management education with global standards. Hu et al. (2021) highlighted DT's role in cultivating entrepreneurial abilities among industrial design professionals. Their findings underscored the potential of DT to improve students' innovation and entrepreneurial skills through iterative teaching methods.

Mayer and Schwemmle (2024) identified four theoretical mechanisms underpinning DT: integration, reframing, enablement, and collaborative engagement. Their review provided a structured overview of DT's impact across organizational, team, individual, and societal levels. This holistic approach is critical for understanding DT's broader implications.Design thinking has shown significant potential in bridging disciplines. Martin et al. (2023) explored its application in social work education, proposing its integration to address complex social problems innovatively.

While DT's potential is widely recognized, the empirical evidence remains limited. Future research should employ longitudinal studies and experimental designs to assess the long-term impact of DT in educational and managerial settings. Design thinking offers a robust framework for addressing complex challenges in education and management. By fostering creativity, collaboration, and problem-solving, DT equips educators, students, and professionals with the skills needed for the 21st century. However, its successful implementation requires overcoming practical and methodological challenges. Future research should focus on empirical validation and exploring interdisciplinary applications to maximize DT's impact.

Nupur Prakash's study (2024), exploring the possibilities of design thinking in Indian education highlights the potential of design thinking to transform Indian education. By integrating its human-centered and iterative principles into curricula, teacher training, and school infrastructure, design thinking can foster creativity, problem-solving, student engagement, and essential 21st-century skills. The study identifies challenges such as resistance to change, resource limitations, and assessment complexities but offers solutions, including comprehensive training, mentorship, collaborative learning, and supportive environments. Embedding design thinking in teacher education programs is also emphasized. Through a theoretical framework and review of existing studies, the research provides actionable strategies for educators and policymakers to implement design thinking, driving innovation and preparing students for modern challenges. While acknowledging implementation hurdles, the study concludes that design thinking can significantly enhance educational outcomes in India.

Challenges, including limited resources, resistance to change, and assessment complexities, are recurring themes (Prakash, 2024). Strategic solutions like mentorship programs, collaborative communities, and teacher training were proposed to overcome these barriers.

Relevance, Contributions, and Application of Design Thinking in the Indian Education System

The integration of Design Thinking (DT) into Indian education offers a transformative approach to learning, fostering creativity, critical thinking, and problem-solving. By addressing the limitations of traditional systems, DT creates a more inclusive, student-centered, and dynamic environment.

1. Curriculum Development: Transforming Learning with DT

Project-Based Learning (DT-PBL):

DT-PBL integrates real-world challenges into curricula using the stages of design thinking: Empathize, Define, Ideate, Prototype, and Test. For instance, a science project could involve addressing a local environmental issue through hands-on learning. DT-PBL enhances creativity, problem-solving, and practical application, aligning with India's shift toward innovation and skill development.

Interdisciplinary Learning:

DT encourages the integration of multiple disciplines to address complex problems. For example, creating a multimedia presentation on a historical event using history, art, and technology develops holistic understanding and mirrors real-world problem-solving.

2. Teacher Training: Building a DT Ecosystem

Effective teacher training is vital for DT's success. Workshops and hands-on activities equip educators to implement DT in classrooms. Collaborative communities of practice—both online and offline—allow teachers to share experiences and continuously improve their methodologies, ensuring the sustainability of DT across the education system.

3. School Infrastructure: Enabling Innovation

Collaborative Spaces: Adaptable classrooms with flexible furniture, whiteboards, and prototyping materials foster teamwork and creativity, supporting DT's iterative process.

Access to Technology: Integrating digital tools enables research, prototyping, and effective communication. Bridging resource gaps is crucial for making technology accessible and enhancing learning, especially in resource-constrained settings.

4. Assessment: Measuring Creativity and Problem-Solving

Traditional exams often fail to evaluate DT's iterative nature. Continuous assessment methods, such as rubrics and reflective journals, track students' progress across:

Problem Identification and Solutions: Effectively defining and addressing challenges.

Research and Exploration: Conducting thorough research for informed solutions.

Design Techniques: Demonstrating proficiency in prototyping.

Solution Effectiveness: Ensuring alignment and impact through testing.

These approaches encourage iterative improvements, emphasizing the process and learning journey.

5. Benefits of DT in Indian Schools

Enhanced Creativity: Encourages innovative problem-solving, preparing students for dynamic global challenges.

Improved Problem-Solving Skills: Develops critical thinking to address complex issues in India's evolving economy.

Increased Engagement: Promotes active, meaningful learning, boosting motivation and outcomes.

21st-Century Skills: Builds collaboration, empathy, and teamwork, aligning with India's educational vision.

DESIGN THINKING AND EDUCATIONAL REFORMS IN INDIA

From a design thinking perspective, the reforms in the Indian education system represent a human-centered approach to solving long-standing challenges. By empathizing with the needs of diverse learners, defining the problems they face, ideating solutions that meet those needs, prototyping innovative initiatives, and testing their impact, these reforms are poised to transform the education system. The adoption of design thinking principles in these reforms ensures that the solutions are not only innovative but also inclusive, equitable, and responsive to the changing demands of the education landscape in India.

STAKEHOLDER PERSPECTIVES ON EDUCATION REFORMS: A DESIGN THINKING APPROACH

1. EMPATHY: UNDERSTANDING THE ASPIRATIONS AND NEEDS OF STUDENTS AND PARENTS

In the context of education reforms in India, the empathy phase involves understanding the hopes, expectations, and concerns of students and parents. Many students and parents are optimistic about the potential for reform, particularly those outlined in the National Education Policy (NEP) 2020. They believe that these reforms can lead to a more equitable and quality-driven education system. Howevesr, their aspirations for better resources and opportunities also highlight the need for continuous improvement in education quality.

2. DEFINE: ADDRESSING CHALLENGES AND CONCERNS

Relevance, Contributions and Application of Design Thinking in the Indian Education System

The integration of Design Thinking (DT) into the Indian education system offers a transformative approach to learning, fostering creativity, critical thinking, and problem-solving skills. Given the challenges of traditional education systems, design thinking presents a solution that adapts to the needs of diverse learners, creating a more inclusive, student-centered, and dynamic learning environment.

- **CURRICULUM DEVELOPMENT: TRANSFORMING LEARNING THROUGH DESIGN THINKING**

Project-Based Learning (DT-PBL):

Design thinking enhances curriculum development by incorporating Project-Based Learning (DT-PBL), which structures education around real-world challenges. The five stages of design thinking—Empathize, Define, Ideate, Prototype, and Test—are applied to engage students in authentic, hands-on learning experiences. For example, a science project could involve students tackling a local environmental issue by empathizing with affected communities, defining the problem, ideating potential solutions, prototyping designs, and testing their effectiveness.

The value of DT-PBL in the Indian education context is profound. It enhances students' creativity, fosters problem-solving abilities, and ensures that learning extends beyond theoretical concepts to include practical application. This method also serves as a vital tool for teacher training, enabling educators to shift from traditional teaching methods to more innovative, collaborative learning

approaches. This aligns with India's educational shift toward fostering critical thinking, innovation, and skill development in the 21st century.

Interdisciplinary Learning:

Design thinking encourages interdisciplinary learning, where students integrate knowledge from multiple subjects. For example, creating a multimedia presentation on a historical event using history, art, and technology not only develops a holistic understanding but also mimics real-world problem-solving processes. This approach reflects the interconnected nature of modern challenges and the need for a well-rounded education, especially in a rapidly evolving world like India's.

- **TEACHER TRAINING AND PROFESSIONAL DEVELOPMENT: BUILDING A DESIGN THINKING ECOSYSTEM**

Effective teacher training is a cornerstone of successfully implementing design thinking. Workshops focusing on hands-on, collaborative activities equip educators with the tools to facilitate design thinking projects in the classroom. These programs empower teachers to implement the design thinking methodology, thus fostering a deeper understanding and application of the process in the classroom.

In addition to structured workshops, ongoing support through communities of practice allows educators to share experiences, challenges, and solutions. Establishing such networks, both online and offline, helps teachers continuously improve their practices and integrate design thinking into their teaching methodologies, ensuring the sustainability of this approach across the education system.

- **SCHOOL INFRASTRUCTURE AND RESOURCES: CREATING ENVIRONMENTS FOR INNOVATION**

Design thinking emphasizes the importance of collaborative spaces where students can work together and engage in creative problem-solving. Schools in India should invest in adaptable spaces that promote teamwork and innovation. This could involve flexible furniture arrangements, whiteboards, and materials for prototyping, which enable both students and teachers to engage in interactive learning. These spaces support the iterative nature of design thinking, allowing students to brainstorm, test ideas, and refine their solutions.

Access to technology is another crucial factor. With the integration of digital tools, students can conduct research, prototype their designs, and communicate their ideas more effectively. The adoption of technology is particularly relevant to India, where access to resources can vary widely. Schools need to ensure that technology becomes an accessible and integral part of the learning process, bridging gaps in resources and enhancing the overall educational experience.

- **ASSESSMENT AND EVALUATION: MEASURING CREATIVE PROBLEM-SOLVING**

Traditional assessment methods, such as exams, often fail to capture the creative and iterative nature of design thinking. In the Indian context, where the focus is frequently on rote learning and memorization, shifting to new assessment techniques is crucial. Evaluation in design thinking should be continuous and encompass various stages of the process.

KEY AREAS FOR ASSESSMENT INCLUDE:

Problem Identification and Solutions: Students effectively define problems and explore diverse, innovative solutions, showcasing their ability to analyze and address real-world challenges.

Research and Exploration: Students undertake in-depth research, leveraging and building upon prior knowledge to develop comprehensive and informed approaches to problem-solving.

Design Techniques: Students demonstrate proficiency in using both digital and manual prototyping techniques, employing a variety of methods to create effective and practical solutions.

Effectiveness of Solutions: Students' solutions are well-aligned with the identified problems, incorporating rigorous testing and evaluation to ensure their efficacy and impact.

Design thinking's emphasis on ongoing evaluation helps track students' progress, encouraging iterative improvements and promoting a deeper understanding of the design process. Tools like rubrics and reflective journals can capture not just the final solution but the journey and thinking behind it, enhancing the assessment process.

- **POTENTIAL BENEFITS OF IMPLEMENTING DESIGN THINKING IN INDIAN SCHOOLS**

The integration of design thinking in Indian education has the potential to bring significant benefits:

Enhanced Creativity and Innovation:

By encouraging students to explore multiple solutions to problems, design thinking nurtures creative confidence and fosters a culture of innovation. This is especially important for India, where educational reforms are geared toward unlocking students' potential and preparing them for a globalized, dynamic workforce.

Improved Problem-Solving Skills:

Design thinking's iterative nature cultivates critical thinking and problem-solving skills, preparing students to tackle complex challenges. This is essential in the context of India's fast-developing economy, where adaptive, agile problem-solvers are needed across industries.

Increased Student Engagement:

Design thinking promotes active learning, where students take ownership of their projects, leading to higher engagement and motivation. This active involvement in meaningful, real-world challenges increases the relevance of education and improves learning outcomes.

Development of 21st-Century Skills:

The approach encourages the development of key 21st-century skills, including collaboration, communication, empathy, and teamwork. These skills are vital for students to succeed in a global, interconnected world and align with India's vision of nurturing responsible, skilled citizens. In the define phase, design thinking helps to clearly articulate the challenges faced by students and parents. Despite the optimism, there are concerns regarding the effective implementation of the reforms:

Quality of Education: Parents are concerned that the reforms may not be implemented consistently across all schools, leading to disparities in educational outcomes.

Teacher Training: There are worries about whether teachers will be adequately trained to adopt and implement the new methods proposed by the reforms.

Access to Technology: With the rise of digital learning, access to technology is a major concern. Inequities in technology access may exacerbate the divide between students from different socio-economic backgrounds.

3. IDEATION AND PROTOTYPING: DEVELOPING SOLUTIONS TO ADDRESS CONCERNS

During the ideation phase, various solutions can be considered to address the identified challenges. Solutions may include:

Providing Teacher Training Programs: Establishing professional development programs for teachers to equip them with the necessary skills to implement new teaching strategies effectively.

Expanding Digital Infrastructure: Ensuring that all students have access to the technology and resources needed for digital learning, particularly in rural or underserved areas.

Standardizing Implementation Across Schools: Developing clear guidelines for schools to follow when implementing reforms, ensuring uniformity in educational practices and quality across the country.

4. TESTING: PILOTING REFORMS AND COLLECTING FEEDBACK

The testing phase involves piloting proposed solutions in schools and gathering feedback from students, teachers, and parents. Through this iterative process, the reforms can be refined based on real-world experiences and the challenges encountered during implementation. Feedback loops will be crucial to identifying areas for improvement and ensuring that reforms are meeting the needs of students and parents.

5. ENSURING SUSTAINABLE AND INCLUSIVE EDUCATIONAL REFORMS

By adopting a design thinking approach, education reforms in India can be better understood, implemented, and continuously improved. Through empathy, defining problems, ideation, prototyping, and testing, the concerns of students and parents can be addressed, ensuring that the education system evolves into one that is more inclusive, equitable, and capable of preparing students for the future.

DISCUSSION ON FINDINGS

Integration of Design Thinking in Indian Education: The application of Design Thinking (DT) in Indian education, particularly through project-based learning (PBL) and interdisciplinary approaches, is gaining traction. The research findings indicate that integrating DT into the curriculum encourages active, student-centered learning that focuses on real-world problem-solving. By using the five-stage framework of Empathize, Define, Ideate, Prototype, and Test, students are able to explore multiple solutions, fostering creativity and innovation. For example, in science curricula, students can address local environmental problems, ensuring that learning is relevant and applicable to their surroundings. The research also suggests that DT enhances problem-solving skills and fosters a deeper understanding of interdisciplinary topics by bridging subjects like history, art, and technology. This aligns with the goals of National Education Policy (NEP) 2020, which aims to make education more holistic and inclusive.

Impact of Design Thinking on Teacher Training Effective teacher training emerges as a critical factor in the success of Design Thinking implementation in Indian schools. The research indicates that many educators face challenges in adapting to new pedagogical methods, especially those involving

creative problem-solving and collaborative learning. Workshops, collaborative teaching methods, and hands-on experience are essential for equipping teachers with the necessary skills to effectively guide students through the DT process. Ongoing professional development through communities of practice further ensures that educators remain supported and up-to-date with the latest practices. The findings highlight that when teachers are adequately trained in DT methodologies, they can better foster an environment of collaborative and innovative learning, helping students develop critical 21st-century skills.

Student Engagement and 21st-Century Skills Development The research findings suggest that Design Thinking significantly boosts student engagement. By allowing students to take ownership of their learning and engage with meaningful, real-world challenges, DT increases motivation and encourages active participation. The iterative nature of DT, where students continually refine their ideas, nurtures important skills such as resilience, adaptability, and critical thinking. The study also highlights that Design Thinking supports the development of key 21st-century skills, including communication, collaboration, empathy, and problem-solving, which are essential for success in the modern, global workforce. These skills are closely aligned with the objectives of NEP 2020, which emphasizes the importance of equipping students with the competencies needed to thrive in the future.

Challenges in Implementation Despite the promising benefits, several challenges hinder the full integration of Design Thinking in the Indian educational context. Limited resources (e.g., access to technology, infrastructure) remain a significant barrier, particularly in rural or underfunded schools. The research also identifies resistance to change from both educators and institutions, with some stakeholders hesitant to adopt non-traditional teaching methods. Additionally, traditional assessment methods do not effectively capture the iterative and creative nature of Design Thinking projects. The study emphasizes the need for new assessment frameworks, such as rubrics, reflective journals, and ongoing progress evaluations, to better measure student performance and development.

The Role of Interdisciplinary Learning Interdisciplinary learning plays a pivotal role in the successful implementation of Design Thinking in schools. The research shows that integrating various subjects into a single project encourages students to see the interconnectedness of knowledge and approach problems from multiple perspectives. For example, combining science, technology, engineering, and mathematics (STEM) with arts in a single project helps students address complex issues in innovative ways. This approach reflects the holistic education model promoted by the NEP 2020, emphasizing that students should not only acquire knowledge but also apply it creatively to real-world situations.

CONCLUSION

The integration of Design Thinking into the Indian education system holds transformative potential to enhance student learning and engagement. By incorporating project-based learning and interdisciplinary approaches, Design Thinking fosters creativity, critical thinking, and problem-solving—key skills emphasized in the National Education Policy (NEP) 2020.

However, challenges such as resource constraints, traditional educational structures, and outdated assessment methods hinder its implementation. These obstacles can be addressed through teacher training, mentorship programs, collaborative learning environments, flexible classrooms, access to technology, and new assessment models aligned with the iterative nature of Design Thinking.Teacher professional development is crucial for success. Equipping teachers with training, collaborative communities of practice, and ongoing workshops ensures their readiness to implement this approach effectively and inspire innovation in students.

Design Thinking presents a unique opportunity to reshape education in India by fostering essential 21st-century skills. A collaborative effort among policymakers, educators, and the private sector is vital to overcoming challenges and creating an environment that supports innovative learning.

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LEADERSHIP DEVELOPMENT IN THE AGE OF AI: A CROSS-DISCIPLINARY APPROACH

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ABSTRACT

This chapter explores the evolving concept of leadership in the context of the AI-driven era, highlighting the need for a cross-disciplinary approach to leadership development. As artificial intelligence transforms industries and organizations, traditional leadership models must adapt to meet new challenges and opportunities. The chapter emphasizes the importance of integrating insights from psychology, neuroscience, technology, and sociology to cultivate leaders capable of navigating the complexities of AI technologies. Key leadership skills, such as emotional intelligence, technological fluency, and ethical awareness, are discussed in detail, along with the need for leaders to effectively manage the ethical implications of AI integration. Drawing on case studies and empirical research, the chapter examines how multidisciplinary frameworks can empower leaders to drive innovation while ensuring fairness, inclusivity, and accountability in AI-driven workplaces. By synthesizing these diverse perspectives, this chapter provides a comprehensive approach to leadership development in the AI era, offering practical guidance for equipping leaders with the tools and knowledge to thrive in a rapidly changing world.

Keywords: Leadership Development, AI Integration, Cross-Disciplinary Approach, Ethical Leadership, AI-Driven Workplaces

INTRODUCTION

The advent of artificial intelligence (AI) has revolutionized workplaces across industries, creating opportunities and challenges for leaders. To succeed in this era, leaders must develop skills that transcend traditional management, drawing on insights from technology, psychology, ethics, and more. This chapter explores a comprehensive, cross-disciplinary approach to preparing leaders for the complexities of automation and AI-driven workplaces. The rapid advancement of artificial intelligence (AI) is reshaping industries, creating both opportunities and challenges for organizational leadership. As AI continues to transform workplaces, leaders are required to adapt their strategies to integrate technological advancements while maintaining a human-centered approach. Leadership in the AI era transcends traditional paradigms, demanding a blend of technical acumen, emotional intelligence, and ethical judgment. This synthesis explores the evolving landscape of leadership in the context of AI, focusing on the competencies required, the role of AI in decision-making, and the challenges of fostering effective human-AI collaboration.

REVIEW OF LITERATURE:

Sposato, M. (2024): AI adoption requires a paradigm shift in leadership, combining technical expertise with emotional intelligence. This study explores leadership development in the AI era, emphasizing proactive strategies, ethical considerations, and behavioral insights. It provides actionable guidance for navigating AI disruptions and fostering resilient organizational cultures. Matli, W. (2024): AI is enhancing decision-making through real-time analysis, pattern recognition,

and predictive simulations. This study explores the integration of "warrior AI" with leadership reflexivity to improve ethical and informed decision-making. It highlights the critical role of leadership reflexivity in contextualizing AI-driven recommendations, offering a framework for adaptable decision-making.

Zaidi, Syed Yasir Abbas et al. (2024): AI is transforming organizational leadership by introducing intelligent decision-making approaches, making leaders more tech-savvy, and fostering AI-congruent leadership. Through interviews with IT companies, this study highlights the importance of sustainability, leadership coaching, and adapting traditional competencies to evolving dynamics. These findings emphasize AI's potential to redefine team interactions and leadership practices. Tasnim, Mayesha (2024): Leadership in the age of AI demands adaptability, emotional intelligence, and creativity. This study emphasizes merging technical and interpersonal skills to address AI's effects on leadership, including fostering entrepreneurship, transitioning organizations, and improving HR practices. These findings offer practical guidance for CEOs to navigate AI's growing influence while addressing skill gaps.

Karakose, T., & Tülübaş, T. (2024): AI is transforming school leadership by enabling intelligent systems for management and education. This study highlights AI's potential to enhance educational processes, support decision-making, and create transparent, participatory leadership models. It underscores the need for digital skills and inclusive management practices in schools. Fenwick, Ali, Molnar, Gabor, & Frangos, Piper (2024): AI has revolutionized human resource management (HRM), creating efficiencies and enhancing data-driven processes. However, challenges remain in human-AI interactions and ethical considerations. This paper proposes a roadmap for integrating AI into HRM, emphasizing human-centric approaches to balance technical capabilities with employee motivation and satisfaction.

Friedrich, J., Brückner, A., & Mayan, J. (2024): Human-centered AI integration is essential for Industry 5.0, focusing on employee involvement throughout the transformation process. Using the Design Science Research method, this study provides a practical approach to integrating AI in small and medium enterprises. The findings highlight the need for uniform guidelines to ensure motivation, satisfaction, and ethical considerations in AI-driven workplaces. Uddin, A. S. M. A. (2023): Ethical leadership in AI-driven organizations addresses challenges such as bias and privacy concerns. This study emphasizes cultivating responsible AI cultures, promoting transparency, and setting ethical standards. It highlights how ethical leadership positively impacts employee well-being and decision-making, offering strategies for maintaining ethical AI practices.

Perifanis, N.-A., & Kitsios, F. (2023): AI integration in business and IT strategies promises to enhance value creation. This literature review identifies performance advantages, challenges, and gaps in adopting AI. It calls for research on strategic AI implementation to help organizations align digital transformation efforts with value creation, addressing complexities in governance and resource orchestration. Dwivedi, Yogesh K., Hughes, Laurie et al. (2021): AI holds transformative potential across industries, offering new opportunities for innovation and decision-making. This multidisciplinary study explores AI's challenges and opportunities in various domains, including business, government, and science. It outlines the societal and industrial impacts of AI, providing a comprehensive research agenda for its integration into diverse sectors.

Larson, L., & DeChurch, L. (2020): Digital technologies are reshaping teamwork and leadership. This study outlines four perspectives on technology's impact on teams: context, sociomaterial integration, creation medium, and teammate. It identifies leadership implications, particularly in human-AI team dynamics, and proposes directions for future leadership research and practice. Smith, Ashley &

Green, Mark (2018): A future artificial intelligence (AI) leadership position will likely include a new follower, the AI machine. With the need to replace a traditional workforce, AI leadership will involve leading programmers and influencing AI decisions post-programming. Communication standards should be set for human and machine members. Ethical and moral mentoring will become critical for building relationships with AI. Adjustments to human leadership behaviors, such as charisma and relationship-building, may be necessary. This study provides ideas for leading teams of AI machines and their programmers.

THE CHANGING LANDSCAPE OF LEADERSHIP IN THE AI ERA

AI's Role in Decision-Making: Artificial intelligence is revolutionizing decision-making processes by automating routine tasks and providing predictive analytics for strategic decisions. Advanced algorithms enable leaders to gain real-time insights, identify patterns, and anticipate future scenarios. This integration of AI enhances efficiency and reduces cognitive load, allowing leaders to focus on high-level strategic initiatives. For instance, Sposato (2024) highlights how AI can amplify leadership reflexivity by improving ethical and informed decision-making. Similarly, Zaidi et al. (2024) emphasize the transformative impact of AI in redefining team dynamics and fostering innovation through intelligent decision support systems.

Shift in Leadership Competencies: The integration of AI necessitates a shift in leadership competencies. Traditional skills like authoritative decision-making are being complemented by emotional intelligence, adaptability, and ethical judgment. Leaders must navigate complex socio-technical ecosystems, balancing technical expertise with human-centric values. Tasnim (2024) underscores the importance of combining technical and interpersonal skills to address AI's impact on leadership. Additionally, Uddin (2023) stresses ethical leadership as a cornerstone for fostering trust and transparency in AI-driven organizations.

Challenges Managing human-AI collaboration: This presents unique challenges, including maintaining trust amidst technological disruptions and addressing ethical dilemmas. Friedrich et al. (2024) emphasize the need for human-centered AI integration, advocating for inclusive practices that prioritize employee motivation and satisfaction. Furthermore, Larson and DeChurch (2020) highlight the complexities of human-AI team dynamics, where leaders must cultivate trust, set clear communication standards, and manage the interplay between human creativity and machine precision.

KEY LEADERSHIP SKILLS IN AI-DRIVEN WORKPLACES

The rapid integration of AI into workplaces has redefined leadership, demanding a combination of adaptability, emotional intelligence, and ethical judgment. In this evolving landscape, leaders must balance technological advancements with human-centric qualities, ensuring that innovation supports both organizational and societal goals.

ADAPTABILITY AND LEARNING AGILITY

In an era of unprecedented technological change, adaptability and learning agility are indispensable for effective leadership. AI is reshaping industries by automating repetitive tasks and optimizing decision-making through predictive analytics. Leaders must continuously update their knowledge, embrace innovation, and foster a learning-oriented organizational culture.

Continuous Learning as a Priority: Leaders who stay ahead of AI advancements can identify opportunities for growth and innovation. They must actively encourage their teams to adopt a similar mindset, integrating AI into workflows in ways that align with strategic goals.

Tech giants like Google emphasize lifelong learning through programs like "AI for Everyone," enabling leaders and employees alike to understand and leverage AI effectively. Adaptable leaders ensure their organizations remain competitive, resilient, and innovative amidst constant change.

EMOTIONAL INTELLIGENCE (EI)

As AI takes over data-driven and routine tasks, the human-centric aspects of leadership, such as empathy, interpersonal communication, and relationship-building, have become critical. Emotional intelligence enables leaders to connect with their teams, address concerns about AI adoption, and foster trust in technology.

The Human Touch in a Tech-Driven World: Leaders must ensure that AI complements rather than replaces human effort. They must communicate transparently about AI's role and address employee anxieties related to job displacement or skill gaps. Salesforce's use of AI for customer relationship management highlights how leaders leverage technology to enhance human interactions while maintaining employee trust.

Insights from Research: Karakose and Tülübas (2024) argue for participatory leadership that integrates digital fluency with emotional intelligence, ensuring that AI adoption strengthens workplace collaboration. Leaders with high EI not only improve team morale but also bridge the gap between technology and humanity.

ETHICAL JUDGMENT AND DECISION-MAKING

AI's potential to revolutionize industries comes with ethical challenges, including bias, data privacy concerns, and accountability. Leaders must navigate these challenges by establishing robust ethical frameworks for AI use, ensuring that technological advancements align with organizational and societal values.

EMERGING SKILLS FOR AI-ERA LEADERS

Collaboration with AI: Leaders need to develop an understanding of AI tools, not as competitors but as collaborators. This includes optimizing human-AI synergy in problem-solving and decision-making.

Visionary Thinking: Leaders must anticipate future technological trends and their implications, steering their organizations through uncharted territories.

Cultural Competence: As AI facilitates globalization, leaders must navigate diverse cultural landscapes, promoting inclusivity and understanding in increasingly interconnected workplaces.

THE ETHICAL DIMENSION OF LEADERSHIP AND AI INTEGRATION

Leadership in the age of AI is not just about leveraging technology to achieve operational excellence; it also requires a strong focus on ethics to ensure fairness, accountability, and societal benefit. As AI becomes more integrated into decision-making and organizational processes, ethical considerations emerge as a pivotal concern for leaders.

Bias and Fairness:

AI systems, if improperly designed, can perpetuate or amplify biases present in training data. Ethical leaders must ensure that AI tools are audited for bias, fostering inclusivity and fairness. In 2018, Amazon discontinued an AI recruiting tool after discovering it exhibited bias against women. The AI, trained on past hiring data, had learned to favor male candidates. Leaders at Amazon took corrective action to uphold fairness in their hiring process.

Transparency and Explainability:

Ethical leadership requires transparency about how AI algorithms function and the basis of their decisions. Leaders must communicate AI outcomes clearly to build trust among stakeholders. In the healthcare sector, IBM Watson's AI tools for cancer treatment faced criticism due to opaque decision-making processes. Ethical leaders in healthcare organizations have since emphasized the need for AI systems that offer clear reasoning for their recommendations.

Data Privacy and Security:

AI often relies on vast amounts of personal data. Leaders must ensure robust data protection policies and compliance with regulations to safeguard sensitive information. The European Union's General Data Protection Regulation (GDPR) has set global standards for data protection. Leaders at global companies like Google and Facebook have revamped their AI-driven processes to ensure compliance with GDPR, emphasizing user consent and privacy.

Accountability:

As AI makes autonomous decisions, leaders must establish accountability frameworks to address potential errors or unintended consequences. Uber faced scrutiny after one of its self-driving cars was involved in a fatal accident in 2018. The incident underscored the need for clear accountability mechanisms when using AI in critical applications like autonomous vehicles.

Balancing Efficiency with Ethical Considerations:

While AI can drive efficiency, ethical leaders must evaluate the broader societal impact of AI implementations. Facial recognition technologies have been adopted for security purposes but have raised concerns about privacy and misuse. Ethical leadership has been demonstrated by companies like Microsoft, which decided to halt the sale of facial recognition technology to law enforcement until regulations are established.

PRACTICAL STEPS FOR ETHICAL AI LEADERSHIP

Develop Ethical AI Guidelines: Leaders must establish comprehensive guidelines that address potential ethical risks and align AI applications with organizational values. Google's AI principles, announced in 2018, commit to avoiding AI development for harmful applications, such as weapons.

Foster Cross-Disciplinary Collaboration: Collaborating with ethicists, data scientists, and legal experts helps ensure a well-rounded approach to AI ethics. Companies like IBM have established AI ethics boards to oversee responsible AI development and deployment.

Prioritize Ethical Training: Training programs for leaders and teams on AI ethics foster awareness and equip them to address emerging ethical challenges. Deloitte has integrated AI ethics training into its leadership development programs to prepare its leaders for the challenges of ethical decision-making.

Leadership development in the AI era requires a comprehensive, multidisciplinary approach that integrates insights from psychology, neuroscience, technology, sociology, and ethics. This fusion

equips leaders with the skills necessary to navigate the complexities of AI-powered environments, enhancing both their personal effectiveness and their organizational impact.

MULTIDISCIPLINARY INTEGRATION INTO AI DRIVEN LEADERSHIP

Psychology and Neuroscience: Enhancing Decision-Making and Stress Management

The integration of psychology and neuroscience in leadership development has become increasingly relevant, particularly in addressing the cognitive and emotional challenges posed by the fast-paced, high-stress demands of AI-driven work environments. Leaders who are trained in neuroscience-based techniques, such as mindfulness and cognitive-behavioral strategies, tend to exhibit improved emotional regulation, greater resilience, and enhanced decision-making capabilities under pressure.

Neuroscience-based Leadership Training: Research indicates that incorporating neuroscience principles into leadership development fosters better emotional regulation and stress management. Mindfulness practices, for instance, help leaders become more aware of their mental and emotional states, leading to improved focus and decision-making capabilities in high-stakes situations. Cognitive-behavioral strategies, such as reframing negative thought patterns, further aid leaders in maintaining composure and making clear, rational decisions in times of uncertainty.

AI Integration in Leadership Development: The increasing adoption of AI-powered tools is revolutionizing how leaders manage their emotional and physiological responses. Technologies such as biofeedback devices provide real-time data on stress levels, enabling leaders to proactively manage their well-being. Wearable devices like WHOOP, for instance, offer real-time insights into physiological indicators like heart rate variability and sleep patterns, helping leaders optimize their routines and reduce stress. This personalized feedback fosters a more scientifically informed approach to stress management, supporting better decision-making in both personal and professional contexts.

Technology Integration: Hands-On Training with AI Tools

In the rapidly evolving landscape of AI technologies, leaders must be equipped with the skills and confidence to leverage these tools effectively. The practical integration of AI into leadership development programs is crucial in ensuring that leaders are not only technologically literate but also able to apply AI tools strategically in their decision-making processes.

Experiential Learning for Technological Fluency: Research has consistently shown that leaders who receive hands-on training with AI tools—such as predictive analytics, machine learning platforms, and natural language processing systems—are more confident in their ability to integrate these technologies into their organizational workflows. Experiential learning, which emphasizes active engagement with AI tools, helps leaders gain fluency and develop the technical competency necessary to make informed decisions in AI-driven contexts. This confidence translates into more proactive leadership in the adoption and implementation of AI solutions within their organizations.

Educational Initiatives and Real-World Applications: Programs such as MIT Sloan's "Leading with AI" exemplify the importance of real-world application in leadership training. These initiatives are designed to equip leaders with the practical knowledge required to use AI tools in everyday business operations, fostering a deeper understanding of AI's strategic potential. Research indicates that leaders with direct exposure to AI systems are 30% more likely to advocate for AI adoption within their organizations (Smith et al., 2024), underscoring the importance of providing leaders with hands-on experience to build their confidence and influence.

Sociology and Diversity: Leading Inclusively in AI-Driven Workplaces

The societal implications of AI technologies particularly with regard to ethics, fairness, and diversity are becoming central concerns for today's leaders. As AI systems are increasingly integrated into organizational practices, leaders must understand how these technologies can impact diverse stakeholders and work towards promoting inclusivity and fairness.

AI and Inclusivity: AI systems are not neutral; they can perpetuate and even exacerbate existing biases if not carefully managed. Leaders in AI-driven workplaces must therefore be attuned to the potential societal impacts of AI systems, ensuring that they are implemented in ways that promote equity and fairness. This requires a deep understanding of how algorithms work and the potential biases that may arise in AI-driven decision-making processes.

Integrating Sociology and AI Ethics: Research by Perifanis and Kitsios (2023) highlights the importance of incorporating sociological and ethical frameworks into leadership training, particularly as it pertains to managing diverse teams and addressing the unintended societal impacts of AI technologies. Leaders must be trained to understand not only the technical aspects of AI but also the broader social implications, such as algorithmic fairness, representation, and inclusivity. By grounding leadership development in both sociological insights and AI ethics, organizations can cultivate leaders who are capable of navigating the complex ethical dilemmas posed by AI technologies.

Practical Examples of Ethical Leadership: IBM's AI Ethics Board serves as a notable example of integrating diversity and sociology into AI decision-making. The board is composed of leaders with diverse backgrounds in ethics, sociology, and technology, ensuring that AI systems are developed and deployed in ways that are fair and representative. This model underscores the importance of diverse leadership in fostering inclusive, ethical AI practices.

CONCLUSION

The landscape of leadership is undergoing a profound transformation, driven by the rapid advancements in artificial intelligence. As we have explored throughout this chapter, the traditional models of leadership are no longer sufficient in navigating the complexities of the AI era. Instead, a more integrated, cross-disciplinary approach to leadership development is essential to equip leaders with the skills, knowledge, and ethical frameworks needed to thrive in this new environment.

Leadership in AI-driven workplaces demands a blend of technical fluency, emotional intelligence, and ethical awareness. Leaders must be adept at harnessing AI tools to enhance decision-making and strategic foresight, while also remaining grounded in human-centric values that prioritize fairness, inclusivity, and societal impact. The integration of psychology, neuroscience, technology, and sociology into leadership development programs provides a comprehensive approach that not only enhances leaders' cognitive and emotional capacities but also prepares them to address the societal challenges AI presents.

The ethical dimension of leadership in the AI era cannot be overstated. As AI technologies reshape industries, leaders must ensure that these innovations are implemented responsibly, with a focus on fairness, accountability, and transparency. This ethical responsibility extends beyond technical considerations, requiring leaders to engage with the broader societal implications of AI and work to mitigate its potential biases and inequities.

The future of leadership in the AI-driven world hinges on multidisciplinary integration. By synthesizing insights from various fields like psychology, technology, sociology, and ethics, leaders can navigate the complexities of AI-driven change with confidence and integrity. This holistic

approach to leadership development will ensure that leaders are not only equipped to adapt to technological advancements but also to shape a future where AI benefits society as a whole. In embracing this cross-disciplinary approach, organizations and leaders can foster environments where innovation, ethical responsibility, and human-centered leadership intersect, driving sustainable growth and positive societal impact in the AI era.

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PHYTOREMEDIATION: A SUSTAINABLE APPROACH TO ADDRESSING ENVIRONMENTAL CONTAMINATION

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ABSTRACT

Environment is facing contamination from various pollutants, including heavy metals and organic compounds. Heavy metals contamination in environment is rapidly increased due to various natural process and anthropogenic activities. These metals are non-bio degradable and therefore accumulate in the environment. The accumulation of heavy metals in soil and water causes serious risk to environment and human health. Therefore, remediation action must be taken to reduce these impacts. Traditional remediation methods can be costly and disruptive. Phytoremediation is a bioremediation process, nature-based technology by utilizing various plant species to remove or degrade the contaminants. This ecofriendly approach offers several advantages over traditional which includes cost effectiveness, minimum environmental impact and long-term eco restoration. This paper explores the mechanism of phytoremediation which includes phytoextraction, phytodegradation, rhizofiltration, phytostabilization and phytovolatilization. This highlights the potential of phytoremediation technology for purifying contaminated water bodies and improving water quality.

Keywords: Heavy metals, phytoremediation, phytodegradation, pollutants

INTRODUCTION

Wetlands are the most valuable, productive and ecologically important ecosystems on the nature. (Bassi et al., 2014). It provides various ecosystem services including water filtration, flood regulation, and habitat for numerous plant and animal species for the healthy environment and human well - being. It also serves as critical breeding and feeding grounds for migratory birds. It also stores and release water which mitigate the impacts of droughts and floods in surrounding areas. Additionally, it maintains biodiversity, removes nutrients, and retains toxins (Turner et al., 2000). Furthermore, wetlands play an important role in in carbon cycle by carbon sequestration thus mitigating the climate change adverse effects.

Numerous human activities pose a serious threat to wetlands. The need for food, water, energy, and other necessities will rise along with the population, putting the environment and natural resources under extreme strain. Environmental contamination and degradation may increase as a result of anthropogenic activities including industrialization, urbanization, and agriculture. Human activities such as water extraction, invasive species, climate change, and chemical pollution pose the greatest threat to freshwater ecosystems. The sewage, runoff, and effluents that these farming methods, urbanization, and industrialization release into the environment result in a significant rise in heavy metal contamination. (Das et al.,2023 ; Bhat et al., 2022).

Heavy metals have a half-life of more than 20 years and are persistent in nature. These fall into one of two categories: necessary or non-essential. Although they are regarded as micronutrients, heavy metals such as cobalt (Co), copper (Cu), iron (Fe), nickel (Ni), chromium (Cr), manganese (Mn), and zinc (Zn) are harmful when ingested in excess (Ashraf et al., 2019). Lead (Pb), cadmium (Cd), and mercury (Hg) are non-essential heavy metals that are extremely harmful to living things (Gunalan, 2018). These contaminants will build up in the food chain, harming plants, animals, and humans by causing severe illnesses (Nedjimi, 2021). Therefore, remediation actions must be taken to stop heavy metals from entering the different ecosystem compartments.

Remediation of the water and soil contaminants is one of the major challenges facing by our society today. Various physical, chemical and biological methods were used to clean up environmental pollution, but there is restriction because of their high cost, labour, safety risk and ecological risks. An alternative method, phytoremediation, that has shown great efficacy and also become more widely accepted. Aquatic plants are efficient for the removal of heavy metals from water. Heavy metals can be effectively removed from water by aquatic plants.

Many pollutants have been successfully removed from soils and water by the use of phytoremediation, which is regarded as an economical and environmentally benign technique (Yuliasni et al., 2023). Use of different plants to remediate contaminated soil and water directly or indirectly is phytoremediation. (Arthur et al., 2005a). It is efficient at removing, immobilizing, mineralizing, and detoxifying a variety of contaminants (Wang & Aghajani Delavar, 2024a). Cleaning technology that treats environmental pollutants such as organic or radioactive substances, heavy metals, trace elements, and groundwater, as well as wastewater from cities, industries, and farms, using grasses or higher plants (Wenzel et al., 1999, Truu et al., 2015). The name "phytoremediation" is derived from Latin and Greek; in Greek, "phyto" means "plant" and "medium." Latin for "the eradication of evil"(Devi & Kumar, 2020). Chaney introduced the idea of phytoremediation in 1983 (Devi & Kumar, 2020; Epa, 2020; Susarla et al., 2002). It is an energy efficient, aesthetically pleasing, cost-effective and eco-friendly technology (Abou Seeda., 2020; Kafle et al., 2022; Wang & Aghajani Delavar, 2024a). Depending on the kinds, media and forms of the contaminants, different plants employ various techniques to remediate soil and water. Remediation of contaminated ground water can be accomplished by rhizo-filtration, rhizo-degradation, phytodegradation, and phytovolatilization. Rhizofiltration, phytodegradation, or rhizodegradation are methods for treating surface and wastewater contamination. The processes of phytoextraction, phytodegradations, phytostabilization, rhizode degradation, and phytovolatilization are used to remediate pollution of soil, sediments, or sludges. (Abou Seeda., 2020; Kafle et al., 2022).

PHYTOREMEDIATION TECHNIQUES:

There are two ways to study and apply phytoremediation: in vitro (in a controlled laboratory setting) and in vivo (with living plants in their natural or field environment). These methods aid in assessing and making use of plants' capacity to purge the environment of contaminants. (Dietz A.C & Schnoor J.L, 2001, Susarla et al., 2002, Arthur et al., 2005a, Das et al., 2023).

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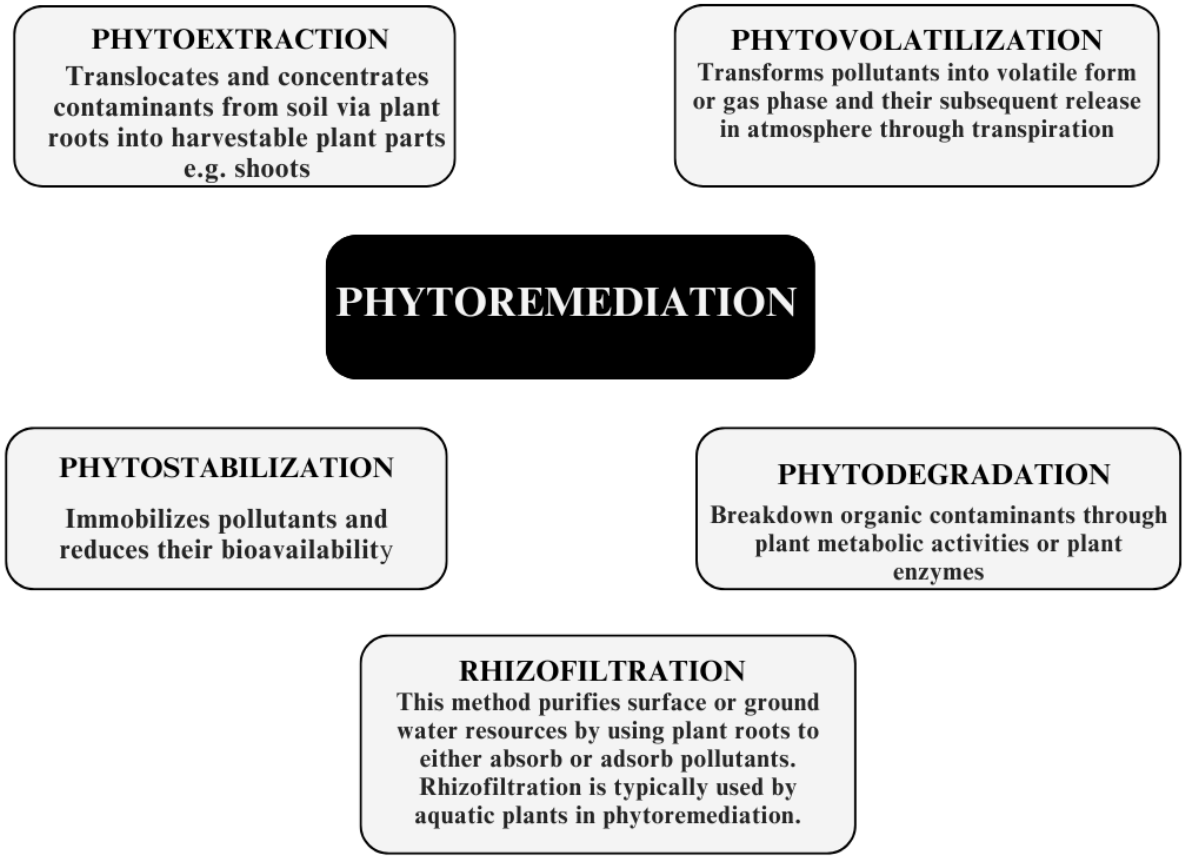
Fig 1: Phytoremediation Mechanisms



PHYTOEXTRACTION/PHOTO ABSORPTION

Hyper-accumulation mechanism is done in phytoextraction. It is the process by which pollutants are taken up by plants from the soil or water through their roots and transferred to their harvestable tissues, such as leaves, stems, or shoots. These plants, referred to as hyperaccumulators, can tolerate and accumulate abnormally high metal concentrations without experiencing harmful side effects. (Kimmatkar et al., 2015; Tahir et al., 2016). For heavy metals present in soils, hyperaccumulators have the capacity to build up significant concentrations of contaminants without exhibiting any overt symptoms or physical signs of toxicity. Heavy metals are taken up and eliminated from the soil by the roots, the concentration in the plant parts rises. It is evident that hyperaccumulators are quite effective at cleaning up polluted soils because the concentration of trace elements like Ni, As, Cd and Zn, is usually up to 100 times greater in their leaves than it is in the polluted soil. The greater concentration of heavy metals in shoot areas relative to the root system is also noteworthy. Plants that produce less biomass as they develop can be used for ideal phytoextraction. This method, commonly known as phytomining, can also be utilized to absorb and concentrate commercially significant nutrients that are present in trace levels in the lithosphere (Broadhurst et al., 2004, Emamverdian et al., 2015, Kramer, 2010; Cardwell et al., 2002, Goolsby and Mason, 2015, Becher et al., 2004). In phytoextraction, pollutants other than metals such as volatile organic compounds [VOCs] are absorbed by plant roots. In phytoextraction, pollutants other than metals such as volatile organic compounds [VOCs] are

absorbed by plant roots. These contaminants can be chemicals in soil, vapor or dissolved in groundwater or soil moisture that attach themselves to the roots. Through transpiration, chemicals enter the stem and roots where they can either be digested, accumulate (phytoaccumulation), or be exhaled into the atmosphere. (Abou Seeda., 2020; Epa, 2020; Ghori et al., 2015a; Williams Araújo do Nascimento & Xing, 2006; Yuliasni et al., 2023).

PHYTOSTABILISATION/ /PHYTOIMMOBILIZATION

Phytostabilization is a phytoremediation technique that uses plants to lessen soil contaminants' mobility and bioavailability, particularly those of heavy metals. By altering the pH and moisture content of the soil and releasing exudates that might precipitate metals, plant roots lessen the interaction of metals with biota. It removes the need to dispose of contaminated plant material, in contrast to phytoaccumulation. Plants immobilize the metals in the soil through a number of processes, such as metal valency, precipitation, rhizosphere reduction, and root sorption. (Yoon et al., 2006, Barcelo et al., 2003, Wuana et al., 2011, Ghosh and Singh, 2005). The valency of metals determines their toxicity. Heavy metal stress is reduced by the numerous enzymes that plants expel that aid in changing dangerous metals into less hazardous ones. (Abou Seeda., 2020, Arthur et al., 2005, Devi & Kumar, 2020; Ghosh & Singh, 2005, Wang & Aghajani Delavar, 2024, Kafle et al., 2022, Susarla et al., 2002, Verma et al., 2022, Yuliasni et al., 2023).

PHYTOVOLATILIZATION

Releasing contaminants into the atmosphere through transpiration after they have been transformed into volatile forms by plants is known as phytovolatilization. When developing trees and other plants absorb water, phytovolatilization takes place both inorganic and organic pollutants. At relatively low quantities, some of these pollutants can volatilize into the atmosphere after passing through the plants to the leaves. Mercury removal is the main use for phytovolatilization, which converts the mercuric ion into less hazardous elemental mercury. (Ghosh & Singh, 2005). Through a process known as phytovolatilization, pollutants are taken by plants from the soil and changed into volatile forms before being released into the sky. When the volatile molecules are less harmful in the atmosphere than they are in the soil, this technique works well. It works very well for organic contaminants. While some pollutants are produced as a result of interactions between roots and soil, others volatilize straight from stems and leaves. The cuticle, epidermis, or suberin layers are examples of plant barriers that hydrophobic chemical molecules leave through. Others are released during transpiration and go upward with the stream of transpiration. For instance, ryegrass leaves can exude trifluralin compounds. Some plants have the ability to change toxic organic pollutants into less damaging forms before releasing them into the sky. (Kafle et al., 2022).

PHYTODEGRADATION AND RHIZODEGRADATION

During phytodegradation, pollutants are absorbed by plants and converted into less harmful, simpler forms. There are two ways that breakdown happens.

1. Through the plant's own metabolic mechanism

2. By use of the plant's enzymes.

In order to grow faster, the plant consumes the contaminants that are broken down into simpler components. Phytodegradation can break down a variety of inorganic chemicals, pesticides, chlorinated solvents, and other organic molecules. (Kafle et al., 2022) Phytodegradation is the process by which plants convert organic contaminants into simpler, less hazardous substances that are subsequently absorbed by their tissues. Plant enzymes known as reductases, oxygenases, and

dehalogenases can break down herbicides, insecticides, trichloroethylene, and munitions wastes. Plants absorb organic contaminants passively, converting them into less toxic forms that are then distributed throughout their tissues. Rhizodegradation occurs in the rhizosphere, or root zone, where organic pollutants are broken down by microbial activity. Microorganisms such as bacteria, fungus, and yeast break down fuels and solvents. This process contributes significantly to the reduction of organic pollutants, albeit being slower than phytodegradation.(Muthusaravanan et al., 2018a; Newman & Reynolds, 2004; Wang & Aghajani Delavar, 2024b).

RHIZOFILTRATION

Rhizofiltration is defined as the process by which aquatic and terrestrial plants with low concentrations of contaminants in their roots absorb, concentrate, and precipitate pollutants from contaminated water sources; it can be used to partially treat acid mine drainage, agricultural runoff, and industrial discharge; it can be applied either in-situ or ex-situ, and species other than hyperaccumulators can be used. (Bakshe & Jugade, 2023; Dushenkov et al., 1995a). Rhizofiltration uses plant roots in a saturated zone to remediate aqueous contaminants from waste water, ground water, or surface water. By employing plant roots to either absorb or adsorb contaminants, this technique purifies surface or ground water supplies. Aquatic plants usually use rhizofiltration in phytoremediation. This method is most effective when used to clean up water and soil that are highly contaminated with nutrients like nitrogen and phosphorus. (Dushenkov et al., 1995a, 1995b; Ghori et al., 2015b; Muthusaravanan et al., 2018b; Pivetz & Kovalick, 2001; Tayde et al., 2020; Arthur et al., 2005b; Bakshe & Jugade, 2023).

Table 1 shows different phytoremediation techniques

Process	Mechanism	Contaminants	Media
Phytoextraction	Hyperaccumulation	Inorganics - Metals	Soil, Sediments & brownfields
Phytostabilization	Complexation	Inorganics - Metals (Pb, Cd, Zn, As, Cu, Cr, Phreatophytic trees for hydraulic Se, U); hydrophobic organics control; grasses with fibrous that are not biodegradable.	Soils
Phytovolatilization	Volatilisation by leaves	Organics/Inorganics - Selenium, arsenic, mercury, Brassica juncea; wetlands volatile organic plants; phreatophytic trees for compounds (e.g., MTBE)	Soils and sediments
Phytodegradation	Degradation in plant	Herbicides; chlorinated ali- Phreatophytic trees (Salix landfill leachate, phatics (e.g., TCE); aromatics (e.g., BTEX); ammunition wastes (TNT, RDX, HMX, perchlorate); nutrients (nitrate, ammonium,phosphate)	Soil, groundwater, landfill leachate, land application of wastewater
Rhizofiltration	Rhizosphere accumulation	Organics/Inorganics - Metals (Pb, Cd, Cu, Ni, Zn); radionuclides, hydrophobicorganics	Groundwater, waste water through constructed wetlands

(Sources: Arthur et al., 2005b; Bakshe & Jugade, 2023; Dushenkov et al., 1995a, 1995b; Ghori et al., 2015b, 2015c, 2015a; Muthusaravanan et al., 2018b, 2018a; Nascimento & Xing B, 2006; Newman & Reynolds, 2004b, 2004a; Pivetz & Kovalick, 2001; Tahir et al., 2016; Tayde et al., 2020; Verma et al., 2022b; Wang & Aghajani Delavar, 2024b; Williams Araújo do Nascimento & Xing, 2006)

Aquatic plants like *Eichhornia crassipes* (Mandal et al., 2023; Patel et al., 2024) *Pistia stratiotes* (Zhilkina et al.,2024) *Azolla pinnata (*Prusty et al.,2024; Patel et al.,2024) *Spirodella polyrhiza*

(Chandini et al,2024) *Lemna minor* (Pang et al.,2024; Saha et al.,2022) *Salvinia* (Pang et al,2023) are effective in phytoremediation, removing pollutants from water by absorbing heavy metals and other pollutants through root system. The advantage of phytoremediation includes feasible, ecofriendly, applicability, prevents erosion and metal leaching, improving soil fertility. Therefore, improving plant performance is a major step for developing effective phytoremediation.

CONCLUSION

Heavy metal pollution is a vital issue for environment due to rapid accumulation. To remediate heavy metal contamination a variety of methods have been developed. The use of low cost and eco-friendly strategies looks to potential approach for removing pollutants. Although phytoremediation is a promising approach for remediation of heavy metal contaminated soil it has also some limitations such as slow time for clean-up, slow growth rate and low biomass. Further more research is needed to better understand the phytoremediation effectively in order to increase its practicability.

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WETLANDS THE CRADLES OF BIODIVERSITY

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ABSTRACT

Wetlands, often misunderstood as wastelands, are essential ecosystems that play a pivotal role in maintaining ecological balance. They serve as hotspots of biodiversity, purifiers water, serves as carbon sinks, and natural barriers against erosion. This chapter highlights the multifarious functions of wetlands, including their role as "biological supermarkets" and "kidneys of the landscape," showcasing their indispensability in sustaining life. A comprehensive analysis of wetlands at international, national, and state levels reveals their distribution, ecological significance, and the growing threats they face due to anthropogenic activities. The chapter also underscores the compelling need for their preservation, advocating for sustainable management to combat climate change and support biodiversity, agriculture, and water security. This exploration emphasizes that preserving wetlands is not merely an environmental necessity but a crucial step toward humanity's survival and prosperity.

Keywords: wetlands, biodiversity, ecological balance, carbon sinks, water conservation, sustainable management

INTRODUCTION

Wetlands should not be taken as wastelands. If wetlands are taken thus, that will spell a global catastrophe. The earth will, then, shrink and shrivel into a dry spherical toy. All conventions and researches on wetlands have wisely and shockingly sounded warnings in this regard. Definitions and cataloguing of benefits have accompanied the warnings. Definitions, given after long and serious deliberations, seem to converge to certain focal points. Benefits enunciated have been enticing humanity, but unfortunately the majority of humanity considers it a routine paper work ensuing from the cerebrations of some pseudo-scientists. But humanity should remind itself that it is not the croaking of a few cranky scholars that we hear in global conventions. It is the voice of wisdom that, unfortunately, seems "to cry in the wilderness".

Acquainting ourselves with the varied definitions, that occupy the pages of research papers and proclamations of conventions, will take us to new royal vistas of what wetlands are. If we try to "crib and cabin" them within the boundaries of measured phrases and expressions, our vision will be blurred and the future of wetlands will be dark and dull and that will spell the end of humanity not with a "bang" but with a "whimper". Hence with open hearts and observant eyes we may turn to comprehensive but wisely and eloquently brief depiction of wetlands.

Wetlands are areas, where the pre-eminent position goes to water, that as the vitalizing factor, holds the reins of the whole ambience, including the wonder-provoking myriad forms of fauna and flora. It is water that decides and facilitates the genesis of wetlands. Inspiring inquisitiveness takes us to places where wetlands occur and discloses to us the fact that they are found where the water table is at or close to the surface of the land or where the land is enveloped in water. Out of the windows thrown

open in the Ramsar Convention Hall there reverberated the broad and integrated definition of wetlands, which runs thus: "Wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Ramsar Convention Secretariat, 2016).

To this quite inclusive list we can add riparian and coastal areas in the proximity of wetlands and insular areas and marine water bodies enfolded in the lap of wetlands, the depth of which goes more than six metres at low tide. Scholars like (Cowardin, 1979), who through dedicated researches have established their renown, maintain that wetlands can be brought under the nomenclature "transitional zones", which lie between lands and water bodies. (Maltby, 1986) maintains that wetlands are areas that have been for long wet and hence are conducive to the growth of specially adapted flora and fauna. (Mitsch and Gossilink, 2000) have rightly pet-named these transitional areas lying between terrestrial and aquatic ecosystems as "the kidneys of the landscape".

FUNCTIONS AND IMPORTANCE OF WETLANDS

Wetlands play a vital and indispensable role in ecological systems by providing wildlife habitat, ensuring erosion control, enabling conservation of water and effecting water purification.

Wetlands arrange wildlife habitat rich with plenitude of food and protective canopies. Wetlands provide healthy and happy homes for birds, mammals, amphibians, fish, invertebrates and multifarious plants. Even non-aquatic wildlife finds agreeable habitat in wetlands.

Water conservation is a valuable silent service rendered by wetlands. Showers and droughts these days are unpredictable. Wetlands strike a balance even through the unpredictable vagaries of nature. Showers may lead to flooding on land. Wetlands absorb and store the excess of water, which they release to mitigate the impact of droughts. Thus they ensure an even distribution of available water. Besides, they unobtrusively support the ecosystem by maintaining the water table.

Wetlands are well equipped laboratories set up by nature, where water purification is done in an astounding manner. Biological, chemical and physical processes go on there, with interruption only by the thoughtless intrusion of man. The aquatic vegetation in the wetlands blocks bacteria, who eventually embrace natural death. The wetland vegetation catches contaminants like pesticides, breaks them down and renders them ineffective. The wetland plants take in phosphorus and nitrogen and store them to be submitted to the disintegrating and transforming activities of micro-organisms. Unfailing support for the wetland ecosystem is ensured by the metamorphosis of phosphorus and nitrogen into nutrients, brought about by the micro-organisms present there.

Wetlands furnish nature with effective erosion control systems. When there is heavy surface run-off, wetlands apply the brakes and decelerate erosion. Wetlands cause sediment deposition, which saves banks of streams and flood prone areas from being eroded.

Wetlands have the very meaningful nickname "biological supermarkets". The nickname is validated by the fact wetlands with their voluminous supply of food allure unnumbered animal species. "Detritus", the highly enriched material, formed from the biological degradation of dead plant leaves and stems, becomes the enticing food for aquatic insects, shellfish and small fish. In the curious food-web these in turn become nourishment for larger predatory fish, reptiles, amphibians, birds and mammals.

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The ecology of watershed is preserved by wetlands. In wetlands we can find the curious combination of shallow water, high level of nutrients and productivity at the primary level. This curious combination promotes the growth of organisms which form the substratum of the food-web on which birds, mammals, fish and amphibians depend for sustenance.

Another inestimable service rendered by wetlands has been recently identified by scientists. The plant communities and soil in wetlands become storehouses of carbon, which they do not release into the atmosphere. That conduces to the moderation of climatic conditions. It is relevant to mention that on this account wetlands have been called "carbon sinks". The voice of wisdom reminds us that the protection of wetlands ensures humanity's protection and wellbeing.

We cannot relegate to oblivion the benefits derived from wetlands. To make our study comprehensive we have to acknowledge and enumerate the economic benefits derived from wetlands. Water supply, fisheries, agriculture, nutrient retention, timber production, transport and tourism are some of the arenas of human activities, where we can find wetlands evincing their beneficial potentials. We can find the conspicuous presence and function of wetlands in humanity's cultural heritage, religious beliefs, cosmological visions, aesthetic aspirations and inspirations and significant local traditions.

EXISTING STATUS OF WETLANDS

It is rewarding to span the international and national scenarios to assess the existing status and relative importance of wetlands and thereafter to focus on the state level conditions.

INTERNATIONAL SCENARIO

Even a casual trip from the Polar Regions to the Tropics will reveal to us the astounding fact that wetlands are found in all climatic zones. How much of the earth's surface is occupied by wetlands hasn't yet been exactly calculated. We have the UNEP – World Conservation Monitoring Centre's estimate of 570 million hectares. We have to mortify our curiosity and satisfy it with what the Rmasar Report says: "It is not possible to provide an acceptable figure of the areal extent of wetlands at a global scale" (Ramsar Convention Secretariat, 2016). The WWF has enlisted the Pantanal Marshland of Brazil and the Wasur National Park of New Guinea as wonder-provokingly rich in biodiversity. Forth Estuary of Eastern Scotland, Humber Estuary of the U.K., Thames Estuary of the U.K., Rio Tinto Estuary of Spain and Sado Estuary of Portugal are noted for their prominent feature of eutrophication.

Minchinton et al., (2019) have meticulously documented the impediments caused in the regeneration of mangrove wetlands. They have pointed out the factors strewing impediments in the regeneration of mangrove wetlands and enlisted the following as the factors: grazing, trampling and degeneration of coastal intertidal habitats. (Ricaurte et al., 2019) have made an organized classification of the wetlands of Columbia. They have categorized these wetlands at the hierarchical, multi-scale and functional levels. They have divided them as system, macro-region, subsystem and class to give an integrated information about the diversity and distribution of the wetlands in Columbia. Their findings provide a baseline for prudent environmental policy making. They have underlined the necessity of understanding the diversity and distribution of the wetlands for formulating policies to protect them.

NATIONAL SCENARIO

More than 70% of wetlands in India are constituted by paddy fields. Of the total wetland area 3% is constituted by manmade impoundments. More than 7 million hectors are mangroves and estuaries (Woistencroft et al., 1989). A meticulous study made for the Directory of Asian Wetlands, reveals that

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in India, wetlands occupy an extensive area of 58.2 million hectares (Scott, 1989). The study discloses that more than half of this comes under wet paddy cultivation. In 1990 the Ministry of Environment and Forests held a survey, which divulges the astounding fact that India has over 67,429 wetlands, which come under both the categories of manmade wetlands and natural wetlands. There are 2,175 natural wetlands and 65,254 artificial wetlands in India (MoEF, 1990). India is enriched with very wide ranging coastal ecosystems, because it is bordered on the peninsular sides with a coastline of over 7500 km (Venkataraman & Wafar, 2015).

Wetlands exert their remarkable influence by their unignorable presence and functioning. The major wetland regions in India are the Deccan plateau in the south, along with the lagoons of the south-west coast, in the saltwater lakes of Gujarat, Rajasthan and the Gulf of Kutch, the delta wetlands, lagoons of eastern coast, reservoirs and lakes in Gujarat, Gangetic plain fresh water marshes, Chilika Lake, the swamps and marshes on north-east India and foothills of Himalayas, the rivers and lakes of Ladakh and Kashmir, mangroves of Lakshadweep, Andaman and Nicobar islands and Western Ghats (Scott, 1989).

Reports of environment ministry reveals that one-third of the wetlands in India has been wiped out by anthropogenic activities. Every year we lose 2% to 3% of our wetlands (Pragatheesh & Jain, 2013). Habitat destruction is the major cause for the loss of 38% of wetlands of India in the last decade (Vijayan, 2004). Reclamation by draining and filling leading to biodiversity loss are a great threat to wetlands all over the country (Wu et al., 2018).

STATE SCENARIO

The people of Kerala used to proudly claim that their land was once blessed with over forty rivers. That may be a tall claim. But even today Kerala can boast of having major rivers like Pampa, Achenkovil, Periyar, Kallayi, Manimala, Meenachil, and Bharathapuzha. The fairly long coastal line and backwaters enrich Kerala's natural scenario. All these have gifted to Kerala wetlands of varying geological ambience. It is reported that of all the states in India Kerala has the largest area of wetlands (Nayar & Nayar, 1997). Along the south-west coast of Kerala, we can find estuarine lake extensions, which have been inviting many from far and wide and thus earned a reputation for the state (Grace, 2014). What backwater wetlands are is exemplified by those in Edava, Kadinamkulam, Kayakulam, Nadayara, Paravoor and Veli. Of the total geographic area of Kerala 20% is under wetlands due to its peculiar climatic conditions (Nair et al., 2001). It goes to the credit of Kerala that some of the wetlands have been identified by the Ministry of Environment and Forests as nationally important wetlands.

The proximity of Veli-Akkulam Lake to Thiruvananthapuram city has increased the anthropogenic interference and has resulted in the shrinkage of the lake over time in a fast pace (Sajinkumar et al., 2017). Veli-Akkulam Lake showed significant ecological degradation which was reflected in the spatial and temporal variations in its water quality and macroinvertebrate communities (Abhijna & Bijukumar, 2015). Accumulation of heavy metals like cadmium, chromium and lead within the muscle tissues of the mangrove crab, *Scylla serrata* inhabiting Ashtamudi Lake, one of our Ramsar sites has been documented by (Lekshmipriya and Sherly Williams, 2018).

Agricultural waste, industrial waste, household sewages, tourism, construction of bunds, sand mining and lime shell industry have adversely affected the quality of water in and around Vembanad Lake (Sajeev et al., 2020). Sasthamcotta Lake, which is a wetland of International importance is deteriorating due to anthropogenic activities like disposal of human waste, soil erosion caused by

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destruction of vegetation and construction activities. This lake is the source of drinking water for the inhabitants of Kollam district and is a major tourist spot (Raj & Kani, 2018)

DANGER OF DEGRADATION

Continuing drainage constructions, conversion activities, pollution and over-exploitation pose the greatest and most intimidating threats to wetlands and consequently scientists have raised a hue and cry over the fact that wetlands are among the world's most threatened ecosystems. Climatic changes, overpopulation, urbanization of coastal zones and river deltas and changing consumption patterns of humanity have accelerated the degradation and disappearance of wetlands. Rising sea-temperature has led to the decline of coral reefs.

CONCLUSION

The imperative need of the time is to preserve the wetlands. If we do not develop effective wetland management systems, we will be compelled to surrender to a doom that will come "like the thief". If these bio-diverse ecosystems are allowed to disappear, "the planet of the apes" will become a part of a fable which extra-terrestrial beings or forces may read and enjoy. If preserved the wetlands will enable humanity to meet many of the challenges of future.

There must be an international agenda for preserving these "supermarkets" of nature and "carbon sinks". Only then sustainable social and economic development can be ensured. Our dreams of economic stability and social cohesion can be translated into reality, if these "well equipped laboratories of nature" are preserved.

Wetlands will help us in our campaign against hunger by promoting sustainable agriculture. They will aid us in combating disastrous climate changes and ensuring availability of potable water. We may decide and act to preserve wetlands or perish in want and ignominy of cowardly surrender to the forces that try to overwhelm us.

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ROLE OF SOCIAL MEDIA IN POLITICS OF ASSAM

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ABSTRACT

The study investigates the role of social media in influencing the voting behaviour of people globally, with a particular focus on India and the northeastern state of Assam. Social media has emerged as a powerful tool in shaping public opinion and political behaviour. Political parties and leaders utilise these platforms to disseminate their ideologies and criticise their opposition. Consequently, the political attitudes of the electorate are evolving. In India, voters have become increasingly politically aware due to the impact of social media content. This trend has significantly grown over the past two decades, including in Assam. Recognising the reach of these platforms, political leaders in Assam have adopted social media strategies to connect with the electorate.

Keywords: Social Media, Assam, Political Behaviour, Facebook, X.

INTRODUCTION

Social media has transformed the way people communicate, interact, and exchange ideas. In today's fast-paced world, staying connected with family, friends, and colleagues on a daily basis has become a challenge. Social media platforms have bridged this gap, offering an accessible and efficient medium of communication. Beyond personal use, these platforms serve as hubs of information, discussion, and entertainment. Users can share their thoughts on diverse topics and find communities of like-minded individuals across geographical boundaries.

Social media also plays a vital role in relieving stress. Platforms like Facebook, Instagram, and YouTube cater to user interests by curating entertaining content such as memes, short videos, and news updates. These features make social media indispensable for millions of users worldwide. For businesses and content creators, these platforms offer invaluable tools to analyse consumer preferences, refine offerings, and expand their reach.

In the realm of politics, social media has emerged as a game-changer. It provides politicians and parties with a direct line of communication to voters, enabling them to bypass traditional media gatekeepers. Social media can shape public opinion on critical matters and even influence large-scale political movements. It offers unparalleled reach and immediacy, making it a powerful tool for mobilising support and disseminating information.

In Assam, a northeastern state of India, social media has become integral to political campaigns. Platforms such as Facebook and X.com (formerly Twitter) are now central to how political leaders engage with voters. Assam's diverse demographic landscape, coupled with its evolving digital literacy, presents a unique case study on the impact of social media in shaping voting behaviour.

THE GROWING INFLUENCE OF SOCIAL MEDIA IN INDIAN POLITICS

India's digital transformation over the past decade has been remarkable. According to the IAMAI Kantar ICUBE 2020 report, the country had 622 million active internet users in 2020. This number is expected to reach 900 million by 2025, representing a growth rate of 45%. The Internet and Mobile Association of India (IAMAI) reported that the number of active internet users had already reached 821 million in 2023.

In Assam, as per the NFHS 2022 report, social media penetration among men and women stood at 42.3% and 28.2%, respectively. These figures reflect a growing digital engagement across the state, mirroring national trends.

The 2014 Lok Sabha elections marked a turning point in Indian politics, with social media taking centre stage. The Bharatiya Janata Party (BJP) utilised these platforms extensively to connect with voters, communicate policies, and counter opponents. The elections also witnessed increased media coverage of BJP's campaigns, leading to allegations of bias by news channels. Reliance Jio, launched in September 2016, further democratised internet access in India. By offering affordable data plans and free voice calls, Jio enabled millions of Indians to access social media platforms for the first time.

Social media's role in shaping voter behaviour has been profound. Traditionally, voting patterns in India were influenced by factors such as religion, caste, and community ties. However, the rise of social media has introduced a new dimension to electoral politics. Today, voters are increasingly influenced by the content they consume online, which includes political campaigns, debates, and news.

Prime Minister Narendra Modi has been at the forefront of this digital revolution. An early adopter of social media, Modi has used platforms like Facebook and X.com to establish direct communication with millions of followers. His consistent engagement on these platforms has not only bolstered his image as a tech-savvy leader but also allowed him to set the narrative on key political issues. Modi's strategy includes guiding BJP workers and leaders on the effective use of social media for election campaigns.

The BJP's IT cell plays a critical role in managing the party's digital presence. It monitors social media trends, promotes the party's achievements, and counters opposition narratives. Techniques include targeted WhatsApp campaigns using voters' contact information. This level of digital organisation has given the BJP a distinct advantage over its rivals.

While the Indian National Congress has also embraced social media, its digital outreach efforts have been less impactful compared to the BJP. The Congress party has struggled to match the BJP's cohesive and consistent online strategies, which have significantly influenced voter behaviour.

THE ROLE OF SOCIAL MEDIA IN ASSAM'S ELECTORAL POLITICS

In Assam, the impact of social media on electoral politics has been transformative. The 2021 Assam Legislative Assembly elections marked a watershed moment in the state's political history. With the COVID-19 pandemic imposing restrictions on public gatherings, political parties turned to social media to engage with voters.

Dr. Himanta Biswa Sarma, the current Chief Minister of Assam, emerged as a prominent figure on social media during this period. As the Health Minister at the time, Sarma used platforms like Facebook and X.com to share updates on Assam's COVID-19 response. His proactive approach, which included setting up temporary hospitals and ensuring the availability of medical supplies,

earned him widespread praise. Sarma's frequent posts highlighting his initiatives not only enhanced his popularity but also established him as a trusted leader among the Assamese electorate.

Sarma's use of social media extended beyond crisis management. His focus on women empowerment schemes resonated with Assamese women, who form a significant voting bloc. He even promised to waive off all the micro-finance loans taken by the women of the State. He also launched "Orunodoi" or Aruni scheme for the women of Assam. It is new scheme, launched on 2nd October, 2020. Under this, monetary assistance are provided for more than 24 lac poor household of the State. Beneficiaries do receive Rs. 1000 per month under this scheme. Particularly Women who are the head and primary caretakers of a family are considered as beneficiaries. By sharing updates on the beneficiaries of these scheme s, Sarma successfully built a narrative around his commitment to social welfare.

Other BJP leaders in Assam also leveraged social media to showcase their campaigns. Posts featuring rallies, slogans, and public meetings were widely circulated. Hashtags like "#AkouEbarBJPSarkar" and campaign songs like "Akon Bar Modi Sarkar," performed by Assamese singer Simanta Sekhar, were instrumental in galvanising support for the BJP.

The Indian National Congress also recognised the importance of social media during campaign period of Assam Legislative Assembly Election, 2021. Congress have done a tough online fight son social media by highlighting wrong decisions made by the BJP. The party actively used platforms to criticise the BJP government on issues such as incompletion of NRC, high price of gas cylinders and other essential essential commodities, the Citizenship Amendment Act (CAA), floods, and unemployment. They used hashtags such as #EtiaAxomeKobo etc. By employing trending hashtags and sharing videos of protests, Congress sought to challenge the BJP's narrative.

Social media also played a role in amplifying public sentiment during the anti-CAA protests in Assam. The protests, which saw widespread participation, were heavily discussed on platforms like Facebook and X.com. Social media became a space for activists, students, and political leaders to voice their opinions and mobilise support.

SOCIAL MEDIA'S BROADER IMPACT ON VOTING BEHAVIOUR

The influence of social media on voter behaviour extends beyond campaign strategies. Platforms like Facebook, X.com, and Instagram have become key sources of political information for many users. Unlike traditional media, social media allows users to interact with content, participate in discussions, and share their opinions. By noticing the strong impacts of social media platforms, the political leaders and parties of India are now focusing on social media campaign, online advertising and achievements of them.

This interactive nature of social media has democratised political discourse. Voters are no longer passive recipients of information; they actively engage with content and shape the political narrative. However, this democratisation comes with challenges. The spread of misinformation and fake news on social media has become a growing concern. In many cases, false narratives have been used to influence public opinion and sway election outcomes.

Social media also plays a crucial role in shaping political perceptions among young voters. Millennials and Gen Z, who form a significant portion of the electorate, are particularly active on these platforms. Political parties have recognised this trend and tailored their campaigns to appeal to younger audiences. Meme campaigns, influencer endorsements, and interactive content are some of the strategies employed to engage this demographic.

In Assam, social media's impact on voting behaviour has been evident in recent elections. The shift from traditional voting patterns to issue-based voting reflects the growing influence of digital platforms. As more Assamese voters gain access to social media, its role in shaping electoral outcomes is likely to increase.

CONCLUSION

Social media has fundamentally altered the political landscape in India and Assam. Its ability to influence public opinion, mobilise support, and shape voter behaviour makes it an indispensable tool for political parties. The 2021 Assam Legislative Assembly elections demonstrated the transformative potential of social media, particularly during times of crisis like the COVID-19 pandemic.

While the BJP has emerged as a leader in leveraging social media for political gains, other parties like the Indian National Congress are gradually catching up. The growing digital penetration in Assam and India as a whole underscores the importance of social media in electoral politics.

However, the increasing reliance on social media also raises concerns about misinformation, digital manipulation, and the erosion of informed decision-making. To harness the positive potential of social media, there is a need for greater digital literacy among voters and stricter regulation of online content. For Assam, social media represents a new era of political engagement. As digital platforms continue to evolve, their role in shaping voting behaviour will become even more pronounced. By fostering greater transparency and accountability, social media can contribute to a more informed and empowered electorate, paving the way for a stronger democratic process.

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TRADITIONAL HEALING AMONG THE DAGARA OF NORTH WESTERN CORNER OF GHANA

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ABSTRACT

The concept of healing has traditionally been perceived through a Western lens. This study offers an understanding of traditional healing practices in the North Western region of Ghana. This study examines the responsibilities of esteemed traditional healers, renowned for their unique proficiency in detecting and treating many maladies, with an emphasis on traditional healing techniques among the Dagara of northwestern Ghana. The research investigates the importance of traditional healers within the community and their contribution to holistic well-being. The researchers employed a descriptive analytical sample survey as their study design. This design was utilized as it is the most suitable for a phenomenological research methodology. The researchers conducted a descriptive study by observing the field directly and inquiring with traditional believers about their sacrifice rites and the impact of these rites on their moral life. The employed sample strategy was purposive sampling. The tools employed for data collection comprised participant observation and structured interview schedules. The researchers engaged with individuals monitoring their daily routines as it pertained to the issue under examination. They noted, for example, how patients or customers sought treatment and subsequently made follow-up visits to their homes to assess their response to the treatment. The study determined that African Traditional Medicine is comprehensive, extending beyond the physical body to encompass the spiritual realm. This contrasts with Western biomedicine, which perceives human bodily parts mechanistically as discrete components and is based on germ theory.

Keywords: Traditional, healing, Dagara.

INTRODUCTION

Research interest in African traditional health care has significantly increased globally during recent decades. Traditional medicine (TM), also referred to as ethno-medicine, folk medicine, native healing, or complementary and alternative medicine (CAM), is the most ancient and enduring health care system. It is a time-honored and culturally specific treatment approach that people have employed to manage and confront numerous ailments that jeopardize their existence and survival. The World Health Organization defines traditional medicine (TM) as "the sum total of the knowledge, skills and practices based on the theories, beliefs and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health, as well as in the prevention, diagnosis, improvement or treatment of physical and mental illnesses" (WHO report, 2001; Ngcobo et al, 2012).

Researchers' investigation into traditional medicine encompasses a wide range of interests, mostly aimed at determining how traditional medicine might be reinvigorated and assessing its efficacy, among other factors. This paper focuses on the essence of Dagara traditional healing.

RESEARCH QUESTIONS

Main question: What is the situation and future of Dagara traditional healing?

Sub-questions:

1. What is the nature of Dagara traditional healing?
2. What is the worldview within which Dagara traditional healer operates?
3. How do Dagara traditional healers get their knowledge of healing?
4. What value systems guide the operation of Dagara traditional healers?
5. What is the SWOT-W of Dagara traditional healing?
6. In what ways can Dagara traditional healing be revitalized?
7. How can Dagara traditional healing communicate and dialogue with other knowledge communities to improve itself.

Research objectives

The research would contribute to:

1. Gaining knowledge into the nature of Dagara traditional healing and understanding of the worldview within which the Dagara traditional healer operates.
2. Getting to understand the Dagara traditional healers' way of learning and way of knowing their trade to see how they can share with other knowledge communities and gaining knowledge into the value systems that guide the operation of the Dagara traditional healer.
3. Knowing the SWOT- of Dagara traditional healing.
4. The revitalization of Dagara traditional healing and improving the service delivery of traditional healing through its dialogue with other scientific communities in the medical industry.

Expectations

At the end of this research the expectation is to:

1. Gain knowledge into the nature of Dagara traditional healing;
2. Gain understanding of the worldview within which the Dagara traditional healer operates;
3. Get to understand the Dagara traditional healers' way of learning and way of knowing their trade to see how they can share with other knowledge communities;
4. Gain knowledge into the value systems that guide the operation of the Dagara traditional healer;
5. Know the SWOT-W of Dagara traditional healing;
6. Discover ways of revitalizing Dagara traditional healing.
7. To be able to improve the service delivery of Dagara traditional healing through its dialogue with other scientific communities in the healing ministry.

REVIEW OF RELEVANT LITERATURE

This study focuses on two essential questions: the definition of the phrase 'traditional healer' as utilized below, and the concept of 'knowledge' under 'African Traditional Knowledge.' In this paper, the term traditional healer refers to an individual who provides services for health maintenance, as well as the prevention, diagnosis, and enhancement of physical and mental ailments, utilizing knowledge, skills, and practices rooted in their cultural heritage. The description of a traditional healer can be categorized into four sorts. The individuals include traditional birth attendants (TBA), faith healers, spiritualists/diviners, and traditional herbalists (Aborigo et al., 2015). Illness disrupts social interactions, a reality that must be addressed and understood by each culture, both pragmatically and philosophically (Obeng, 2002; Azongo, 2014). Sickness is regarded as an autonomous biological phenomenon that compels individuals to scrutinize their social interactions (Wilkinson, 2020). Illness refers to the patient's subjective experience when seeing the doctor, whereas disease denotes the medical condition the patient possesses once returning home. Illness is the subjective reaction of the patient and those in proximity to him regarding his state of unwellness; specifically, how he and they perceive the cause and importance of this occurrence, its impact on his behavior and interpersonal relationships, and the measures he undertakes to address the situation. Helman, 1985, p. 69. The patient's subjective experience may or may not signify the existence of sickness. A patient may present to a physician with the complaint of a 'chain system' in his brain that is causing persistent headaches. Upon evaluating a patient, the physician may discover no anatomical or physiological abnormalities to explain the symptom; yet, the patient genuinely experiences illness and discomfort within themselves.
In this study, illness is defined as a deviation from optimal health in physical, spiritual, psychological, mental, and emotional dimensions. Illness is subjective to the individual experiencing it. Disease is an objectively confirmed dysfunction of biological functions or systems, distinguished by a discernible cause and a specific set of signs and symptoms (Azongo, 2014).

The definition of traditional healing varies. According to (WHO, 2019) traditional medicine/healing is *"the sum total of all knowledge and practices, whether explicable or not, used in diagnosing, preventing or eliminating a physical, mental or social disequilibrium and which rely exclusively on past experience and observation handed down from generation to generation, verbally or in writing"* and *" health practices, approaches, knowledge, and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercise, applied singular or in combination, to treat, diagnose and prevent illnesses or maintain well-being"*. Further, traditional healing encompasses treating illnesses with herbs to spiritual treatment. It is holistic in its approach and embodies the collective wisdom of indigenous knowledge handed down over many generations (Ashforth, 2005).

Traditional healing is not a homogenous healing system, but varies from culture to culture and from region to region. It seems to be more established in some countries and regions when compared to others (Sofowora, 1996). In this regard, it is apparent that traditional healing is well organized and established in countries such as China compared to countries such as Ghana. Next is to look at what constitutes traditional knowledge.

INDIGENOUS KNOWLEDGE

African traditional medicine is grounded in indigenous knowledge systems. A detailed understanding of the epistemology of indigenous knowledge (IK) and its numerous applications is necessary to fully comprehend traditional medicine. I will use the terms 'traditional knowledge' and 'indigenous knowledge' interchangeably, depending on the context and intended meaning. This perspective is

grounded in my comprehension that indigenous knowledge constitutes a subset of traditional knowledge. It is essential to endeavor to identify traditional knowledge to differentiate it from other forms of knowledge (Tharakan, 2015). Traditional or indigenous knowledge can be characterized as a manner of understanding that embodies a belief system and lifestyle that is separate from contemporary industrial paradigms.

AFRICAN BELIEF SYSTEMS AND WORLDVIEW

v The historical precedents of the African continent have perpetually engendered numerous challenges in delineating the identity of an African. The political differences, diverse languages, cultures, and traditions have resulted in the partitioning of the African continent into two distinct political, social, and cultural blocs: North Africa and Sub-Saharan Africa. North Africa, predominantly Arab, has its customs and perspectives shaped by Middle Eastern Arab culture. South of Saharan Africa, predominantly inhabited by the black population until the last fifty years, was colonized and politically and culturally enslaved by a system that has left them struggling to reclaim their identity. This discussion will focus exclusively on the black population residing in sub-Saharan Africa, despite the fact that North Africans are geographically African; their culture, history, and perspectives significantly differ from those of 'black Africa' (Thabede, 2008).

African Traditional knowledge cannot be comprehensively evaluated or comprehended in isolation from the belief systems and worldviews of Africans. Traditional religion represents the essence of Africans in the Global South. A philosopher named Sire (2009) examined the definition of worldview from a broader perspective. He believes that the term worldview ought to encompass specific disciplines in every description of the concept. He suggested that the term worldview pertains to humanity's method of comprehending God, the world, and humanity's relationships with both. Specifically, a worldview should encompass a distinct perspective on each of the following ten disciplines: theology, philosophy, ethics, biology, psychology, sociology, law, politics, economics, and history. Sire's reasoning suggests that 'theology' and 'philosophy' are fundamental to one's worldview, with fields like sociology and psychology being interconnected (Sire, 2009).The worldview of African people is consequently shaped by theological or religious influences. Indigenous Knowledge (IK) in this context, contrasts with the global knowledge system produced by universities, research institutions, and commercial enterprises (Njiraine, 2015). Nonetheless, the growing focus on indigenous knowledge by academia and development agencies has not resulted in a consensus regarding the definition of the notion. The rationale is that indigenous or traditional knowledge possesses a dual nature, encompassing both a practical foundation and a spiritual dimension. The practical foundation offers crucial elucidations of environmental phenomena, such as winds and water currents, which can only arise from a cumulative collective experience, refined over centuries, by individuals possessing advanced and pragmatic knowledge of the land upon which they relied for all facets of life. The spiritual dimension is fundamental to the ethical convictions and perspectives of indigenous populations. While it may be nearly impossible to apply a scientific metric to assess the validity or truth value of the spiritual dimensions of traditional knowledge, its social existence and transmission are observable, and the impact of that spiritual dimension on the environment can be quantified (e.g., resource conservation) (see Dowdall, 1998).

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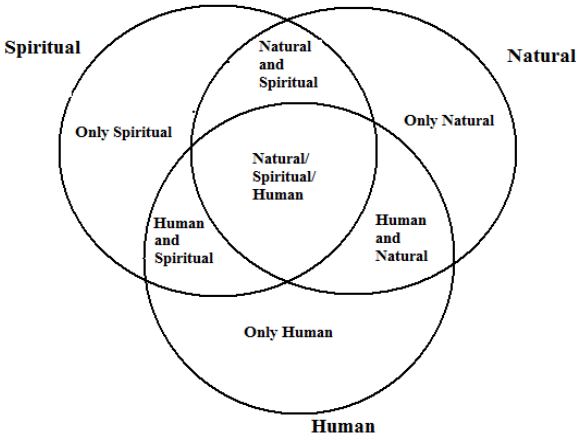
CONSTELLATIONS OF COSMOVISION RELATED TO KNOWLEDGES.



Source: (African Knowledges and Sciences: *Understanding and supporting the ways of knowing in Sub Saharan Africa.)*

The aforementioned graphic illustrates the continuous interplay of the spiritual, natural, and human realms. It is a mutual connection founded on a shared logic of comprehension, wherein the diverse 'knowledges' within the 'triad' are integrated for the efficient advancement and distribution of knowledge.Chilisa (2017) asserted that the three rings representing African worldviews elucidate the several levels of 'knowledges,' whether independently or in together. Consequently, you would possess knowledge derived solely from social (human) interactions; a synthesis of social and natural knowledge; a synthesis of social and spiritual knowledge; knowledge derived exclusively from natural interactions; a synthesis of natural and spiritual knowledge; knowledge derived solely from spiritual interactions; and finally, a synthesis of social, spiritual, and natural knowledge. Many African worldviews are based on the aspects of ancestors, the living, future generations, and nature. The Almighty God, as the supreme deity, operates through other deities who govern the earth, including the earth god, rain god, and tree god. The belief in natural, supernatural, and spiritual forces is crucial in interactions, with each significantly influencing the living.

Traditional medicine is frequently regarded as sacred, which necessitates its operation in secret. The practice of traditional medicine is characterized by confidentiality and reverence. Atran and Axelrod's (2008) research indicated that global policymakers frequently recognize their own ideals as sacred but inadequately grasp the sanctity of others. Atran and Axelrod (2008) assert that sacredness establishes the moral framework that constrains the range of permissible agreements. Generally, members of a moral community — whether a family, ethnic group, religious congregation, or nation – implicitly uphold their community's holy principles. Consequently, it is typically unnecessary to reference these values or even to be aware of them when engaging in trade-offs or negotiations within a community. Sacredness typically gains significance and prominence only when it is contested, similar to how food assumes immense importance in individuals' lives alone when it is withheld. Direct dangers to a community's sanctity become evident during conflicts between disparate moral communities. This study examines African traditional healing, utilizing the Dagara of the Upper West Region in North-Western Ghana as a case study. This study focuses on the Dagara knowledge community, emphasizing their traditional healing practices in relation to their worldview (Ontology), value system (Axiology), learning methods (Gnoseology), and epistemological approaches, with the objective of determining the future prospects of traditional healing among the Dagara. Is traditional healing in the

Dagara community facing extinction, or does it possess the possibility for growth and future prosperity? This is the significance of the selected topic. The initial inquiry pertains to the identity of the Dagara.

The Dagara inhabit the extreme northwestern region of Ghana, specifically in the Upper West Region. The region inhabited by the Dagara exemplifies the savannah landscape of West Africa, characterized by sparse trees and abundant long grasses. The population primarily consists of subsistence farmers who cultivate crops such as millet, guinea corn, maize, and rice. They cultivate livestock, including cattle, goats, and sheep. They also raise chickens and guinea fowl. The year is segmented into two different seasons: the dry season and the wet season. The wet season is designated for agriculture, whereas the dry season is allocated for hunting, construction, home repairs, and festival celebrations. The Dagara resided in village settlements, some of which have evolved into townships today. Each village, instead of functioning as a political entity, served as a ritual zone unified by the institution of the "Tengan" - the cult of the Earth-Shrine. Each settlement comprises a cluster of clan settlements. Similar to how the Tengan consolidates the diverse settlements inside a certain village, the Ancestral religion unified the members of each clan within that village. The villagers possess a leadership hierarchy that mirrors the hierarchy of spiritual entities. The Tengan-Sob, the custodian of the Earth-Shrine of the village, is accompanied by the Teng-nibere, the leaders of the numerous clans who oversee their clan ancestral shrines, and the yie-nibere, the elders of the individual families within each clan. Other significant figures in the Dagara community are the soothsayer/diviner (bagr-bugre), the priest (suo-sob), the seer or one with four eyes (mimie-anaar-sob), and the traditional healer (tii-ere). All of these, particularly the traditional healers, constitute the knowledge community of this study.The information utilized herein derives from prior research conducted by the researchers among the Dagara, particularly an interview with Thomas Nazaghl of Nandom-Koghle, a traditional believer, healer, soothsayer, and priest, who permitted me to engage in participant observation during several of his healing rituals. The researchers also connected with additional healers in the village through him. He identified as a Christian until, as to his account, he visited a farm one day and was abducted by fairies (kontombili), who held him hostage for three years. They regarded him as possessing numerous attributes, including the ability to cure. They also bestowed upon him the ability of divination. Subsequently, he adopted traditional beliefs and became a healer. Approach The research methodology employed for data collection in this study involved the revitalization and reconstruction of endo-sciences design. The research employed this method over other designs due to its alignment with the study's objective: to forge a relationship with local experts in traditional healing. This collaboration aims to uncover fundamental systems, including their worldview, learning processes, epistemology, and value systems, thereby enhancing our understanding of the nature of their healing practices and their enduring relevance. Due to the rapport developed with the healers, we were permitted to attend their healing sessions to watch firsthand and engage in personal discussions regarding their work. Upon evaluating the alternative research designs, we deem this one more appropriate.

Another reason for these informal discussions is that, in Dagara culture, a young person is not permitted to pose direct inquiries to an older, such as, "Why do you do this or that?" The inquiry may be lengthy and indicative, so, "we seek to understand the rationale behind undertaking a particular action." During the interviews, we utilized the Dagara language, which the participants comprehended.

FINDINGS

THE WORLDVIEW (ONTOLOGY) OF THE DAGARA

The Dagara see the universe as comprising of two realms; the spiritual realm and the physical realm. The spiritual realm is populated by the spiritual forces and beings and the physical realm is inhabited by the physical animals, plants and other physical objects. Human beings are part of this physical world. The world also has a horizontal dimension and a vertical dimension; the world above ***(saazu)*** and the world below ***(tengzu)***. The celestial beings such as; the sun, the moon, the stars and the sky form this ***saazu*** dimension. It is believed that the Supreme Being, ***Naamwin*** lives in the above. The horizontal dimension consists of the interaction between human beings and the other beings like the plants, animals and the other physical beings. This horizontal dimension also includes human beings' relationship with the spiritual beings and forces.

In this worldview the human person is seen as a unique being made of a physical body ***(yangan)*** and a spiritual soul ***(sie)***. He is, therefore, spiritual and physical; different from the deities who are only spirits and the animals, plants, stones and other physical objects which are only physical. The soul can leave the body temporarily and come back. This happens during sleep and this explains how we have dreams. While the body sleeps in bed, the soul travels to places performs acts and return. The Dagara believe that man has two souls; the black soul ***(sie-sebla)*** and a white soul ***(sie-pla)***. The ***sie-sebla*** is the life-source in the person. Without it the person dies. It is actually the white soul that leaves the person and returns. It is believed that because the white soul goes out and comes back it can be attacked by witches and sorcerers and when it is hurt it can bring sickness to a person. Healing is therefore directed at both the body and soul. That explains why Thomas Nazaghl states that "healing among the Dagara is a ritual of keeping the body and soul together in a harmonious union." For him healing is not just a single act but a ritual that involves both the physical and the spiritual realms.

The Dagara believe that the universe is created by a creator God; ***Naamwin***. After creating the world, ***Naamwin*** also created the spiritual beings to take care of the world and to control the life of human beings. The first among them is ***Tengan*** (the Earth Deity), followed by the Ancestors. Apart from ***Tengan*** and the ancestors, they also believe in many other spiritual beings (***tibe***). These non-human spirits are often personifications of natural phenomena. They are spirit of; the river ***(Kula)***, the Hill ***(Tang)***, the farm land ***(Wie)***, the rain ***(Saa)***, etc. These too are of great help to human beings in their search for success.

The Dagara believe that people get sick because they have offended one of the deities or because of witchcraft. To be able to cure the disease, according to the Dagara, one must know the cause of the disease and the reason why that one should get that disease. For Thomas, he finds out the cause of sickness and disease through soothsaying, after which he counsels the patient and those who have brought him\her. It is only after that he begins his healing. For him, "healing is a ritual process of saving souls through the intervention of God and the other deities. The healer is a mere servant"

THE WAY OF LEARNING (GNOSEOLOGY) OF THE DAGARA TRADITIONAL HEALER

The Dagara traditional healer rather than learning how to heal receives his knowledge through various ways; some say the knowledge was handed down to them by their ancestors and these healers should share their knowledge with the mainstream sciences for us to preserve our herbs for posterity. Other traditional healers say they were trained by the fairies in a mysterious way they cannot explain to anyone. According to Thomas the fairies (***kontombili)*** trained him in the bush for one and half years and under water for another one and half years, making three years. How this was done, he is told by the ***kontombili,*** to keep as a secret. This secretive way of learning makes it difficult for traditional

healers to share their knowledge with each other and with other knowledge-based communities outside like the mainstream sciences or orthodox medicine.

THE VALUE SYSTEM (AXIOLOGY) OF DAGARA TRADITIONAL HEALER

The value systems of the Dagara traditional healers vary from healer to healer depending on how they get the knowledge of healing. There is no general value system for all of them. Though most of them have a religious influence, they operate independent of each other. Some charge money, some animals and some do not charge at all. The common moral value according to them is that every genuine traditional healer sees his mission as given him\her for the service of the community.

STRENGTHS OF TRADITIONAL HEALING

Traditional healing is cheaper and easier to access than orthodox healing. Traditional healing addresses the ontology of the Dagara as a people. This worldview, despite the influence of foreign cultures has not changed much. This makes many people still prefer traditional healing. Even hospitals sometimes refer patients to traditional healers, a sign that they acknowledge the potency of traditional medicine. A certain Marcel Kuu-em admitted that he reported to the Nandom hospital with a condition and was asked to consider traditional medicine. The results thereof was phenomenal. This shows that traditional healing will stay around and grow to bear greater fruits.

THE WEAKNESSES OF TRADITIONAL HEALING

Traditional healing is not open to sharing its knowledge with other knowledge-based communities and hence runs the risk of extinction, out of self-isolation. This view is held by some people in the Dagara community. However, in the view the traditional healers themselves, the real weakness is in the fact that people fail to understand the setting and context of their healing process which is closely related to the spiritual realm.

REVITALISATION OF TRADITIONAL HEALING

As a consequence of its strong link with the spiritual realm and because it is often shrouded in secrecy and mystery it appears very difficult for people to know much about traditional healing so as to revitalise it. For Dagara traditional healers, revitalisation is possible if false traditional healers are removed from the system. They however, concede that they do not know how this can be done. To revitalise traditional healing, the state actors and orthodox medicine practitioners must respect must traditional healers.

CO-EVOLUTION OF TRADITIONAL HEALING

Despite the difficulties that may be involved there can be, to a certain extent some sharing between traditional healers themselves as well as traditional healing and the orthodox scientific ways of healing. The traditional healers believe that this is possible only if the orthodox healers respect and accept their traditional way of doing things.

It was for instance revealed that Dagara traditional healers provide culturally sensitive care and can often offer affordable as well as sustainable solutions and resources. This corroborates the world Health Organization's findings that, many people in developing countries use the services of the traditional healers for their needs. For example, the World Health Organization (Ekor, 2014; Shewamene et al., 2020), estimates that up to eighty percent of the population in developing and poor countries use traditional practitioners and medicines for their primary health care needs.

Additionally, the study further discovered that the services of traditional healers go far beyond the use of herbs for physical illnesses. Traditional healers were esteemed by the populace and could leverage their power in social reconstruction and community revitalization, especially in rural regions. This reaffirms a prior stance articulated by Mokgobi (2013). Traditional medicine and healing (TMH) significantly address the healthcare requirements of residents in several nations, particularly in emerging countries and among the rural impoverished (Kwame, 2016). This argument holds considerable validity in remote settlements inside the Nandom region, where conventional healthcare is inaccessible to certain residents. Individuals who utilized traditional healthcare cited the following reasons: accessibility, affordability, availability, and acceptability. Aniah, 2015, concurred with all these assertions, except to note that the contributions of these healthcare practitioners remain undocumented.

Moreover, the study demonstrated that traditional healers are highly resourceful and play a crucial role in several aspects of people's life, as they are considered 'repositories of medical knowledge' (Yeboah, 2000). In Nandom, the study revealed that traditional healers played significant roles as educators on traditional culture, cosmology, and spirituality. They function as counselors, social workers, proficient psychotherapists, and stewards of indigenous knowledge systems. This coincided with prior claims made by Mills, Cooper, and Kanfer (2005).

CONCLUSION

We have looked at the situation of traditional healing among the Dagara of north western Ghana as the knowledge community. We discussed the worldview (Ontology) of the Dagara as comprising both physical and spiritual realms. We also deliberated on the way of learning (gnoseology) of the Dagara traditional healer, which is said to be through fairies or handed down to them through their ancestors. The value system (Axiology) of Dagara Traditional Healer is seen as service to the community**.** We considered the strengths, weaknesses, revitalization and the co-evolution of Traditional Healing.

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STUDY ON THE FACTORS CAUSING LEADERSHIP CHALLENGES IN HOSPITALITY INDUSTRY

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ABSTRACT

The difficulties of hospitality industry leadership are the focus of this chapter. The causes of leadership problems in the hospitality industry have been the subject of research. It has always been tough to make it big in the hotel business, but things have gotten much worse recently. Companies in the sector have grown acutely aware of the importance of being able to adapt to frequently changing conditions, such as talent availability, rising costs, demand, and increased competition, after the unprecedented supply-and-demand fluctuations caused by the pandemic.

Keywords: Leadership challenges, Factors, Barriers, Hospitality Industry

INTRODUCTION

The hotel industry is a vast enormously huge sector where one can find gender diversity and sell their product and services. As per the Kotler and Makens 2006, hotel industry sell the inventory which are referred as rooms and found to be perishable if not sold and their revenue if lost forever. To work in these heavy shifts, one has be flexible and motivated efficient and secure satisfaction while working in the environment. Profit and gains could be achieved by providing customer satisfaction which is a important aspect for the success of the hotel industry.

Hotel industry has diverse characteristics/features including long working hours, labour intensive activities, growing competition, digitalization and adaptive travel patterns of travellers which leads to huge amount of stress for employees. It is simultaneously very capital intensive with huge amount of investment employed in it in furniture, fixtures, physical structures, equipments. This industry is also known by the term lodging and fooding industry which is difficult to manage as well. Industry operation is of 24*7 *365 days ,demand fluctuate significantly by seasons, festivals, economic factors, technological factors, social factors as well. Due to the changes in the outside environment, fluctuation in industry demands, terrorism, political unrest, fluctuating travel patterns, there is a need of re-evaluate the skills, knowledge, abilities for success in the hotel industry. Similarly this paper will explore the parameters of leadership challenges which hinder the employees in reaching the higher echelons of the career.

LITERATURE REVIEW

Female at higher management

As the hotel industry depend on its successful operation, employees to remain successful, leadership styles thought to be the most effective where employees are given large amount of control over their situations. Approximately around the 30 years the status of women in lower and medium level has changed drastically, infact female of c-suite could not be able to reach at top level (Powell,2018).Women in higher management are just able to advance in the higher echelons face a hindering glass.This is referred to as Glass ceiling which is an invisible barriers for any lower

minority or even women managers that stops female to reach at higher ranks (Smith & Nkomo, (2021).)The same stody has been presented well in fortune magazine,where female ratio has been presented as 1:5 that exhibit even 5 male managers 1 were at the corporate era. (Catalyst, 2000 ; Kulkarni & Mishra, 2022).

Glass ceiling problems

At the higher level, the concept of invisible glass ceiling represent problems with at least three reasons. First if female who is currently at lower level and sees that reaching at higher level will have to cross some invisible barrier then her motivation to reach high will be destructed. There is a belief that hard work, preservence will not pay off will make anyone feel demotivated (Vroom, 1964; Baughn, (2023). Second reason is too much similarity leads to low quality decisions-which is also means too much lack of diversity in the organization (Janis,1982; Glendon, Clarke, & McKenna, (2016).Thirdly under strict labour conditions, gender based barriers, can further reduce the supply of needed talent and resources.

Theories

Researchers have also introduced various theories related to them in relation to glass ceiling phenomena. Social contact theory have suggested that increase the proportionate size of the minority group should promote more contact with the majority members and reduce the stress and performance stress (Kanter 1977).Kanter theory develop the idea that in highly narrowed ranks ,minority members are at disadvantage that's due the number of social behaviour exhibit by majority members. This happens because majority members remain quiet and distance themselves from minority members therefore there is a huge gap between them. Kanter also argues that as sex ratios become more balanced, minority members can become allies, can form union and affect the members of the group.

FINDINGS OF THE STUDY

The study states that there are some of the major challenges identified when sees that females are trying to reach at the higher echelons.

1.Recruitment and retention of talent was not favourable by the organization. While they are recruited on the basis of skills, still due to diverse role qualified individual poses a major obstacle while reaching at the higher level. Whenever they try to reach at the higher level , the kind of expertise and leadership skills are expected from them are highly masculine.it has been seen from the literature that the female face some invisible barrier which act as a challenge while reaching at heighted ladder. Bias could be sense as preferences for female while trying to reach at higher level.

There are two types of biases one is conscious and other is unconscious bias.it has been seen from the study that unconscious bias creates more hurdle and prevent them to reach at higher positions. Research shows such biases can make it far more difficult (and slower) for women to climb to executive positions than men. Judgement from peers, subordinates create a kind of uncomfortable environment for female leaders who wish to reach at some ladder.

It has also been observed that female with unequal pay but bear same qualifications as males also a type of leadership challenges and posited some kind of low level of motivation for them. Female earn 8% whereas male earn 25% for the same executive position, even at the corporate level they are paid less in terms of their counter parts.

Females are expected to be bold and masculine in comparison to male when seek at higher position. They are expected to be "authoritative" role and generally face lower expectation for their career

advancement. As per the literature it has been observed that female bosses are taken less seriously in comparison to male bosses and found less likely for that position.

Females are considered still as minority and less favourable for.

5. **Limited Career advancement opportunities:** Speaking of opportunities and expectations, research continually indicates women are more likely to be passed up for promotions.

This is especially true between first and second-tier management positions. Once women reach a second-tier management position, many struggle to climb to higher leadership and C-suite roles. The opportunities either aren't presented or are more often going to male candidates.

Generally, women are less likely to know about promotions and are even less likely to actually land the positions. A 2021 study from Yale found women are 14% less likely to be promoted at their companies every year and are consistently judged as having "lower leadership potential" than their male counterparts.

The best way to promote career advancement for women is to ensure equal access to promotions and new leadership positions. Mentorship programs and professional development strategies are also helpful when it comes to expanding opportunities and growing professional networks.

6. **Sexual or Gender Based Harassment:** Even women in positions of power still contend with sexual and gender-based harassment. In fact, the American Academy of Arts and Sciences found that sexual harassment is more prevalent for women supervisors than for other women employees in the United States, Japan, and Sweden.

As more women advance to management and leadership positions, they also face the risk of:

- Sexual hostility
- Unwelcome physical actions
- Offensive remarks or innuendos
- Unwanted sexual attention

It's estimated that up to 85% of all female employees have experienced sexual harassment in their job at least once, and that number is likely higher for women in management and supervisor positions.

7. **Lack of sponsorship and mentors:** To get to the top of the corporate ladder, people need sponsors that can demand opportunities and support leadership development. There are many barriers between entry-level positions and C-suite opportunities, but sponsorship can help employees break through them.

Many male executives have mentors providing such support, but research from the Harvard Business Review indicates women are less likely to obtain sponsorship. Female employees are not as likely to organically meet sponsors, and they often don't know what steps to take to seek the full sponsorship they need.

What women can do is seek out strong leadership mentors and coaches. A mentor can be a powerful source of knowledge, help set critical goals, and keep female employees accountable for their own advancement.

8. **Becoming C-Suite members:** As per Fortune 500 Women in C-Level positions. However, for every company run by a woman, there are nearly 13 run by a man. The bottom line is those female leaders face many barriers to becoming full-fledged C-suite members, not just managers and supervisors.

A 2019 study by Working Mother and the National Association for Executives found that:

- When contending for C-suite positions, nearly half of the male candidates received detailed information and coaching for the spots – and only 15% of women received the same.
- Almost all of the surveyed women (77%) said a top barrier to gender equity was a lack of information on how to advance in their careers.
- Men are three times as likely to have been considered for profit-and-loss roles and twice as likely to have received a promotion within the last 24 months.

If businesses are going to encourage female leadership, they must provide women with access to C-suite level positions – as well as the necessary resources and support to obtain them.

One beneficial step any business can take is to perform a workplace culture audit. Determine how current employees (including the women) feel about their opportunities for advancement. Learn how executives feel about their positions and their ability to grow as leaders.

CONCLUSION

In conclusion, effective leadership is essential for overcoming the myriad challenges faced by hoteliers in today's dynamic hospitality landscape. By implementing strategic solutions and leveraging technology to streamline operations, hoteliers can navigate challenges effectively and ensure sustainable growth and success in the ever-evolving hospitality industry. Working hours has been seen as a bigger challenge for female manager to strike balance between personal and professional work.37.5% states that they do face lot of working hours issues at their organization due to which either they leave their work or refuse to go at higher position.

The findings states that gender inequality arise in the organization due to lack of females in senior position causing disharmony and conflict in organisation. Some females receive support of family but lack support in professional front. It creates unhealthy environment and hinder organisation growth. The act (Remuneration Act 1976) has been framed by government where equal pay should be provided to both the gender and pay should not be decide the basis of gender but skill and talent one possesses. Many of the studies claim that discrimination start at the hiring stage only for the senior position. The talent of women is going unrecognizable by the organization.

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RECENT UPDATE ON FUTURE PROSPECTIVE ON DRUG DELIVERY APPROACH FOR NEXT GENERATION

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ABSTRACT:

In the recent years, novel approaches to the administration of medications have made significant strides to overcome the drawbacks of traditional approaches. Improvements in drug delivery techniques have revolutionised medicine by increasing the therapeutic efficacy and safety of several drugs. In this study, innovative novel pharmaceutical delivery methods are examined that show promise of revolutionising medical treatment. Its goal is to analysis and deliver a broad a recap of prospective future advances in drug administration techniques for the coming generation. We discuss several methods in this area, including lipid nanoparticle-based cell-targeted delivery, tissue-targeted delivery, controlled release, bioresponsive drug delivery, alternate routes of administration, gene therapy, and RNA-based drug delivery. We also highlight the potential and challenges of each strategy, as well as any potential applications in the management of various illnesses. The goal of this study is to promote more study and development in the field by providing an overview of these cutting-edge pharmaceutical delivery techniques. By improving drug efficacy, lowering side effects, and providing customised treatment options, these cutting-edge techniques hope to revolutionise how we deliver pharmaceuticals in the next medical age.

Keyword: Lipid nanoparticles; Controlled-release; CRISPR-Cas9; Biodegradable implants,

1. INTRODUCTION:

The advancement of pharmaceutical delivery technologies has revolutionized medicine, enhancing treatment outcomes and patient compliance[1]. Significant progress has been made in innovative drug delivery systems that improve efficacy, target specific regions, and minimize side effects[2]. Emerging trends in next-generation drug delivery systems hold great promise[3]. Researchers focus on distinctive biology, developing diverse methods that go beyond traditional small and large molecules lacking precise targeting[3]. High-tech delivery systems enable targeted and regulated release within cells or tissues, maximizing benefits for patients[4]. Efforts include creating nanoparticles of varying sizes for controlled delivery[5], exploring oral biologics to overcome intestinal barriers[6], and ensuring therapeutic breakthroughs reach intended destinations[7]. These advancements aim to transform healthcare.

1.1 Drug delivery's systems significance in raising the effectiveness of therapy;

Drug delivery systems play an essential role in improving therapeutic outcomes by enabling precise delivery of medications to targeted sites, such as tumors or infected tissues[8]. This targeted approach ensures sufficient drug concentrations at the intended site, enhancing efficacy while reducing side effects on healthy tissues. Controlled release mechanisms regulate drug release rates and duration[9], maintaining steady therapeutic levels and avoiding peaks and troughs. Delivery systems also improve bioavailability by optimizing formulations, carriers, and administration routes, enhancing solubility, stability, and absorption[10]. They protect unstable drugs from degradation, maintaining efficacy and improving pharmacokinetics[11]. These systems reduce administration frequency[12], increasing patient compliance and convenience. Additionally, co-delivery methods enable combination therapies,

enhancing synergistic effects and overcoming resistance[13]. Personalized medicine benefits from adaptable drug regimens tailored to patient needs, improving precision and flexibility in treatments[14]. Thus, drug delivery systems advance medical interventions, optimizing effectiveness, minimizing side effects, and contributing to efficient, precise therapies.

1.2 Limitations of conventional drug delivery methods

Conventional drug delivery methods face limitations that can affect their efficiency and effectiveness[15]. They often lack precise targeting, leading to widespread drug distribution, affecting healthy tissues, and causing side effects[16]. Limited solubility of drugs can hinder absorption and therapeutic efficacy[17]. Rapid clearance or enzymatic metabolism can reduce drug concentration and duration of action, while conventional methods may not provide sustained release or protection[18]. Low bioavailability can result from poor absorption, first-pass metabolism, or breakdown in the stomach[19]. Non-specific distribution may necessitate higher doses, increasing adverse effects. Frequent dosing or invasive procedures can lower patient compliance and comfort[20]. Additionally, conventional methods lack real-time monitoring or personalized dosage adjustments[21], highlighting the need for advanced drug delivery systems.

1.3 Need for innovative approaches to overcome existing challenges

Innovation is critical for addressing challenges across industries, as traditional methods often fail to resolve emerging issues in a rapidly evolving world[22]. Advancements in technology offer powerful tools for developing novel solutions and improving existing systems[23]. Many challenges today are complex and interconnected, requiring multifaceted, interdisciplinary approaches that encourage creative and holistic thinking[24]. Scarcity of resources financial, natural, or humandemands innovative strategies to optimize usage, discover alternatives, and enhance efficiency. Evolving user needs necessitate solutions that are relevant, effective, and sustainable, emphasizing user-centric innovation[25]. In competitive environments, innovation drives differentiation, efficiency, and adaptability, providing a significant advantage. Global issues like climate change, healthcare access, poverty, and cybersecurity highlight the need for collaboration, creativity, and innovative approaches on a worldwide scale[26].

Comparison in conventional and controlled and future drug delivery system with examples

Aspect	**Conventional drug delivery's system**	**Controlled Drug delivery's system**	**Future Drug delivery's systems**
Release Mechanism	Immediate and uncontrolled release the medication.	controlled and long-term medication release.	Advanced, programmable release mechanisms.
Drug Concentration	Drug concentration may fluctuate over time.	Maintains a constant and therapeutic drug concentration.	Precise and targeted drug concentration control.
Dosage Frequency	Often requires frequent dosing throughout the day.	Reduces the dosage frequency (e.g., once or twice daily).	Extended dosing intervals or one-time administration.
Drug Stability	May result in drug degradation due to rapid release.	Improved drug stability as it is released in a controlled manner.	Improved drug stability and preservation.
Therapeutic Efficacy	May lead to suboptimal therapeutic effects.	Enhances therapeutic efficacy by ensuring constant drug levels.	Highly effective drug targeting to specific cells/tissues.

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Side Effects	Higher chances of side effects due to fluctuations.	Lower risk of side effects with better-controlled drug release.	Minimized off-target effects and reduced side effects.
Examples	Traditional oral tablets, immediate-release capsules.	Transdermal patches, sustained-release tablets, liposomes, etc.	Nanoparticles, implantable devices, gene delivery systems.

Table no. 1 showing the Comparison in conventional and controlled and future drug delivery system with examples

2. Future prospective on drug delivery approach for next generation:

A. Lipid nanoparticle-based therapy delivery directed towards specific cells (LNPs)

B. Tissue-targeted delivery to expand druggable targets

C. Controlled release system

D. Bioresponsive Drug Delivery Systems

E. Various delivery systems: turning oral biologics from a concept into a reality

F. RNA-based medications and gene therapy

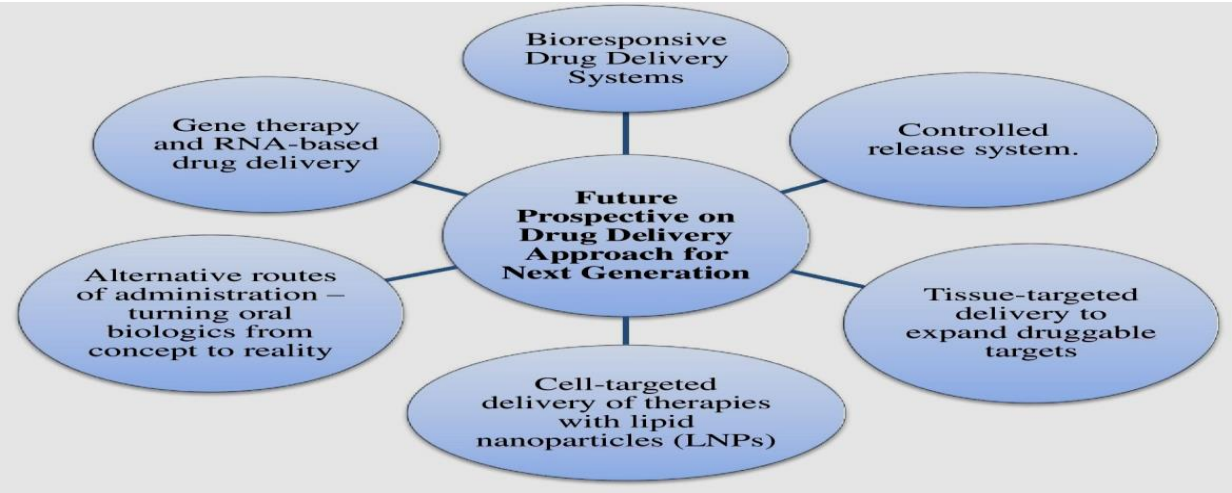

Figure no.1: Future prospective on drug delivery approach for next generation

A. LIPID NANOPARTICLE-BASED THERAPY DELIVERY DIRECTED TOWARDS SPECIFIC CELLS (LNPS)

Lipid nanoparticles (LNPs) offer a promising approach for delivering small molecule drugs, nucleic acids, or proteins in cell-targeted therapies[27].

Approaches used in Lipid nanoparticle-based therapeutics for specific cells

Lipid nanoparticles (LNPs) enable targeted delivery of small molecules, proteins, peptides, and nucleic acids (DNA, RNA), enhancing treatment effectiveness and reducing off-target effects in specific cells or tissues[28] shown in figure 2.

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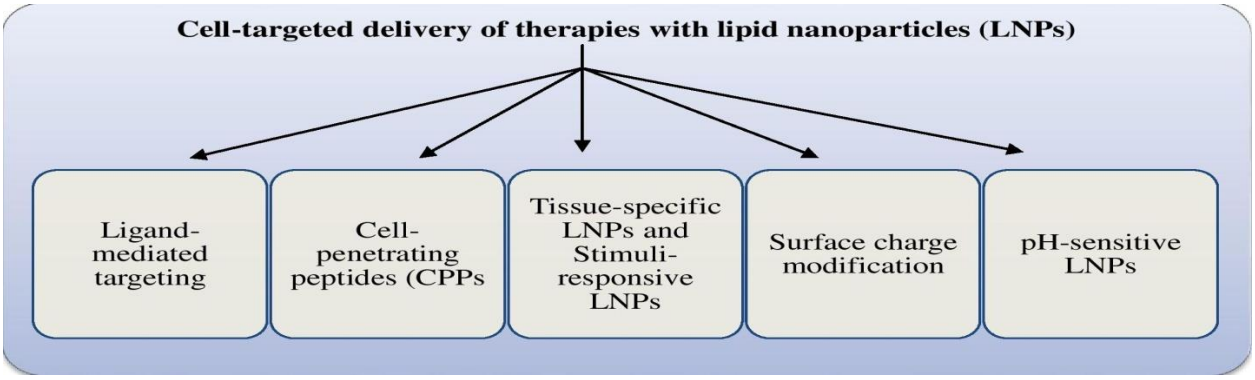

Figure no.2:Lipid nanoparticle-based therapeutics delivered to specific cells (LNPs)

Lipid nanoparticles (LNPs) enable targeted therapy by incorporating ligands, pH sensitivity, CPPs, surface charge, tissue-specific ligands, or stimulus-responsive components. Functionalizable with peptides, antibodies, or aptamers, LNPs facilitate receptor-specific targeting[29]. pH-sensitive LNPs selectively release cargo in acidic compartments, enhancing efficacy[30]. CPPs improve cellular uptake via endocytosis or membrane penetration[31]. Surface charge modifications aid interaction with specific cell types, such as cationic LNPs targeting negatively charged cancer cells[32]. Tissue-specific ligands ensure precise delivery to organs like the liver or tumors[33]. Stimuli-responsive LNPs release drugs upon exposure to temperature, light, or enzymes[34]. Despite challenges like immune responses and optimized release kinetics, advancements in nanotechnology promise enhanced therapeutic delivery[35].

B. TISSUE-TARGETED DELIVERY TO EXPAND DRUGGABLE TARGETS

Tissue-targeted delivery enhances therapeutic specificity by directing drugs to specific tissues, increasing their concentration at the target site and minimizing side effects in other areas[36]. This strategy expands the range of druggable targets, enabling treatment of tissues once considered difficult to target. Various methods, such as nanoparticle-based delivery, can be employed. These nanoparticles can be engineered with specific surface modifications to attach to receptors on target cells, facilitating precise drug delivery[37]as shown in figure no. 3.

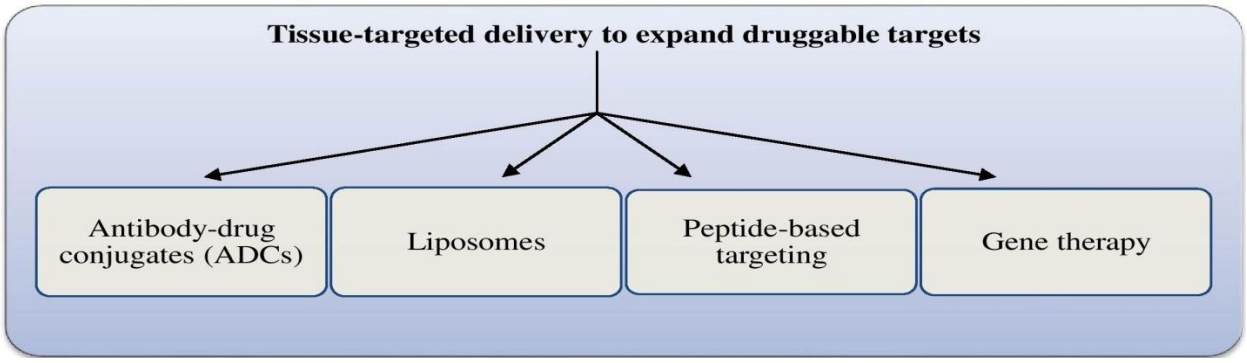

Figure no.3:Tissue-targeted delivery to expand druggable targets

ADCs combine the specificity of monoclonal antibodies with the cytotoxicity of drugs, allowing targeted delivery to cells expressing specific antigens[38]. Liposomes are lipid-based vesicles that encapsulate drugs, and surface modifications enable them to interact with target cells, enhancing selectivity[39]. Peptides can be designed to bind to specific receptors or cell types, facilitating targeted

drug delivery[40]. Gene therapy delivers therapeutic genes, such as RNA or DNA encoding proteins, to target cells to produce therapeutic proteins[41]. Tissue-targeted delivery methods overcome barriers like the blood-brain barrier, expanding druggable targets and enabling treatment of previously inaccessible tissues[42]. However, these strategies remain under development, requiring further studies to optimize safety and effectiveness[43].

C. CONTROLLED RELEASE SYSTEM

Controlled-release formulations are designed to release medication gradually over time, improving patient adherence, reducing dosage frequency, and enhancing therapeutic outcomes, thus making treatments more convenient and effective for patients[44]as shown in figure no. 4.

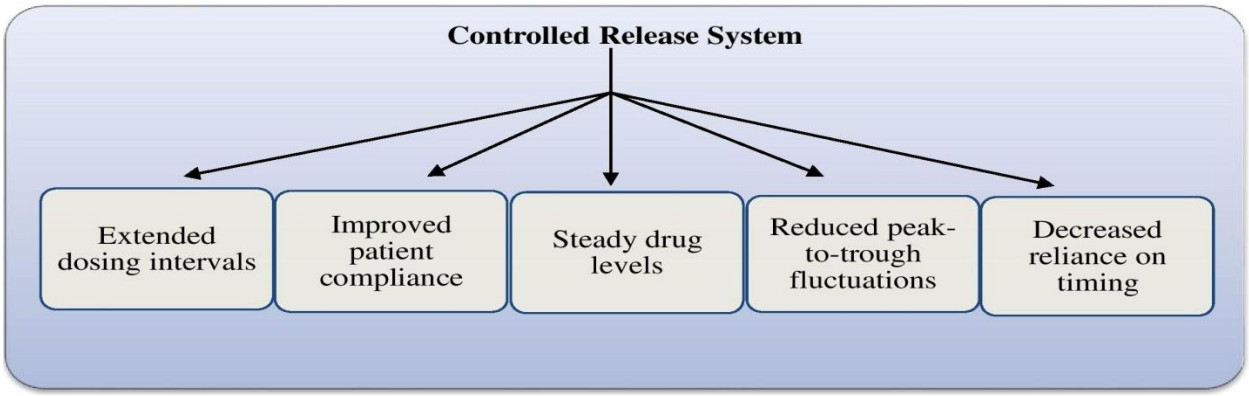

Figure no. 4: Controlled Release System

Controlled-release formulations enable less frequent dosing compared to immediate-release options. For instance, a medication that requires three doses daily in its immediate-release form may only need one dose with a controlled-release formulation, improving convenience and reducing the risk of missed doses[45, 46]. These formulations maintain consistent drug levels in the body, avoiding fluctuations that could lead to side effects and enhancing treatment efficacy[47]. They provide flexibility in dosing, eliminating the need for precise timing, which is especially beneficial for medications requiring consistent blood levels[48]. By reducing the number of doses, controlled-release formulations improve patient adherence, leading to better outcomes[49]. Successful development requires collaboration and careful consideration of drug properties and patient needs[50].

MISCELLANEOUS CONTROLLED RELEASE APPROACH:

- **Polymeric particles and implants**

Medications can be released in a controlled manner through biodegradable particles made from polymers like polycaprolactone and PLGA, which gradually break down. Larger subcutaneous biodegradable implants, with diameters up to 1 mm, also release medication over time, reducing the need for frequent administration. Preclinical studies show enhanced anti-tumor efficacy, reduced side effects, and the potential for switching from weekly to monthly treatments with PLGA nanoparticles[51].

Silica particles

An intriguing option for controlled release involves silica particles, which are biocompatible as silicon occurs naturally in the body. By using water-based silica particle production, biologics can be delivered more effectively, with controlled release observed for up to two months in preclinical studies[52].

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Metal oxides using atomic layer deposition (ALD)

Once nanoshells are formed on the particle surface, Atomic Layer Deposition (ALD) is used to apply metal oxide layers in a dry process, facilitating sustained release. Preclinical studies have confirmed ALD's effectiveness in regulating the release of medication[53.]

D. BIORESPONSIVE DRUG DELIVERY SYSTEMS:

Bioresponsive drug delivery devices represent a promising avenue in medical research, enabling targeted and controlled medication delivery to specific body sites. These systems offer significant advantages over traditional methods, paving the way for personalized and effective treatments[54]. Sensing and smart materials play a critical role in controlled drug release, facilitating precise delivery to targeted areas, enhancing therapeutic efficacy, and reducing side effects. Such systems hold immense potential to improve patient outcomes and quality of life in future medical applications[55]as show in figure no. 5.

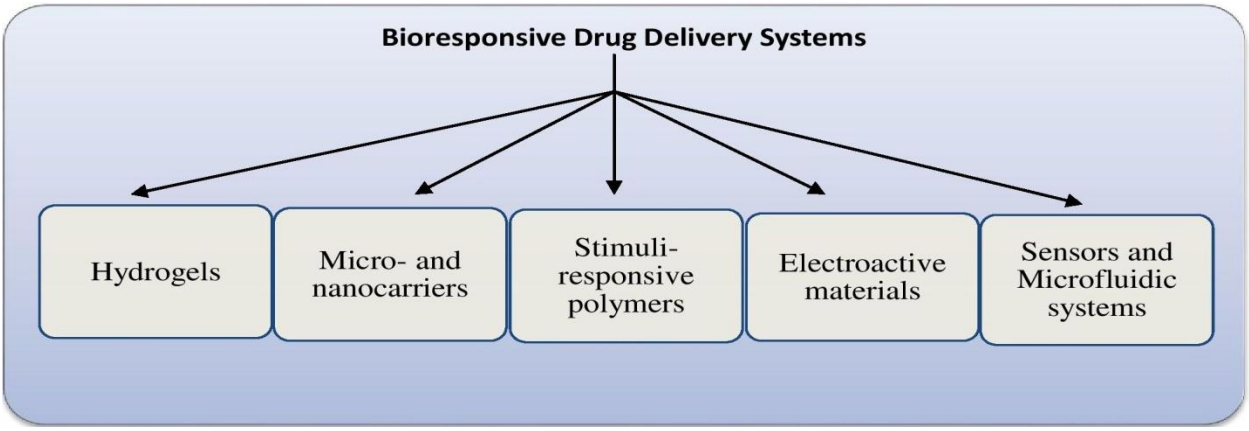

Figure no.5: Bioresponsive Drug Delivery Systems

Hydrogels, composed of hydrophilic, three-dimensional crosslinked polymers, can absorb large amounts of water and encapsulate drugs, releasing them in response to external stimuli like temperature, pH, light, or electric fields. For instance, temperature-sensitive hydrogels release drugs at specific temperatures[56]. Micro- and nanocarriers, functionalized with stimuli-responsive materials, enable controlled drug release, such as pH-sensitive nanocarriers responding to acidity changes[57]. Polymers alter their properties with external cues, aiding in targeted release, like pH-responsive polymers in inflamed tissues[58]. Electroactive materials release drugs with electrical signals[59]. Sensors trigger drug delivery by monitoring parameters like pH or biomarkers[60], while microfluidic devices ensure precise drug distribution and on-demand release[61].

E. ALTERNATIVE ROUTES OF ADMINISTRATION: TURNING ORAL BIOLOGICS FROM A CONCEPT INTO A REALITY

Since the 1920s, when insulin became available, creating oral biologic formulations has been a key goal for pharmaceutical chemists. Today, advancements in drug delivery and design technologies are making oral biologics a practical reality[62]as show in figure no. 6.

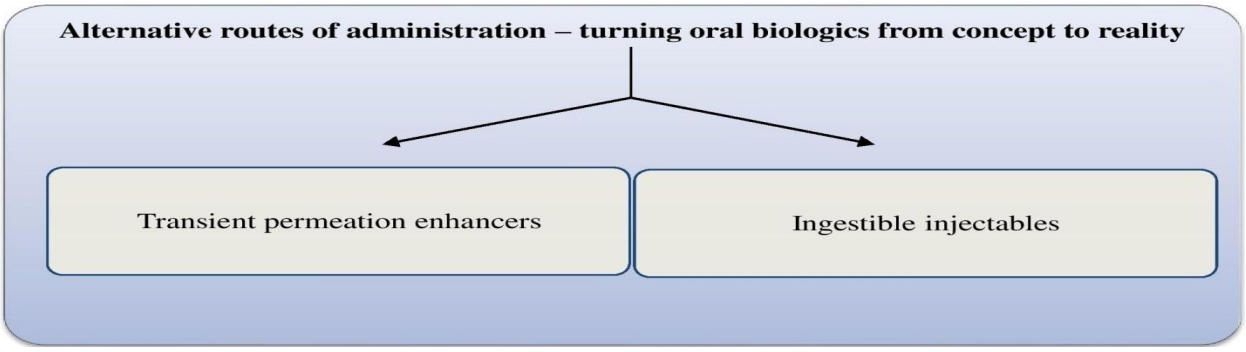

Figure no. 6: **Various delivery systems: turning oral biologics from a concept into a reality**

- **Transient permeation enhancers**

Transient permeation enhancers (TPEs) can be combined with pharmacological agents like peptides or antisense oligonucleotides in tablet form to overcome GI tract barriers[63]. TPEs temporarily loosen intestinal epithelial membranes and open tight junctions, enabling macromolecule transport. Co-formulation with TPEs enhances macromolecule stability, extends half-life, and optimizes them for oral delivery[64].

Ingestible injectables

Ingestible injectablesare a novel approach enabling oral biologic delivery by utilizing the intestine's lack of pain receptors[65]. A tablet activates upon ingestion, injecting the biologic into the gastrointestinal mucosa via liquid jets or microneedles, offering bioavailability comparable to subcutaneous injections without pain[66].

F. RNA-BASED MEDICATIONS AND GENE THERAPY

RNA-based medications and gene therapy are promising areas of medical research[67]. CRISPR-Cas9 has revolutionized gene editing, enabling precise modifications to genetic material. Gene therapy involves adding or altering genes in patient cells to treat or prevent diseases, with CRISPR-Cas9 used to correct mutations like those causing sickle cell anemia or cystic fibrosis[68]. Therapeutic genes or RNA are delivered using viral vectors like adeno-associated viruses or synthetic non-viral systems[69]. Exosomes, small vesicles secreted by cells, are also used to transport therapeutic materials to target cells, offering potential for cancer treatment[70]. Despite challenges like delivery effectiveness, immune responses, and off-target effects, ongoing advancements bring targeted therapies closer[71,72].

3. CHALLENGES AND OPPORTUNITIES:

The distribution of drugs has seen remarkable progress, with next-generation drug delivery approaches presenting safety, biocompatibility, regulatory, and commercialization challenges, alongside opportunities for future advancements and significant impact[73].

3.1 Challenges for next generation:

Delivering drugs to target cells or tissues while minimizing off-target effects remains a major challenge in drug delivery[74]. The complexity of diseases and patient heterogeneity complicates universal targeting strategies. Many drugs face stability issues under physiological conditions, requiring delivery methods that protect them until reaching the target site[75]. Ensuring biocompatibility and safety is critical, with immune responses, toxicity, and long-term effects requiring thorough

evaluation to reduce adverse reactions[76]. Regulatory compliance for next-generation delivery systems involves demonstrating safety, efficacy, and quality, which can be time-consuming and expensive[77].

3.2 Opportunities for next generation:

Advanced drug delivery approaches enable personalized medicine by tailoring treatment based on a patient's genetic profile, disease characteristics, and other factors, improving outcomes and reducing side effects[78]. They facilitate combination therapies by delivering multiple drugs simultaneously, overcoming resistance, enhancing efficacy, and reducing new resistance mechanisms[79]. These systems offer precise control over drug release, allowing prolonged and regulated medication delivery, improving compliance, dosing frequency, and therapeutic outcomes[80]. Non-invasive methods like transdermal patches, inhalation devices, and oral systems enhance patient acceptance and drug bioavailability[81]. Nanotechnology, using nanoparticles, liposomes, and micelles, improves drug solubility, stability, and targeting for effective therapies[82]. Integration with digital health enables monitoring, optimizing regimens, and enhancing adherence[83].

4. CONCLUSION:

The next generation of drug delivery approaches promises to revolutionize healthcare by improving efficacy, safety, and patient convenience. Targeted systems using nanoparticles, liposomes, and antibodies deliver drugs directly to diseased cells, enhancing therapeutic outcomes while minimizing side effects. Nanotechnology plays a critical role by enabling drug encapsulation, controlled release, and selective targeting through functionalized nanoparticles. Implantable devices and smart systems offer personalized medicine with real-time monitoring and adjustable release based on physiological cues. The integration of digital health technologies, such as sensors and wearables, enables continuous patient monitoring, optimizing treatment regimens. These innovations pave the way for individualized, precise, and transformative therapies.

CONFLICT OF INTEREST

The authors declare no conflict of interest

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COMPARATIVE EVALUATION OF FOLDSCOPE AND COMPOUND MICROSCOPE FOR ANALYZING MICROSCOPIC CHARACTERISTICS OF CHILI, TURMERIC, AND BLACK PEPPER POWDERS

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ABSTRACT

Microscopic characteristics are essential for identifying and analyzing substances to detect adulteration. Adulteration has become increasingly common and can be examined using a Foldscope. The Foldscope, also known as an origami-based paper microscope, is assembled from simple components like a sheet of paper and a lens, providing magnification up to 2000x with a resolution of 2 microns. This study presents a comparative analysis of the microscopic characteristics of non-adulterated varieties of chili powder, black pepper, and turmeric powder. The observed microscopic features of chili powder include chili flesh, cilium, scalariform vessels, and foliage; black pepper exhibits lignified endocarp cells, hypodermal cells, parenchyma, stone cells, and mesocarp cells; turmeric shows oleoresins with starch grains, annular vessels, and parenchymatous cells. The study concludes that the Foldscope can produce imaging results comparable to those of a compound microscope, making it a practical tool for households to detect adulterated powders.

Keywords: Foldscope, Adulteration, Chili powder, Black pepper, Turmeric, Glycerin water, Phloroglucinol-HCl.

INTRODUCTION

Foldscope is a pioneering, low-cost science tool that provides a comprehensive understanding of an optical microscope made from simple components, including a paper sheet and a lens. Microscopes are essential tools in science, providing a visual bridge between the familiar macro-world and the hidden micro-world [1]. A foldscope is an optical microscope that is assembled from a punched sheet of water-resistant cardboard, a spherical glass lens, and magnetic couplers. When fully assembled, it measures approximately 70 mm x 20 mm x 2 mm and weighs about 8 grams. The foldscope comes in a kit that includes slides, an LED light, a petri dish, tweezers, and other scientific tools, with a variable magnification range from 140x to 2,000x. Magnets can be attached to the foldscope to connect it to a smartphone, allowing users to capture images or videos at different magnifications [2].

Foldscopes are suitable for use in classrooms or labs, where they can help students study different microscopic structures. The simplicity and affordability of the foldscope make it ideal for fostering a self-discovery and learning environment, even among school students. This inexpensive paper microscope is useful for studying various life forms in the environment and exploring the hidden details of the microscopic world [3,4,5]. Foldscope Instruments Inc. won a Golden Goose Award for

developing a cost-effective, high-performance microscope to diagnose diseases and expand education in remote areas [6].

Despite its potential, there is a need to evaluate its effectiveness compared to conventional compound microscopes in analyzing food-grade powders. This study evaluates the efficacy of the Foldscope by comparing its performance with that of a compound microscope in analyzing three commonly used food-grade powders: chili powder, black pepper, and turmeric. These powders were selected for their diverse microscopic features such as chili flesh and cilium in chili powder, lignified endocarp cells and stone cells in black pepper, and oleoresins and annular vessels in turmeric, making them ideal for assessing the Foldscope's ability to capture detailed structures. The study aims to demonstrate the practical applications of the Foldscope in detecting adulteration and provide insights for both educational and diagnostic purposes

MATERIALS AND METHODS

Pure food-grade powders of chili, turmeric, and black pepper were collected from a supermarket. All chemicals used were of analytical grade and sourced from Chalapathi Institute of Pharmaceutical Sciences, Lam, Guntur, Andhra Pradesh, India.

MICROSCOPY OF POWDER CHARACTERISTICS

The microscopic characteristics of the powders were identified using Phloroglucinol-HCl (Wiesner) staining [7]. A 3% Phloroglucinol solution was prepared by dissolving 0.3 g of phloroglucinol in 10 mL of absolute ethanol. One volume of concentrated HCl was added to two volumes of the 3% phloroglucinol in ethanol to create the staining solution. A small amount of each sample powder was placed on a glass slide and stained with a drop of the phloroglucinol-HCl solution, applied with a glass rod. A drop of glycerin water was then added, and the sample was covered with a coverslip for examination under a compound microscope [8]. To examine the sample using a Foldscope, transparent tape was used to seal the sides of the coverslip, and the sample was observed under magnification [9]. Photographs of the powder characteristics were taken using an Android phone [10]. Some powder characteristics were observable only after adding glycerin water [11,12].

RESULTS AND DISCUSSION

The microscopic characteristics of chili powder, black pepper, and turmeric powder were examined using both a compound microscope and a Foldscope. For chili powder, the Foldscope and compound microscope provided clear images of chili foliage, flesh, cilium, and scalariform vessels (Figures 1a, 1b, 2a, 2b, 3a, 3b, and 4a, 4b). In black pepper, the Foldscope effectively captured mesocarp cells, stone cells, hypodermal cells, and endocarp cells (Figures 5a, 5b, 6a, 6b, 7a, 7b, and 8a, 8b). For turmeric powder, both microscopes offered detailed views of annular vessels and parenchyma cells (Figures 9a, 9b, 10a, and 10b).

DISCUSSION

The comparison of the Foldscope with a compound microscope in analyzing the microscopic characteristics of chili powder, black pepper, and turmeric powder reveals that the Foldscope can serve as a practical and effective alternative for detailed microscopic analysis. The findings align with recent literature, which highlights the Foldscope's potential for providing high-quality imaging at a fraction of the cost of traditional microscopes.

In our study, the Foldscope successfully captured the complex structures of chili powder, including chili foliage, flesh, cilium, and scalariform vessels (Figures 1a, 1b, 2a, 2b, 3a, 3b, and 4a, 4b). This is

consistent with previous research by Waas et al. (2014), which demonstrated that the Foldscope could resolve intricate biological features, making it suitable for various educational and diagnostic applications [13]. The ability of the Foldscope to visualize these features effectively supports its use in detecting adulteration, as emphasized by Pacheco et al. (2021), who noted its effectiveness in identifying contaminants in food products [14].

Similarly, the Foldscope provided detailed images of mesocarp cells, stone cells, hypodermal cells, and endocarp cells in black pepper (Figures 5a, 5b, 6a, 6b, 7a, 7b, and 8a, 8b). This aligns with findings from Li et al. (2017), who observed that the Foldscope could capture fine structural details comparable to those of a compound microscope [15]. In the case of turmeric powder, the Foldscope effectively visualized annular vessels and parenchyma cells (Figures 9a, 9b, 10a, and 10b), which supports the results from earlier studies by Molyneux et al. (2016), who demonstrated the Foldscope's capability to reveal detailed cellular structures in various samples [16].

CONCLUSION

Overall, the Foldscope's performance in this study is consistent with the growing body of literature that highlights its efficacy as a low-cost, high-resolution tool for microscopic analysis. Its ability to provide comparable imaging quality to that of a compound microscope makes it a valuable tool for food safety assessments and educational purposes, especially in settings where access to traditional microscopy equipment is limited. The results affirm the Foldscope's role in advancing accessibility to microscopic analysis and promoting food safety.

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Data sharing

Data on foldscope and testing procedure videos are available.

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INTERDISCIPLINARY LEARNING: A TRANSFORMATIVE WAY AHEAD

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ABSTRACT

Interdisciplinary education creates a more integrated and holistic learning experience for students by bridging the traditional academic disciplines. This education helps in blending knowledge and methodologies from diverse fields and foster critical thinking, problem solving, creativity and collaboration amongst learners. This education is not only crucial for preparing the students for the challenges of a rapidly changing world but also helps in cultivation a deeper understanding of how knowledge and disciplines intersect. This chapter explores the concept of interdisciplinary education, its history, growing importance, role in empowering students for the VUCA world (Volatile, Uncertain, Complex and Ambiguous), benefits, challenges, alignment with SDGs and the way forward.

Keywords: Interdisciplinary, empowerment, innovation, critical thinking, collaboration, global perspective

INTRODUCTION

In today's world characterized by complexity, global interconnectivity, and rapid change interdisciplinary learning has become an increasingly critical approach to education. Interdisciplinary education now has been recognized as an essential approach in preparing students for the complexities and challenges of the 21st century. It integrates diverse perspectives, knowledge as well as methods from different disciplines. It involves the amalgamation of varied concepts, theories, practices and methods from various academic fields. This helps in addressing topics, problems, issues and questions that do not fit neatly just within one discipline.

This chapter explores the importance of interdisciplinary learning in empowering students to navigate complex challenges. It examines the role of interdisciplinary learning in achieving educational outcomes and its role in developing deeper understanding along with some crucial skills such as critical thinking, problem-solving skills, team building, collaboration, networking and better preparedness for real-world challenges.

INTERDISCIPLINARY LEARNING: AN OVERVIEW

According to Klein (2014), interdisciplinary learning involves a synthesis of different disciplines and offers new ways of thinking and problem-solving. According to Repko (2012), it encourages students to transcend the boundaries of traditional academic disciplines and engage in learning that mirrors real-world challenges. It goes beyond teaching students about different subjects and focuses on the interrelation and connection between different disciplines, creating a new way of thinking, learning and resolving issues. Beers in 2011 posited that it integrates knowledge and methodologies from multiple disciplines to solve complex problems. It explores topics that need an integrated perspective from different disciplines to be fully understood allowing them to gain a more comprehensive understanding of complex issues.

Interdisciplinary education has evolved over centuries and involves integrating knowledge and methods from different disciplines to solve complex problems. The history of interdisciplinary education can be traced back to the early philosophical thoughts and foundations of universities and higher education institutions. However, the formal recognition and systematic practice of this education is relatively recent and witnessed a clear emergence in the 20th century.

HISTORY OF INTERDISCIPLINARY EDUCATION

The idea of integrating knowledge across disciplines has been evident since the classical education system. Plato and Aristotle, the ancient Greece Philosophers, in their works emphasized on the interconnectedness of various domains of knowledge related to ethics, politics, and natural philosophy (Lattuca, 2001). However, this field remained lesser known till a long time. Even during the age of Renaissance and Enlightenment and 19th and early 20th century more emphasis was laid on disciplinary specializations only. Till this time too more focus was laid on specialized study in specific fields (Newell, 2001) further leading to rise in disciplinary silos, making knowledge more compartmentalized, field specific knowledge was considered more pertinent whereas interdisciplinary work as considered to be less valuable and rigorous in nature.

The mid-20th century, driven by increasing global challenges, could not address the issues merely with the knowledge of specific fields or disciplines and that's the time that witnessed the emergence of interdisciplinary education. The *Boulder Report* (1948) on the thriving economy of that age highlighted the fact the higher education studies need inculcate a more flexible approach to education and promote interdisciplinary studies as that was the way ahead towards addressing real-world problems and cultivating a more holistic educational experience (Newell, 2001). The 1960s and 1970s noticed the formalization of interdisciplinary programs at different universities with the University of California, Berkley in 1965 taking the lead by starting *Interdisciplinary PhD Program in Humanities* (Repko, 2008).

The interconnectedness of issues and technological innovations in the late 21st century saw interdisciplinary education gaining further traction. This period prompted further integration of interdisciplinary frameworks into curriculums at all levels, especially at the higher education level. Several academicians like Abraham Flexner (1910), Jean Piaget (1936), Haward Gardner (1983), David A. Kolb (1984), Julie Thompson Klein (1990), Ernest L. Boyer (1990), William H. Newell (1998), Gerald Graff (2006) played an instrumental role in shaping the theoretical foundations of interdisciplinary education. They emphasized on the integration of knowledge across disciplines to foster deeper understanding and creativity. Their works shaped the theory and practice of integrating knowledge from different disciplines to address complex problems.

INTERDISCIPLINARY LEARNING: EMPOWERING STUDENTS FOR A COMPLEX WORLD

As a response to the limitations of traditional discipline specific education, interdisciplinary education emerged as a key enabler in addressing the complex real-world problems. Klein (1990) emphasized that interdisciplinary education aimed to address problems from a comprehensive perspective, synthesizing concepts, methodologies, and insights from various fields of study to gain a deeper understanding of complex issues hence empowering the students to resolve complex and multi-dimensional issues. Newell's (2001) conceptualization of this area highlighted that interdisciplinary education enhances both the depth and breadth of knowledge. It draws insights from various disciplines by combining methods, theories and perspectives from different disciplines that help in

solving problems that will be relatively difficult to be solved by knowledge of single discipline alone. Repko (2008) in his study elaborated on the integrative aspect of interdisciplinary education, suggesting interdisciplinary education as a collaborative process of research and learning that involves the integration of knowledge, methodologies, and theories from diverse disciplines to create new insights or solutions. Lattuca (2001) stated that interdisciplinary education prepares students for the complexities of modern life by helping them develop skills to think across disciplines and apply multiple perspectives. Lattuca's research emphasized that interdisciplinary education equips students with the flexibility needed to adapt to the evolving demands of the job market, where problems increasingly require expertise from various fields. Gardner (2006) stressed upon the role of interdisciplinary education in developing creativity and critical thinking. He argued that interdisciplinary approaches enable students to think outside traditional academic boundaries, leading to innovative solutions and students are encouraged to engage in creative synthesis, making interdisciplinary education a key strategy for addressing global challenges such as climate change, public health crises, and technological innovation.

Scholars apart from listing the benefits of interdisciplinary education have pointed out that the on challenges faced in defining and implementing this education need to be addressed properly. For example lack of consensus on what constitutes true interdisciplinary work is debatable and people lack clarity on it. Jacobs (1989) and Repko (2008) argued that interdisciplinary education should not simply involve drawing on knowledge from different disciplines. It should ideally focus on creating new frameworks that transcend disciplinary distinctions. Beers (2011) argued that as interdisciplinary approaches help students gain a holistic understanding of problems, enabling them to consider multiple perspectives is crucial. The ability to think across disciplines helps students adapt to rapidly changing environments, making them more flexible and capable of approaching problems in innovative ways. Newell (2010) stated that by working with different knowledge areas, students are encouraged to question assumptions, make connections between seemingly unrelated ideas and develop a deeper understanding of the issues. These skills are indispensable in an age where traditional career paths are evolving, and interdisciplinary thinking is often required in the workforce. Beers (2011) found that learners who engaged in interdisciplinary projects demonstrated greater enthusiasm for learning. The integration of disciplines helped them to see the relevance of their studies to real-world issues and get a better understanding of how theoretical knowledge can be applied in practical and everyday scenarios. Repko (2012) asserted on the role of fostering collaboration via interdisciplinary approach as students often have to collaborate with peers from different academic backgrounds while undertaking interdisciplinary projects which in turn promote their communication, teamwork, negotiation and creative skills. These collaborative skills play a pivotal role for success in future careers. Beers & Newell asserted that interdisciplinary learning environments simulate real-world working conditions, where diverse teams learn to cooperate in order to tackle complex problems and issues.

BENEFITS OF INTERDISCIPLINARY LEARNING

By linking concepts across disciplines, students are able to move beyond memorizing isolated facts to achieving a more holistic understanding of topics. This integrated learning approach enables students to see the broader implications of their studies and fosters a greater sense of meaning and relevance in their education and making their studies more relevant and dynamic.

The benefits of interdisciplinary approach of learning are as follows:

- As interdisciplinary learning involves active, hands-on projects it promotes intrinsic motivation by allowing students to explore real-world issues.
- Many present age challenges related to climate change, healthcare, global inequality, and much more require solutions that draw upon knowledge from multiple disciplines. Interdisciplinary education by providing a broader perspective prepares students for these challenges by fostering flexibility and adaptability.
- Students learn to approach issues from a holistic perspective that prepare them for their workplace and also leadership roles where cross-disciplinary collaboration is essential.
- Students engaged in interdisciplinary education often perform better as it promotes deeper cognitive engagement and fosters a more integrated approach to knowledge.
- This method increases student retention by creating more meaningful and connected learning experiences.
- As the ability to integrate and apply knowledge across disciplines is a critical skill, students built this competency which is crucial for a variety of professions.
- This approach enhances their employability and adaptability in the job market.
- It develops a sense of social responsibility and a greater awareness of global issues and sustainability.
- Helps in encouraging problem solving and critical thinking skills as it challenges students to approach problems from multiple disciplinary perspectives.
- By integrating concepts, theories, methods, and principles from different fields, students develop stronger critical thinking skills.
- They understand the complexities of real-world issues in a better manner as it requirea analysis from diverse viewpoints.
- Projects that are interdisciplinary in nature allow students to examine the issues in depth and find acceptable and sustainable solutions.
- This learning encourages students to work in teams and collaborate with peers from diverse specialisations that help them to listen to different perspectives, find solutions and come to practical, feasible and socially acceptable solutions.
- Nurtures adaptability amongst team members by requiring them to shift between different ways of thinking, methods, ways, disciplinary vocabularies and principles.
- It provides intellectual flexibility that enables students to approach problems with a broader toolkit and easily adapt to rapidly changing circumstances, new technologies, evolving societal needs and global issues.
- Promote creativity and innovation by making connections between disparate methods and ideas.
- As this method requires to explain complex ideas to peers from different academic backgrounds, this helps develop strong and effective communication skills along with ability to translate specialized knowledge into accessible language.

- This helps in fostering global awareness and social responsibility as interdisciplinary learning helps students gain a broader perspective on global issues. Students develop a deeper understanding about the interconnectedness between the social, environmental, political and economic systems. This heightened awareness makes the students realize the impact of their work on local and global communities.
- This helps in building self-directed learning and lifelong learning skills as students while doing collaborative projects take ownership of their learning by seeking out information from various sources and disciplines. This also develops self-directed learning along with a sense of initiative and personal responsibility for learning, which is essential for lifelong learning.
- As students learn the ways to explore different academic areas and synthesize knowledge, they become more independent and proactive learners.
- One of the most powerful ways interdisciplinary learning helps is by empowering students by engaging them in real-world challenges where they can see the direct application of their learning. These experiences empower them to take action and contribute to solving societal challenges, promoting social responsibility and citizenship.
- This learning promotes ethical considerations as it often involves discussions about ethical dilemmas and the societal impact of decisions. By engaging with multiple perspectives, students are encouraged to consider the ethical implications of their work and its consequences for various stakeholders. This fosters in them a sense of ethical responsibility and equips them to make more informed and thoughtful decisions.
- By engaging with multiple perspectives, students easily adopt to a broader and more inclusive view of the world, which fosters a sense of global citizenship and empathy.

INTERDISCIPLINARY LEARNING AND SUSTAINABLE DEVELOPMENT GOALS (SDGS)

Interdisciplinary learning plays a crucial role in advancing the United Nations' Sustainable Development Goals (SDGs). The SDGs, established in 2015, consist of 17 goals designed to address global challenges, including poverty, inequality, environmental degradation, climate change, peace, and justice. These goals are deeply interconnected and require a holistic approach to address the complex issues they represent.

Interdisciplinary learning, which integrates knowledge, methods, and perspectives from multiple disciplines, is essential for fostering the understanding and problem-solving capabilities necessary to achieve the SDGs. This approach empowers students to understand the multifaceted nature of global challenges and prepares them to contribute to solutions that span environmental, social, economic, and political domains. This approach helps in addressing complex global challenges that fall under global issues such as poverty (SDG 1), inequality (SDG 10) and peace (SDG 16). This approach also helps in addressing the issue of promoting quality education (SDG 4) by promoting lifelong learning opportunities that foster skills like critical thinking, problem solving and collaboration amongst students. This approach also supports SDG 13 (Climate Action) which requires integrated solutions across environmental sciences, engineering, and social sciences to develop sustainable policies and practices that mitigate climate change. This approach also helps in addressing issues of gender equality (SDG 5) and equality (SDG 10). Interdisciplinary learning by focusing on issues related to urban planning, environmental science, engineering and social sciences helps in achieving SDG 11 ie

advancing sustainable cities and communities. As addressing climate change is a key global priority, interdisciplinary learning by providing understanding about the broad range of factors that contribute to climate change and developing effective solutions helps in achieving SDG 13. While the blending of disciplines leads to breakthrough ideas and innovations, it helps in supporting SDG 8 & 9 that deal with enhancing innovation. Most importantly, interdisciplinary learning helps in strengthening global partnerships and attainment of SDG 17.

CHALLENGES IN IMPLEMENTING INTERDISCIPLINARY LEANING AND WAYS TO OVERCOME

Interdisciplinary learning possesses immense potential to empower students and provide a holistic approach to addressing complex problems however its implementation is not without challenges. Various stakeholders such as institutions, educators, and students face various obstacles while integrating interdisciplinary approaches into curricula, teaching methods, and assessments. Some of the key challenges are institutional and structural barriers which include departmental silos, lack of institutional support and rigid curriculum structures. Faculty resistance and lack of training is another major challenge that happens due to lack of disciplinary expertise, insufficient training and lack of academic reward systems. As assessing interdisciplinary learnings is inherently a complex process so lack of defined assessment and evaluation methods can be a major challenge. Students may also face difficulties when adapting to interdisciplinary learning, so student resistance and perceptions because of uncertainity, ambiguity, lack of familiarty with multiple disciplines and lack of depth in knowledge can be a hurdle. Limitation of resources and integrating indisciplinary learning in curriculum can also pose to be a major challenge.

All these challenges require careful planning to ensure that interdisciplinary content is meaningfully incorporated into the overall academic trajectory of student. These challenges also require a multi-faceted approach involving strategic changes at the institutional, faculty, student, and resource levels by promoting interdisciplinary departments, institutional support and funding, curricular flexibility, faculty trainings and incentives, interdisciplinary teaching teams, leadership support, rigorous and refined assessment and evaluation strategies, students engagement and mindset shifts, promoting collaborative learning, resource allocation and infrastructure, cross-institutional collaboration and leveraging technology.

Overcoming the challenges in implementing interdisciplinary learning requires concerted efforts and by promoting structural changes, providing faculty development opportunities and fostering a culture of collaboration, educational institutions can overcome these barriers.

INTERDISCIPLINARY LEARNING: THE WAY FORWARD

Interdisciplinary learning represents a crucial approach to education in the 21st century. With the right strategies, interdisciplinary learning can become a powerful tool for preparing students to tackle the complex, interconnected problems. Interdisciplinary learning will shape the future of education in the times to come and play a key role in tackling global challenges, fostering innovation, and equipping students with the skills needed to thrive in a rapidly evolving world. As discussed earlier in the chapter, interdisciplinary education is essential for complex problem-solving, innovation and creativity, bridging the gaps between theory and practice and adapting to the future careers.

Going forward, redesigning curricula, collaborative learning environments, project based learning, leveraging technology and digital tools, fostering faculty collaboration, promoting lifelong learning**,** strengthening global perspectives and incorporating soft skills can help immensely.

CONCLUSION

Interdisciplinary education is essential for tackling the complex challenges of the 21st century, and its influence continues to grow in higher education, research and professional development. It empowers students by providing them the skills and mindset necessary to thrive in an interconnected and complex world. The future of interdisciplinary learning will bring forward critical thinkers, problem-solvers, and innovators equipped in tackling complex global challenges.

By embracing interdisciplinary learning approaches, institutions can better prepare learners for the dynamic world and foster a generation capable of working across boundaries to address pressing societal needs. The integration of multi-disciplines will enhance the learning experience and also drive innovation, creativity, adaptability, sustainability, ethical awareness and positive change in our societies and the world at large.

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CONVERTING WASTE TO WEALTH: VERMICOMPOSTING FOR CLIMATE RESILIENT FUTURE

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ABSTRACT

The growing demand for food production from the shrinking land resources demands the use of improved agricultural practices. However in a world facing climate crisis, these improved agricultural practices must be developed and implemented in such a way that they pose the minimum threat to the environment while meeting the resource needs of the present population. Keeping that in mind, there has been a growing need to involve those practices which aid the environment towards achieving climate resilience. Vermicomposting is one such practice which has been developed a long time ago. It converts the otherwise waste products from homes, agricultural practices etc. into a nutrient rich product with good physical and well as microbiological characteristics. This contributes towards improving soil health and producing healthy crops. Owing to its mesophilic nature, Vermicomposting produces lesser amounts of Greenhouse Gases compared to that of other processes of waste degradation and contributes significantly towards carbon sequestration. All these benefits from Vermicomposting make it a beneficial process towards climate resilience.

Keyword: vermicomposting, waste recycling, climate resilience, soil health

INTRODUCTION

With the exponential rise in global population, there has been a growing pressure on agriculture, industry and other such factors which poses significant threats to ecosystems, livelihoods and all around habitability of the planet earth. A growing global population results in an increase in waste generation which has led to environmental degradation. It has been predicted that waste generation in the world would reach 2.2 billion tons by 2025 (David *et al.*, 2019). In the small towns of India, waste is generated at the rate of 0.41 kg/capita/day while for the rural areas, it is 0.3 to 0.4 million metric tons of solid waste on a daily basis (Kibria, 2017). At present, the world is faced with the alarming issue of climate change with the rising temperatures, extreme weather conditions and increased occurrences of events such as droughts and floods. For a healthy environment and to mitigate the growing hazard of climate change, proper waste management is the need of the hour. These factors point towards the need for developing sustainable solutions to enhance climate resilience.

The IPCC Sixth Assessment Report defines climate resilience as "*the capacity of social, economic and ecosystems to cope with a hazardous event or trend or disturbance*". Vermicomposting can prove to be one sustainable solution which utilizes otherwise discarded organic waste to produce a stable product called Vermicompost by utilizing earthworms which is rich in nutrients. (Figure 1).

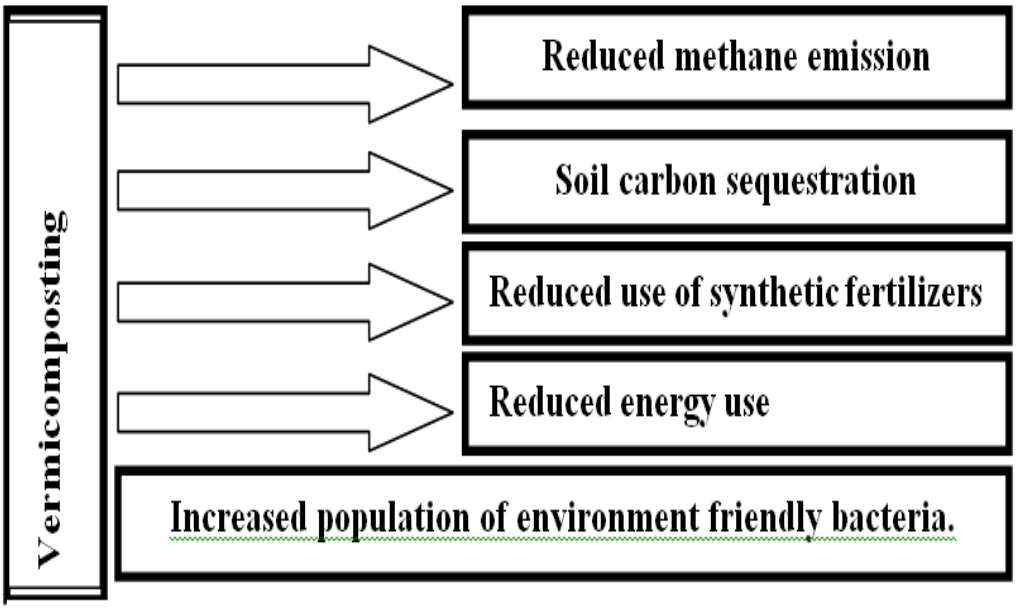

Figure 1. Role of Vermicomposting in climate resilience (Hajam *et al.*, 2023)

VERMICOMPOSTING

The term Vermicomposting is derived from the Latin word *vermis*, which means "worms." Vermicomposting is an eco-friendly process which involves the use of earthworms to convert organic wastes into a nutrient rich, dark colored organic product called Vermicompost. This involves a series of processes such as burrowing, gut digestion, casting and mucus secretion of earthworms (Huang *et al.*, 2018). Vermicomposting involves the use of epigeic, fast reproducing earthworms such as *Eisenia foetida, Eudrilus euginiae, Perionyx excavates* etc. Any biodegradable wastes such as agricultural waste, kitchen waste, leaf litter, banana pseudo stem etc. can be used mixed with cow dung slurry as raw materials for Vermicomposting.

CLIMATE RESILIENCE THROUGH VERMICOMPOSTING

Soil health and productivity

Numerous studies have demonstrated that vermicompost is an excellent source of nutrients such as organic carbon (C), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), and various micronutrients. These nutrients are readily available for plant uptake and, combined with diverse microbial populations, contribute significantly to soil health (Rehman *et al.*, 2023; Madhuwanthi *et al.*, 2021; Mahmud *et al.*, 2020). The high porosity, improved aeration, and superior water-holding capacity of vermicompost promote better soil nutrient retention and absorption. Additionally, vermicompost stimulates the activity of vital soil enzymes like amylase, protease, and urease, which are essential for maintaining soil fertility and supporting plant health (Rekha *et al.*, 2018).

Unlike conventional compost, vermicompost does not have negative impacts on soil or the environment (Hajam *et al.*, 2023). By converting organic waste into vermicompost, commonly referred to as "black gold," the process prevents waste from ending up in landfills, thereby

contributing to sustainable waste management and reducing the adverse effects of climate change (Singh *et al.*, 2023).

Table 1. Comparison of Vermicomposting with Other Waste Management Methods (Hajam *et al.* 2023)

Aspect	Vermicomposting	Incineration	Landfill
Environmental impact	Minimal carbon footprint, enhances soil quality	Significant carbon emissions, contributes to air pollution	Methane emissions, potential groundwater contamination
Input material	Organic waste	All waste types	All waste types
Output product	Compost, clean water	Ash, air pollutants	Leachate, methane gas
Economic feasibility	Cost-effective, potential revenue from compost sales	High capital and operational expenses	Low-cost
Public acceptance	Generally well-received as environmentally friendly	Controversial due to pollution and health concerns	Often faces opposition from local communities

Greenhouse Gas Mitigation

Vermicompost is a mesophilic (<30^{o}C) process involving earthworms and various microorganisms that breakdown and stabilize organic materials (Lim *et al*., 2016). Thermophilic composting (>45^{o}C) increases NH_3 volatilization as well as NH_4 volatilization along with higher CH_4 emissions. Earthworms improve air movement by continuous turning of the substrate which maintains an aerobic condition in the composting process. Earthworms through their associated microbes also affect N mineralization, volatilization, nitrification and denitrification. This indicates that Vermicomposting can be a good alternative for reducing N losses and GHG emissions (Nigussie *et al*., 2016). Earthworms also play a positive role in soil carbon mineralization. It was observed that there was a 24% increase in carbon mineralization in the soil with 1.95mg/g soil dry mass earthworm density (Garnier *et al*., 2022). Different parameters affecting the GHG emissions in Vermicomposting are mentioned in table 2. The use of Vermicompost not only reduces the emissions of GHGs but also improves carbon sequestration in the soil and thus contributes towards climate resilience.

Table 2. Parameters mitigating GHGs emissions during Vermicomposting (Panda et al., 2022)

S. No	Parameters	Methane [CH_4]	Nitrous Oxide [N_2O]	Carbon Dioxide [CO_2]	Duration Days	References
1.	Earthworm species					
	i) *Eisenia fetida, Perionyx excavatus, Eudrilus euginae* and *Lumbricus rebellus*	4.76 kg mg^{-1}	1.17 kg mg^{-1}	1675 kg mg^{-1}	30–60	Chan *et al.*(2011)
	ii) *Eisenia andrei* and *Eisenia fetida* (Red mud addition)	0.033 (μg g^{-1} h^{-1})	0.012 (μg g^{-1} h^{-1})	16.5 % decrease	56	Barthod *et al.*(2018)
	iii) *Eisenia fetida*	2.28 (kg CO_2-eq t^{-1} DM)	5.76 (kg CO_2-eq t^{-1} DM)	-	50	Yang *et al.*(2017)
2.	Waste characteristics					
	Municipal Solid waste	2.2×10^{-3} kg mg^{-1}	-	-	240	Lleo *et al.*(2013)
	Household waste	4.76 kg mg^{-1}	1.17 kg mg^{-1}	1675 kg mg^{-1}	30–60	Chan *et al.*(2011)
	Waste segregated	0.02–0.38 kg mg^{-1}	0.12–1.5 kg mg^{-1}	-	84	Hobson *et al.* (2005)

Plant adaptation to stress

Vermicompost and its derivatives are rich in humic acids, nutrients, microbial populations, growth hormones and enzymes. Application of Vermicompost helps crops withstand a wide range of abiotic and biotic stresses (Vambe *et al.*, 2023, Voko *et al.*, 2020). Vermicompost leachates (VCL) are biostimulants that along with their inherent ability to enhance photosynthetic activities, plant growth and nutrient use efficiency also helps in counteracting the effects on biotic and abiotic stresses on the crops. The biostimulating effect of VCL (water extracts of earthworm - decomposed organic matter) might be due to individual, additive or synergistic effects of its various constituents, particularly amino acids, humic acids, beneficial bacteria and trace amounts of plant growth regulators (e.g. auxins, cytokines etc.) (Aremu *et al.*, 2015).

RESEARCH FINDINGS

Hrebeckova *et al.* (2019) investigated the enzymatic activity of eight different enzymes across three types of aged vermicompost derived from household biowaste, a mix of malt house sludge and agricultural waste, and grape marc. The vermicompost heaps were segmented into five distinct layers based on their depth and age. The highest bacterial and fungal activities were found in the youngest layers, which correlated with the highest density and biomass of earthworms. Among the tested substrates, household biowaste-based vermicompost exhibited the highest enzyme activity, with lipase showing the greatest activity and arylsulfatase the least.

Another study examined the effects of vermicompost produced from various substrates on soil health (both physical and chemical properties) and wheat growth under field conditions. Soil tests conducted at different intervals revealed marked improvements in the physico-chemical properties of the soil. Physiological attributes of the wheat plants responded positively to the application of NPK fertilizer

(100:50:50 kg ha^{-1}) combined with vermicompost at a rate of 10 t ha^{-1}. Post-harvest soil analyses showed that vermicompost treatments enhanced soil quality, improving its physical and chemical properties. The findings indicated that cow dung-based vermicompost, when applied alongside the recommended NPK levels, boosted crop yield, improved soil health, reduced aphid infestations, and enriched the grains with zinc (Zn) and fluoride (F) (Aslam *et al.*, 2019).

Nigussie *et al.* (2016) explored the potential of vermicomposting to mitigate nitrogen losses and greenhouse gas (GHG) emissions compared to thermophilic composting. The results showed that vermicomposting reduced CH_4 emissions by 22% in high C:N substrates and by 26% in low C:N substrates compared to thermophilic composting. Additionally, N_2O emissions decreased by 36% in low C:N substrates and by 25% in high C:N materials. Vermicomposting consistently released fewer GHGs than thermophilic composting, attributed to earthworm activity, which enhanced substrate aeration through continuous turning and increased air circulation.

Lv *et al.* (2018) evaluated the emission of greenhouse gases (CO_2, CH_4, and N_2O) during the bio-stabilization of sewage sludge under varying C/N ratios, with and without the inclusion of Eisenia fetida. The study found that vermicomposting significantly lowered pH, total organic carbon (TOC), and C/N ratios compared to the control group without earthworms. While vermicomposting reduced CH_4 emissions, its impact on CO_2 emissions was negligible. However, a higher N_2O emission rate was recorded in vermicomposting compared to the control. The study concluded that both C/N ratios and the presence of earthworms significantly influenced GHG emissions. Vermicomposting effectively accelerated organic waste degradation and nitrogen mineralization, with higher C/N ratios helping to reduce GHG emissions during sewage sludge processing.

Yang *et al.* (2017) compared greenhouse gas emissions between vermicomposting and thermophilic composting. Their study, conducted over a 50-day period, utilized tomato stems as bedding material and cow dung as a nutrient substrate for vermicomposting with Eisenia fetida. A thermophilic composting setup without earthworms served as the control. The results revealed that vermicomposting reached maturity (Germination Index, GI ≥ 80%) faster and achieved a higher GI (132%) than thermophilic composting (Table 3). Vermicomposting also showed significant reductions in NH3 emissions (12.3% of initial nitrogen) and total GHG emissions (8.1 kg CO_2-eq/t DM) compared to thermophilic composting (24.9% of initial nitrogen and 22.8 kg CO_2-eq/t DM). (Figure 2 and 3). The findings highlighted that vermicomposting not only shortened the composting process but also reduced GHG emissions. Additionally, processed earthworms could serve commercial purposes.

Table 3. Chemical properties and Germination Indices of the composts at different composting times.

Composting time (days0	pH	Total N (gkg^{-1})	Total Organic Carbon (%)	C/N ratio	GI (%)
Vermicomposting					
0	8.54	14.2	43.6	30.7	33.6
5	8.32	14.5	42.8	29.5	22.3
10	8.18	15.0	39.9	23.6	62.8
20	8.78	15.7	34.1	22.7	96.3
30	8.67	16.2	34.2	21.1	113.0
40	8.57	16.5	33.7	20.4	124.5
50	8.48	17.2	31.9	18.6	132.3
Thermophilic composting					
0	8.54	14.2	43.6	30.7	33.6

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5	8.12	14.0	43.4	31.0	28.9
10	7.92	14.6	43.9	30.1	54.8
20	8.91	14.9	40.9	27.5	80.3
30	8.46	13.8	33.6	24.4	102.3
40	8.40	14.2	32.9	23.2	100.3
50	8.33	15.0	32.1	21.3	105.7

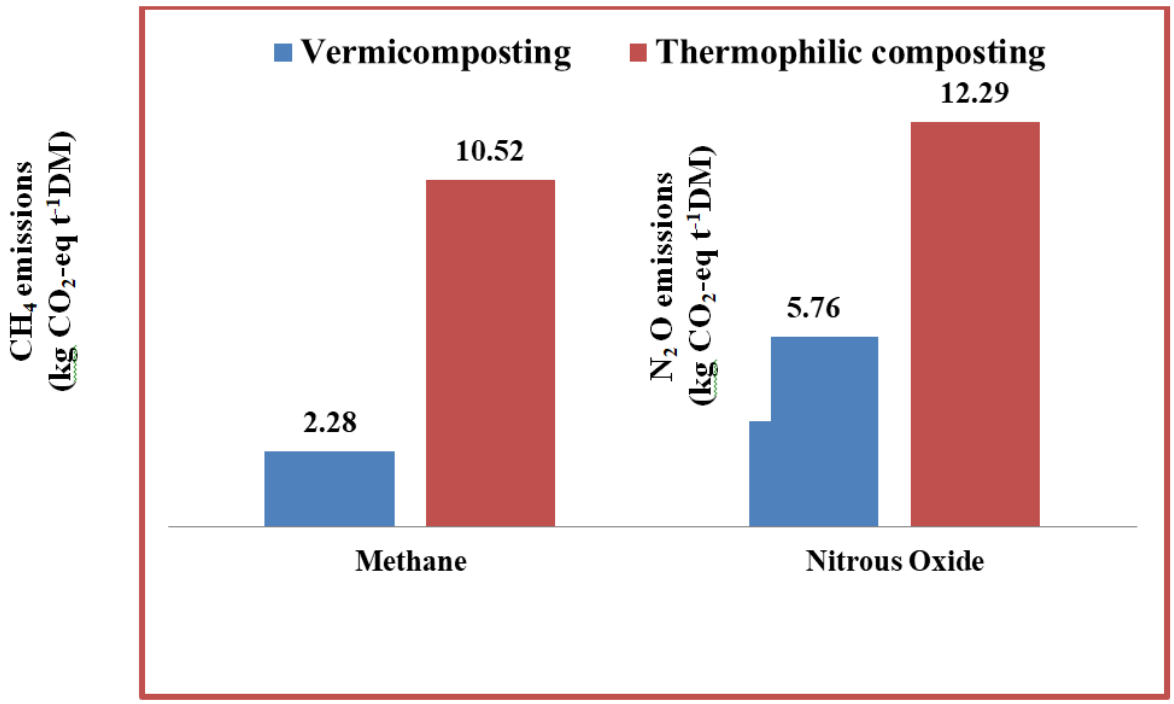

Figure 2. Methane and Nitrous Oxide emissions from Vermicomposting and thermophilic composting

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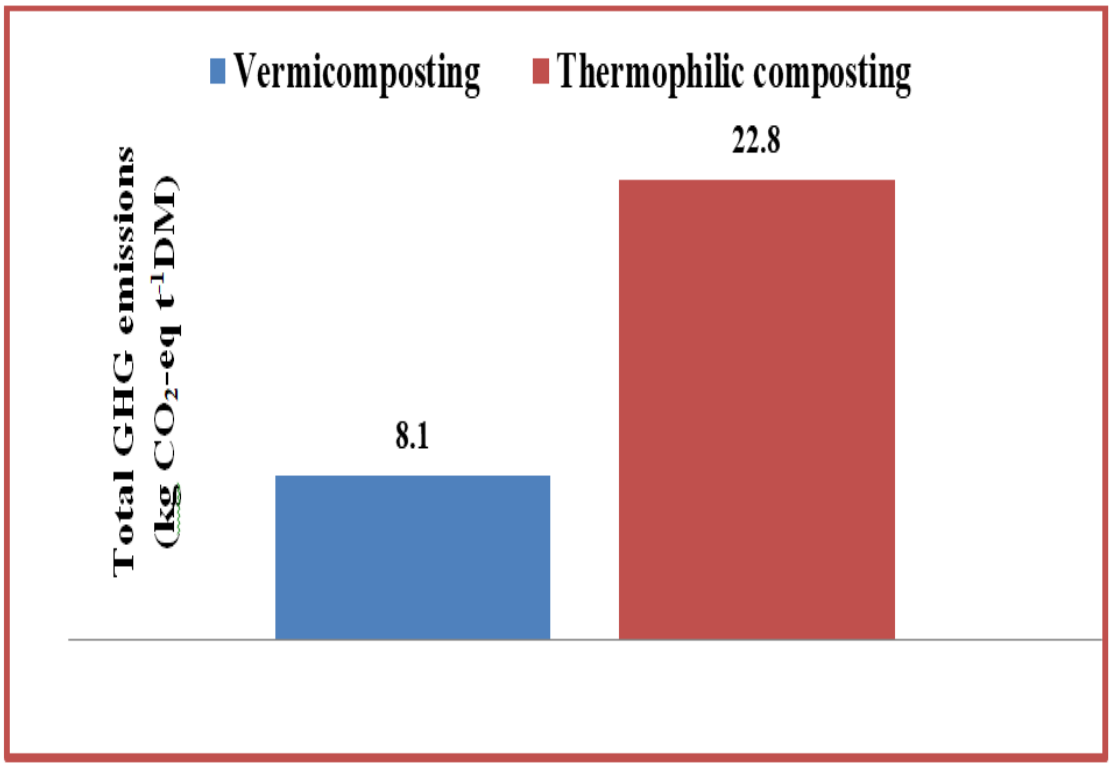

Figure 3. Total GHG emissions from Vermicomposting and thermophilic composting

CONCLUSIONS

There has been ample evidence over the years which show that Vermicompost helps in improving soil physico-chemical and biological properties which help in maintaining soil health. As a result it also has a positive effect on growth and production of crops and helps them in mitigating climate stress. This can contribute towards achieving food security in a world with a growing population. The increasing burden of waste on this planet can also be mitigated by the process of Vermicomposting which converts organic biodegradable waste to produce nutrient rich Vermicompost. Moreover, compared to traditional composting methods Vermicomposting releases lesser amount of green house gases into the atmosphere and also contributes positively toward carbon sequestration. Vermicomposting thus is a less time consuming and cheap method of composting which releases minute GHGs making it a suitable process of converting waste to wealth while contributing towards a climate resilient future.

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INFLUENCE AND INTERACTION: THE ROLE OF SOCIAL MEDIA IN FAST MOVING CONSUMER GOODS PURCHASE DECISION

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ABSTRACT

Social media platforms have become key tools for brands to engage with consumers, create awareness, and influence purchase decisions. While its potential is vast, brands must navigate the challenges thoughtfully, focusing on transparency, authenticity, and meaningful engagement to build lasting consumer relationships. By leveraging the power of social media strategically, FMCG companies can not only enhance their market presence but also foster deeper connections with their consumers. The study reflected the role of social media in redesigning the consumer decisions by providing a platform for product comparisons, reviews, and recommendations. It explores various aspects of social media marketing, including information accessibility, personalization, influencer marketing, and user-generated content. The study suggests that companies should adopt a hybrid approach blending traditional and digital marketing strategies, ensuring transparency and ethical practices in their online presence. The paper concludes by emphasizing the importance of further research into the evolving dynamics of social media in the FMCG sector.

Keywords: Social Media, Consumer, Purchase Decision, User-generated content, FMCG.

1. INTRODUCTION

In the evolving landscape of the digital world, marketing dynamics are undergoing significant transformations. Social media has emerged as a pivotal tool that drives business models by fostering enhanced customer interaction and connectivity (Cvijikj & Michahelles, 2013). This integration with new technologies has amplified the influence of marketers on both new and existing consumers (Hanna, Rohm, & Crittenden, 2011). However, in this era of digitization, marketers face numerous challenges in understanding consumer behaviour and consumption patterns (Bond, Ferraro, Luxton, & Sands, 2010). Many organizations are devoting their efforts in social media, showing their presence, they felt it's necessitate engaging in active social media conversations in order to build their consumer brand (Siriwardana, 2020).

According to Kaplan and Haenlein (2010) "Social Media is a group of Internet-based applications that is built on the ideological and technological foundations of Web2.0, and that allows the creation and exchange of User Generated Content." The advent of social media has notably reshaped consumer decision-making processes. Buyers now actively compare products and rely heavily on reviews and recommendations shared by other customers on social platforms before making purchase decisions (Khatib, 2016). Diverse companies, from consumer durables to fast-moving consumer goods, are gradually more using online marketing strategies. In the current scenario, the FMCG industry stands out as one of the most prominent and rapidly growing categories on e-commerce platforms (Dave, 2016). Over the past fifteen years, the Indian FMCG sector has witnessed substantial growth, driven by changing lifestyles and rising income levels among domestic consumers. Also, online marketing has influenced the purchasing decisions of consumers regarding fast-moving consumer goods (FMCG). Consumers attain information from the internet and social media platforms, analyse it, read

customer reviews, and conduct comparisons before making a purchase decision (Rahul & Varshan, 2023).

Globally, the FMCG sector has increasingly shifted focus to e-commerce, propelled by widespread mobile internet usage. In India, a demographic shift in the last decade, marked by a surge in internet usage and the expansion of digital media, has significantly influenced consumer decision-making processes (IBEF, 2024). As the global marketplace continues to witness unprecedented changes influenced by economic shifts, consumer decision-making processes regarding FMCG brands have become increasingly intricate (Tamilmani, 2023). This study highlights the critical role of social media in shaping consumer purchase decisions for FMCG products. By reviewing previous research on the intersection of the FMCG sector and social media, the paper provides valuable insights to strengthen understanding in this domain.

2. REVIEW OF LITERATURE

A. Social Media and FMCG SECTOR

The rapidly changing landscape of the FMCG (Fast-Moving Consumer Goods) industry is being heavily shaped by the growing influence of digital technologies and social media. As companies strive to keep up with these technological advancements, the integration of IT and digital marketing strategies has become crucial. However, challenges persist, particularly in the shortage of qualified IT personnel, which could potentially hinder companies' ability to adopt and leverage digital solutions effectively. George and George (2023) highlighted how the lack of IT expertise is particularly damaging in areas such as real-time data use for inventory and logistics, digital marketing, and cyber security, urging companies to invest in training programs and collaborate with IT service providers to address these gaps. In the monarchy of digital marketing, social media has become an incontestable influence in determining consumer behaviour. Aydin, Uray, and Silahtaroglu (2021) investigated how different types of posts—like videos and images—affect engagement on platforms such as Facebook and Twitter. Their research revealed that the frequency of posts and interactive content play a key role in driving consumer engagement, suggesting that a nuanced approach to social media is necessary for brands to succeed. This is further supported by the work of Aji, Nadhilaa, and Sanny (2020), who demonstrated that Social Media Marketing Activities (SMMA) positively influence brand equity and customers' purchase intentions, ultimately driving e-WOM (electronic word-of-mouth) and reinforcing the importance of social media in influencing purchasing decisions. As more consumers turn to social media for brand interaction, the need for brands to refine their strategies has become clear. Siriwardana (2020) explored how social media has become one of the defining technologies of the digital age. Brands now see the value in participating in online conversations to strengthen their consumer relationships, recognizing that social media is an essential tool for modern branding. This shift is echoed in the findings of Dissanayake, Siriwardana, and Ismail (2019), who stressed the importance of user-generated content (UGC) and social networking sites (SNS) in enhancing consumer engagement. The paper highlighted that social media is a powerful tool for creating meaningful connections between brands and consumers, while also underscoring the need for further research to fully understand its strategic role.

At the ground level, Pavithra (2018) revealed how consumer participation in marketing via social media platforms is reshaping brand perceptions. Through a survey of consumers in South Bangalore, it was found that social media has become a key avenue for consumers to share their opinions, both positive and negative. This instant feedback loop creates a dynamic and interactive brand experience, making social media a critical tool for FMCG marketers. In line with this, Banerjee (2015)

highlighted social media's interactive nature, which effectively builds brand awareness and drives purchasing decisions compared to traditional advertising. Rashid (2014) emphasized the need for a hybrid marketing approach, as lighter social media users prefer traditional channels, while heavier users engage more with digital platforms. In rural markets, Mbuyazi (2012) demonstrated how FMCG companies leverage social media to raise awareness, overcome retail access barriers, and address social issues like poverty and job creation.

Together, these studies paint a picture of an FMCG sector in transition, where digital marketing and IT integration are becoming critical to growth and competitiveness. Social media, in particular, has surfaced as a influential tool for engaging consumers, building brand equity, and guiding purchase decisions. However, companies face ongoing challenges, including the need to bridge the IT skills gap and refine their digital marketing strategies to stay relevant in an increasingly tech-driven marketplace. As the industry continues to evolve, businesses must remain adaptable, leveraging both digital and traditional marketing approaches to effectively connect with consumers across different demographics and geographies.

B. Factors Affecting Purchase Decision in FMCG Sector

The Fast-Moving Consumer Goods (FMCG) sector presents a fascinating landscape where consumer behaviour is influenced by a multitude of factors, from demographic variables and marketing strategies to the powerful role of advertising and brand loyalty. As companies strive to capture consumer attention and drive purchases, understanding these factors becomes essential to designing effective marketing campaigns and brand strategies. One of the key studies, Sisodiya and Sharma (2018), explored the impact of demographic variables and the marketing mix on consumer behaviour in Jaipur, India. Their research revealed that price was the most influential factor in driving purchasing decisions, with family income and education playing pivotal roles as well. Interestingly, age had minimal influence on consumer choices, emphasizing the importance of pricing strategies in the FMCG sector. This insight is crucial for brands aiming to optimize their marketing mix to cater to specific consumer demographics. On a broader scale, Adam and Khan (2017) examined the factors influencing Pakistani consumers' purchasing decisions, particularly when it came to international FMCG brands. Their study uncovered that while product quality and price played important roles, the origin of the brand held the most significant weight in the decision-making process, accounting for nearly 66% of purchase behaviour. This highlights the growing importance of brand consciousness among consumers, where national identity and loyalty significantly impact buying intentions. In the competitive world of FMCG marketing, brand extension is another crucial strategy that can bolster brand equity and reduce advertising costs. Joshi and Yadav (2017) studied brands like Fortune and Saffola and found that successful brand extension hinges on factors such as consumer perception, the reputation of the parent brand, and perceived risk. A well-executed brand extension can enhance consumer trust and loyalty, providing powerful tools for companies looking to expand their market reaches.

Promotions are another powerful tool in shaping consumer behaviour, particularly when it comes to price. Mcconnochie, Walton, Campton, Inglis, & Omar (2017) explored the role of price promotions in grocery stores and discovered that such promotions significantly influenced consumer buying behaviour, often leading to brand switching. Moreover, the study found that long-term promotions could enhance brand loyalty, demonstrating the critical role that pricing strategies play in fostering repeat purchases and consumer retention. In a different vein, Shukla and Sanghvi (2017) turned the spotlight on Patanjali Ayurveda Limited (PAL) and its unique customer-centric marketing strategy. PAL’s "Carpet Bombing" approach, which focuses on a low product mix and catering to the growing

demand for Ayurveda products, proved successful despite initially low profit margins. By tapping into India's Swadeshi Movement and promoting Indian-made products, PAL established a strong market presence, showing how innovative marketing strategies can redefine consumer behaviour and brand success.

The influence of advertising on consumer perception is another critical factor in FMCG marketing. Awan, Ismail, Majeed, & Ghazal (2016) studied advertisements' impact in southern Punjab, finding that advertisements played a significant role in shaping consumer perceptions. Elements such as the necessity of the product, brand recall, and pleasure were key drivers in attracting consumers. Effective advertising helps consumers make informed decisions and expands their product choices, reinforcing the importance of strategic ad campaigns in FMCG marketing. Celebrity endorsements have long been a popular marketing tool, and Nasir, Khan, Sabri, & Nasir (2016) examined their influence on consumer buying behaviour in Pakistan. Their study revealed that celebrity endorsements positively impacted brand image and consumer purchasing behaviour. This finding underscores the power of celebrity associations in boosting brand equity and influencing consumer choices, making them a valuable asset in FMCG marketing strategies.

Rural markets are often overlooked in discussions of FMCG marketing, but Pant, Pant, and Joshi (2016) explored how advertising resonates with rural consumers in India. They found that television advertisements, particularly those featuring celebrities, had a profound influence on rural consumers' attitudes toward FMCG products. Print advertisements were also effective, showing that targeted media strategies can enhance the reach of FMCG brands in less urbanized regions. With the growing emphasis on sustainability, Singh, Singh, and Thakur (2014) examined consumer behaviour toward eco-friendly FMCG products. Their study found that consumers who were satisfied with green products were more likely to repurchase them and even pay premium prices. This growing trend toward eco-conscious consumption highlights the increasing importance of sustainability in shaping consumer purchasing decisions. In urban India, Srivastava (2013) studied consumer preferences in unauthorized colonies, uncovering that while consumers favoured branded goods, their purchasing decisions were influenced by socio-economic factors, promotional offers, and product characteristics. This study sheds light on the complexity of consumer behaviour in low-income urban areas, where multiple variables shape purchase intentions.

Packaging, often overlooked, also plays a crucial role in attracting consumers. Deliya (2012) studied consumer responses to newly packaged FMCG products and found that eco-friendly and protective packaging could significantly influence consumer purchasing decisions. This highlights the growing trend of sustainability in packaging, which is becoming increasingly important in the FMCG sector. Jeevananda (2011) focused on the retail environment in Bangalore, where factors such as packaging, branding, and pricing were found to be key drivers of consumer perception and purchase decisions. Both consumers and retail managers agreed that product quality and branding were the most influential factors, underscoring the importance of these elements in retail FMCG marketing. Kumar, Gangal, and Singh (2011) studied Nestlé's advertising efforts in Agra, demonstrating how creative marketing communication, especially through TV ads, could significantly impact consumer preferences. Their findings show that well-executed advertising campaigns are crucial in boosting brand appeal and fostering consumer loyalty.

In summary, these studies paint a rich and complex picture of the factors influencing consumer behaviour in the FMCG sector. Price, brand perception, advertising, packaging, and even celebrity endorsements all play a crucial role in shaping consumer decisions. As the FMCG market continues to

evolve, understanding these factors and adapting to changing consumer preferences remains essential for companies seeking to stay competitive and build lasting brand loyalty

C. Social Media and Consumer Decision Making Process

In a world increasingly dominated by digital interactions, researchers have turned their focus toward understanding how social media shapes consumer decision-making. Tamilmani, (2023) in his article explores how economic variables influence consumer decisions regarding international FMCG products. It examines macroeconomic factors (e.g., inflation, exchange rates, income levels) and microeconomic aspects (e.g., price elasticity, affordability, purchasing power) through case studies and survey data across global markets.The findings reveal how economic conditions shape consumer behavior and offer actionable strategies for businesses to adapt. This research provides valuable insights for marketers, policymakers, and industry professionals, enhancing understanding of the interplay between economics and consumer choices in the global FMCG sector. Abdullah, Dima, Norvadewi, Sutaguna, & Sumarni (2023) explored the impact of social media on consumer purchase intentions using a quantitative approach with 181 respondents. Multiple linear regression analysis revealed that brand image, social media, electronic word-of-mouth (eWOM), and perceived value significantly influence purchase intentions, with perceived value being the most dominant. Dadwal and Malik (2019) explored how social media influences consumer behavior in Delhi, Noida, and Gurgaon. Their findings revealed that platforms like Facebook and YouTube play a pivotal role in the evaluation stage of purchasing. Consumers often altered their buying decisions after encountering positive or negative reviews, showcasing social media's credibility and reliability. Not only did these platforms help users recognize their needs, but they also built strong brand images through engaging advertisements. Similarly, Voramontri and Klieb (2019) investigated social media’s impact on high-involvement, complex products in South-East Asia. Using Facebook and WhatsApp for data collection, their study demonstrated that social media significantly enhanced satisfaction during the information search and evaluation stages, even extending into the post-purchase phase. As users moved through their decision-making journey, their satisfaction with social media’s role only grew stronger. Kiran and Vasantha (2017) honed in on how user-generated content on social media impacts consumer purchases. Their study revealed that consumer-generated content significantly influenced purchase decisions, while information about product attributes on social media had comparatively less impact.

The study by Jashari and Rrustemi (2017) brought psychographics into the mix. Their research in Pristina revealed that consumers relied on social media for reliable, easily accessible information, influencing every stage of their decision-making process. Social media also encouraged unplanned purchases and gave consumers a platform to share their satisfaction or dissatisfaction with brands and peers alike. Turning to influencers, Gashi (2017) explored the role of social media influencers in shaping consumer behavior. Through qualitative methods, this study illustrated how factors like attractiveness, trust, expertise, and social identity impacted every stage of the purchase journey. Consumers' connections with influencers and their age played crucial roles in determining how deeply they were influenced.

Nyagucha (2017) focused on youth in Nairobi, unveiling social media’s pervasive impact on decision-making. From sparking initial needs to simplifying information searches, social media platforms proved more reliable than traditional media. Friends and family comments on social media also influenced future purchases, while advertisements played a significant role in the pre-purchase and purchase stages. Gupta (2016) highlighted the power of electronic word-of-mouth. Based on data from Delhi-NCR, the study showed how social media platforms influenced purchase decisions

through knowledge sharing, user recommendations, and online reviews, reinforcing the significant role of peer opinions in consumer behavior. Ertemel and Ammoura (2016) shifted focus to the fashion retail industry in Istanbul, where social media advertising was found to influence the evaluation of alternatives significantly. The study revealed that while social media had a moderate effect on purchasing and post-purchase behaviour, its impact on the need recognition and information search stage was relatively weak.

Rouckova (2015) explored the relationship between online stimuli and decision-making across age groups. Positive online reviews and blog content showed strong correlations with consumer emotions and decisions, particularly in the food and dining industry. This study emphasized the responsibility consumers felt toward online communities, encouraging them to contribute reviews and experiences. Xie and Lee (2015) examined the interaction between earned and owned social media actions in the FMCG sector. They found that while social media could increase purchase likelihood, it did not always translate into offline sales. Instead, these actions were more effective in building a consumer base than directly driving conversions. Altaf (2014) provided insights into how social media users process and select information. Respondents of the study preferred social media over traditional media for its convenience, using platforms to read blogs, view ads, and share feedback. Social media's role as a reliable source of product information emerged as a key finding. Finally, Darban and Li (2012) and Gros (2012) explored the nuanced ways in which social media influences decision-making. Darban and Li found that Facebook significantly impacted the information search and purchase stages for food retailers. Gros, on the other hand, revealed that while social media's influence was strong in the early stages of decision-making, it diminished at the point of purchase. Cultural factors also played a role, showing variations in influence across nationalities. Together, these studies weave a compelling narrative about social media's profound and multifaceted impact on consumer decision-making, shaping behaviours across industries, regions, and demographics.

3. DISSCUSSION

Social media marketing has emerged as a pivotal driver in shaping consumer decision-making, particularly in the fast-moving consumer goods (FMCG) sector. With its ability to create a dynamic, interactive, and personalized environment for consumers, social media has fundamentally redefined the purchasing journey. The following discussions explore the multifaceted influence of social media marketing on consumer behaviour in the FMCG sector.

a) Information Accessibility and Awareness Creation

Social media platforms provide FMCG brands with an unparalleled opportunity to create awareness about their products. Platforms like Instagram, Facebook, and YouTube have become powerful tools for disseminating product information, promoting new launches, and engaging users with creative campaigns. Consumers are constantly exposed to product advertisements, influencer endorsements, and peer recommendations, which amplify product visibility and brand recall. However, while social media enhances information dissemination, it also demands authenticity and transparency. Consumers today are more critical of the content they encounter and are likely to verify claims through reviews, ratings, and peer discussions before making a purchase.

b) Personalization and Targeted Marketing

One of the most significant advantages of social media is its ability to enable hyper-targeted marketing. FMCG brands can leverage data analytics to identify consumer preferences, behaviours, and buying patterns, tailoring advertisements and promotions to individual needs. For instance,

algorithms on platforms like Facebook and Instagram track user activity and suggest products or services that align with their interests. This targeted approach not only increases the relevance of advertisements but also enhances the likelihood of conversions.

c) Influence of Social Media Reviews and eWOM

Electronic Word of Mouth (eWOM) and peer reviews play a critical role in influencing FMCG consumers. Studies indicate that positive reviews and testimonials significantly impact the evaluation stage of the decision-making process, where consumers weigh alternatives before making a purchase. Negative reviews, on the other hand, can deter potential buyers, showcasing the dual-edged nature of social media influence. Brands need to actively manage their online reputation, respond to consumer grievances promptly, and maintain a consistent tone of communication to retain trust.

d) Role of Influencers

Social media influencers have emerged as key players in promoting FMCG products. Their ability to blend authenticity with promotional content resonates strongly with their followers, making them effective in driving purchase decisions. For example, an influencer's demonstration of a skincare product can directly lead to an uptick in sales, especially when the product is perceived as solving a specific consumer problem. However, the reliance on influencers also comes with challenges, such as ensuring that the endorsement aligns with the brand's values and avoiding controversies that could negatively impact brand image.

e) User-Generated Content (UGC)

Encouraging user-generated content, such as customer reviews, photos, and videos, creates a sense of community and trust around a brand. UGC campaigns like challenges or contests are particularly effective for FMCG brands as they engage consumers while promoting products organically. For example, brands like Coca-Cola and Oreo have successfully run UGC campaigns that not only boost engagement but also foster a sense of belonging among their consumers.

f) Impact on Brand Loyalty and Post-Purchase Behaviour

Social media marketing extends its influence beyond the purchase decision to post-purchase behaviour. Platforms allow consumers to share their experiences, provide feedback, and interact directly with brands. Positive experiences often result in repeat purchases and brand loyalty, while negative experiences can spread rapidly, impacting future sales. To capitalize on this, FMCG brands must engage with their audience continuously through loyalty programs, exclusive offers, and prompt customer service.

g) **Challenges and Ethical Considerations**

While social media marketing offers immense opportunities, it also raises challenges and ethical considerations. By using various social media platforms, consumers may feel overwhelmed by the volume of advertisements and promotions, leading to scepticism or ad fatigue. In addition to this data privacy and security posed another challenge where consumer data for targeted marketing has raised concerns. Also its important for FMCG brands to ensure that their sustainability claims are genuine, as consumers are increasingly holding brands accountable for greenwashing.

4. CONCLUSION

Social media has become a crucial factor in shaping customer behavior in the rapidly changing digital landscape, especially in the fast-moving consumer goods (FMCG) industry. Brands can contact

directly with consumers thanks to its dynamic and interactive character, which promotes loyalty, awareness, and trust. In addition to offering unmatched access to consumer insights, platforms such as Instagram, Facebook, and YouTube also make it possible for user-generated content (UGC) to be amplified, for targeted marketing, and for personalized interaction. Social media marketing has drawbacks despite its benefits, such as handling unfavourable reviews, preventing ad fatigue, and handling moral dilemmas including data protection and sustainability claims. To effectively interact with a wide range of consumer demographics, brands must use a hybrid marketing strategy that strikes a balance between traditional and digital tactics. Adopting innovation, transparency, and consumer-centric strategies will continue to be essential to success as the FMCG sector navigates technological upheavals.

5. FUTURE RESEARCH DIRECTONS

Future research can explore the role of emerging technologies such as AI, AR, and VR in FMCG marketing and strategies for reaching rural markets also warrant attention. Additionally, studies could focus on measuring the impact of influencer marketing, understanding the dynamics of electronic word-of-mouth (eWOM), and fostering long-term brand loyalty, offering deeper insights into social media's role in shaping consumer behaviour and marketing strategies.

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SUSTAINABILITY THROUGH INTERDISCIPLINARY APPROACH

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ABSTRACT

Sustainability is a multifaceted challenge that demands innovative solutions transcending traditional disciplinary boundaries. This paper explores the role of interdisciplinary approaches in addressing environmental, social, and economic dimensions of sustainability. By integrating perspectives from science, engineering, social sciences, and the humanities, we propose a framework that leverages the strengths of diverse fields to tackle complex global issues such as climate change, resource depletion, and social inequity. Case studies highlight successful collaborations between disciplines, including renewable energy development, circular economy models, and community-driven conservation efforts. The findings underscore the importance of fostering interdisciplinary education, research, and policy-making to achieve holistic and impactful outcomes. This approach not only bridges knowledge gaps but also promotes inclusivity, innovation, and resilience in the pursuit of a sustainable future.

Keywords: Sustainable development, Interdisciplinary approach,

INTRODUCTION

The concept of sustainability encompasses the capacity to meet the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability is one of the most pressing challenges of the 21st century, encompassing environmental preservation, social equity, and economic development. Traditional siloed approaches to these issues often fail to address their interconnected nature, resulting in fragmented solutions. An interdisciplinary approach offers a pathway to understanding and solving complex sustainability challenges by integrating diverse perspectives and expertise. This paper aims to explore the benefits, challenges, and practical applications of such an approach.

THE ORIGIN OF EDUCATION FOR SUSTAINABLE DEVELOPMENT

Although the idea of sustainable development first surfaced in the early 1970s, the United Nations study "Our Common Future," also known as the Brundtland study of the World Commission on Environment and Development, provided the first definition of the term in 1987. According to the Brundtland Report, sustainable development is growth that satisfies current demands without endangering the capacity of future generations to satisfy their own (WCED, 1987). Following this description, the idea of sustainable development—which emphasises preserving the present for the sake of future generations—became a top concern for national, international, and local organisations and nations (Abu-Alruz et al., 2018). According to Sauvé et al. (2016), the idea was also seen as an advancement that tackles current problems without sacrificing the ability to meet the requirements of future generations.Accordingly, sustainable development involves using resources that don't endanger the environment or human health or make it harder for future generations to meet their requirements (Dernbach & Cheever, 2015). The ability of the nation to meet the SDGs is a major focus of a large portion of the present literature on sustainability (Glass & Newig, 2019). The interdisciplinary

approach is the scientific method humanity requires to accomplish the Sustainable Development Goals (SDGs) of the United Nations (UN), as almost every field is pertinent to the SDGs. To put it another way, the concept of sustainable development helps to unite various academic disciplines that support the SDGs. Sustainable development can be conceptualised in a number of ways, such as social, economic, and environmental. Purvis et al. (2019) also describe the three pillars of sustainable development: environment, economy, and society. Social and cultural factors contribute to environmental problems, and sustainable development calls for development that supports environmental preservation while meeting human social and economic needs (Borg et al., 2014). According to Younis and Chaudhary (2017), it requires countries to manage their natural resources, foster social inclusion, safeguard the environment, and improve the calibre of their institutions. This suggests that in order to solve the problem, new knowledge needs to be created. Collaborating with individuals from diverse backgrounds can be a successful approach to problem solving because sustainability difficulties often involve a range of stakeholders and aspects that affect social, economic, and environmental issues. Working together is essential to creating solutions that effectively address environmental problems. It ensures that everyone who matters has the power to make decisions and shares accountability for active participation. Effective collaboration requires that stakeholders and/or specialists from different disciplines and backgrounds identify a specific issue and agree on what is expected of them.

According to Purvis et al. (2019), sustainability requires all three of the components of sustainable development. According to Ozili (2022), sustainability is a practice that directs the use of present resources in an attempt to guarantee their availability to future generations. It is the capacity to use and allocate resources to economic and non-economic activities responsibly in order to accomplish specific social, economic, and environmental goals (Ozili, 2022). The idea of sustainability entails ecologically conscious and harmonious behaviour that is considerate of future generations (Kapecki, 2020).

In order to help students develop the knowledge, skills, and attitudes necessary to act as global change agents and support, create, and shape a more sustainable future for the world (Kelley & Nahser, 2014; Wiek et al., 2016), it has been argued in the literature that teacher education can be regarded as the primary contributor to sustainability (Dickson et al., 2013; Godemannet et al., 2014). Kabadayi (2016) states that teacher education programs should provide graduating students with the knowledge and comprehension they need to be regarded change agents for sustainability both today and in the future.

In light of this, the United Nations Assembly passed a resolution establishing the United Nations Decade for Sustainable Development (UNDESD), which calls for everyone to have access to education in order to acquire the knowledge, abilities, and attitudes as well as the values, principles, and practices necessary for a sustainable future (Pipere, Veisson, & SalÓte, 2015). To ensure that everyone has access to high-quality education, this declaration urges Member States to integrate sustainable development concerns into all facets of education (UNESCO, 2009). ESD is the practice of teaching for sustainability, according to Grosseck et al. (2019). Furthermore, according to UNESCO (2018), ESD is a collection of various disciplines, including environmental economics, climate change, and the management of the effects of social and economic changes. Humanity must comprehend environmental challenges since they are complicated. therefore, it is thought that the crucial element is an interdisciplinary approach (UNESCO, 2013). Given this, ESD can be viewed as

a comprehensive strategy that incorporates important sustainable development concerns into all instructional methods (Grosseck et al., 2019).

The Need for an Interdisciplinary Approach: Sustainability challenges are inherently complex, involving overlapping systems and competing priorities. For instance, climate change impacts not only ecosystems but also human health, economic stability, and geopolitical relations. Addressing these interconnected issues requires collaboration across disciplines such as environmental science, economics, sociology, and political science. An interdisciplinary approach fosters a comprehensive understanding of these challenges and facilitates the development of innovative, integrative solutions.

Framework for Interdisciplinary Sustainability A structured framework is necessary to operationalize interdisciplinary approaches. Key components include:

- **Collaborative Research:** Establishing research teams that bring together experts from diverse fields to co-create knowledge and solutions.
- **Systems Thinking:** Emphasizing the interconnectedness of ecological, social, and economic systems to identify leverage points for intervention.
- **Stakeholder Engagement:** Involving policymakers, businesses, and communities in the co-design of sustainable practices.
- **Interdisciplinary Education:** Training future professionals to think beyond disciplinary boundaries and work collaboratively.

CASE STUDIES

1 Renewable Energy Development The transition to renewable energy exemplifies the need for interdisciplinary collaboration. Engineers design efficient solar panels, economists develop financial models to incentivize adoption, and sociologists address community acceptance and behavioral change. The integration of these perspectives has led to scalable and sustainable energy solutions.

2 Circular Economy Models Circular economy initiatives aim to minimize waste and maximize resource efficiency. These models require collaboration between material scientists, industrial designers, business strategists, and environmental policymakers. Successful examples include closed-loop manufacturing systems and urban waste recycling programs.

3 Community-Driven Conservation Biodiversity conservation efforts often benefit from combining ecological science with cultural anthropology and local governance. Projects such as community-managed forests have demonstrated how blending scientific expertise with indigenous knowledge can lead to sustainable outcomes.

4 Urban Sustainability Urban sustainability initiatives, such as green infrastructure and smart cities, require collaboration between urban planners, environmental scientists, technologies, and policymakers. For instance, Singapore's "Garden City" initiative integrates urban planning with ecological preservation.

5 Agricultural Sustainability Sustainability agriculture involves integrating knowledge from agronomy, environmental science, and social studies. Practices like agroecology and precision

framing demonstrate how interdisciplinary approaches can enhance food security while minimizing environmental impact.

Challenges and Opportunities While the benefits of interdisciplinary approaches are clear, implementing them poses challenges. These include:

1. **Barriers to Interdisciplinary Collaboration**

- **Communication Barriers:** Differences in terminology and methodologies across disciplines can hinder collaboration.
- **Institutional Silos:** Academic and organizational structures often reinforce disciplinary boundaries.
- **Resource Constraints:** Interdisciplinary projects may require additional time, funding, and coordination efforts.

2. **Facilitating Interdisciplinary Work**
    a. **Educational Reform**: Incorporating interdisciplinary courses and research opportunities in academic curricula.
    b. **Policy Support**: Encouraging funding agencies to prioritize interdisciplinary research.
3. **Opportunities for Innovation** Interdisciplinary approaches can lead to breakthroughs in areas such as climate adaptation, circular economy, and sustainable development technologies.

Despite these challenges, opportunities abound. Advances in digital technology, such as data-sharing platforms and virtual collaboration tools, are making interdisciplinary work more feasible. Additionally, growing recognition of the interconnected nature of sustainability challenges is driving demand for integrative approaches.

PRACTICAL APPLICATIONS

1. **Policy Development** Interdisciplinary research can inform policies that balance economic growth with environmental conservation and social equity.
2. **Community Engagement** Engaging local communities in sustainability projects ensures that solutions are context-specific and socially acceptable.
3. **Technological Integration** Technologies such as artificial intelligence and the Internet of Things (IoT) can be leveraged to monitor and manage sustainability initiatives, provided they are developed with input from diverse disciplines.

CONCLUSION AND RECOMMENDATIONS

Sustainability challenges are too complex to be addressed by any single discipline. An interdisciplinary approach is essential for understanding and solving these challenges. By fostering collaboration across disciplines, we can develop innovative solutions that promote environmental health, social equity, and economic resilience. An interdisciplinary approach is essential for

addressing the multifaceted challenges of sustainability. By breaking down disciplinary silos and fostering collaboration, we can develop holistic solutions that are both innovative and impactful.

To advance this agenda, we recommend:

1. **Promoting Interdisciplinary Education:** Universities should incorporate interdisciplinary courses and projects into their curricula.
2. **Encouraging Collaborative Research:** Funding agencies should prioritize projects that integrate multiple disciplines.
3. **Building Inclusive Networks:** Stakeholders from diverse sectors must be engaged in sustainability initiatives.
4. **Leveraging Technology:** Digital tools should be utilized to facilitate communication and data sharing across disciplines.

By embracing these strategies, we can harness the power of interdisciplinary collaboration to create a more sustainable and equitable future.

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BUILDING SKILLS IN TEACHERS FOR INTERDISCIPLINARY RESEARCH

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Education has always been a sector that self-regulates to provide students the skills they need to live, adapt, contribute, grow, and produce better results for themselves and future generations. In order to meet students where they are in their knowledge and guarantee an uphill learning curve, educators have consistently attempted to modify their methods to fit the needs of particular communities. They have used a variety of tactics in their pursuit, including cross-curriculum, multidisciplinary, and traditional teaching, with varying degrees of success.

Interdisciplinary research combines data, information, methods, tools, viewpoints, ideas, or theories from two or more fields of study or specialized knowledge bases. Teams or individuals can complete it. It solves issues whose answers go outside the purview of a particular discipline or field of study, or it increases basic understanding. Combining several academic fields into a single activity, such as a research project, is known as interdisciplinary or interdisciplinary studies. It incorporates information from a variety of disciplines, including economics, psychology, sociology, and anthropology. As new needs and professions arise, it is associated with an interdisciplinary field, also known as an interdisciplinary, which is an organizational unit that transcends conventional boundaries between academic disciplines or schools of thought.

Studies that incorporate techniques and ideas from many well-established disciplines or conventional fields of study are said to as interdisciplinary in the context of education and training pedagogies. In order to connect and integrate many academic schools of thought, professions, or technologies—along with their unique perspectives—in the pursuit of a shared objective, interdisciplinary entail researchers, students, and teachers.

HOW TO IMPLEMENT INTERDISCIPLINARY TEACHING

In order to assist students, acquire the abilities necessary to manage our quickly changing world, interdisciplinary instruction is crucial. However, if not executed strategically, it can also be labor-intensive, adding to the already heavy workload of educators. We also have some advice to help simplify and facilitate the introduction and mastering of this method for instructors who may have been hesitant to use it, as well as for campus or district administrators who wish to assist teachers in doing so:

1. Establish a detailed procedure

Give educators a dependable procedure. To improve the classroom experience, start by guiding them via pre-instructional planning, where discussion guides and action plans can be created. Then, they discuss how they might learn alongside their students and how they may explain interdisciplinary learning to pupils. Assist educators in creating a student evaluation rubric and use tests to motivate students to evaluate themselves.

2. Promote cooperation

Interdisciplinary learning requires collaboration between educators as well as between educators and their students. However, it's imperative that schools encourage natural collaboration by bringing teachers together in a common physical or virtual environment.

3. Make use of the appropriate technology

For trans disciplinary learning to be successful, instructional preparation and professional development for educators are essential. However, educators may lack the time and resources necessary to create interdisciplinary lesson plans that promote the kind of in-depth learning that this kind of instruction seeks to accomplish.

Investing in the correct technology is one of the best methods to overcome these obstacles. Teachers can spend their preparation time modifying their classes and adjusting the content to meet the specific requirements of their students by using Propello to quickly obtain standards-aligned curricula, including labs and assignments. Teachers can also practice their newly acquired skills while teaching and obtain training and information at their own pace.

For many schools, interdisciplinary learning can represent a big change, and its careful implementation may necessitate extensive planning and preparation. But the reward is substantial. Pupils will interact with the topic more fully, which will aid in their mastery of it. Additionally, you can expedite deployment and assist your school in rapidly achieving success in interdisciplinary learning by adhering to the aforementioned advice and guidelines.

INTERDISCIPLINARY TEACHING METHODS

1. Integration of Curriculum:

Integrated Courses: Students are better able to understand the links between studies when several disciplines are combined into a single course. For instance, biology, economics, and policy studies may all be included in a course on environmental sustainability.

Thematic Units: By structuring the curriculum around themes rather than subjects, students can delve deeply into issues from a variety of angles. Students are encouraged by this method to recognize how several subjects are interconnected.

2. Group Instruction:

Collaborative Instruction: Teachers from several disciplines teach a course together. Because teachers contribute a variety of viewpoints, this approach encourages teamwork. Exposure to other points of view helps students better understand difficult subjects.

3. Learning through Projects:

Applications in the Real World: Project-based learning entails students working on lengthy assignments that tackle actual issues. These initiatives frequently call for expertise from other fields, encouraging a comprehensive approach to problem-solving.

Students can be assigned to interdisciplinary teams, each of which brings expertise from their own fields to the table. This is similar to situations in the real world where experts work together on challenging assignments.

4. Learning through Problems:

Critical Thinking: Students are encouraged to think critically when they are given interdisciplinary problems to solve. In order to suggest solutions, they must examine issues from several perspectives and use information from diverse fields.

Case Studies: Students can be given real-world examples of interdisciplinary problem-solving by incorporating case studies that span several disciplines.

5. Evaluations across Subjects:

Assessment Integration: Tests that incorporate information from other fields strengthen the idea that subjects are related to one another. Essays, presentations, or projects requiring students to synthesis data from multiple sources may fall under this category.

6. **Holistic Grading:** Assessing students' application of knowledge across disciplines rather than just one promotes a more comprehensive comprehension of the subject matter.

7. **Experts and Guest Speakers:**

Diverse Views: Students are exposed to a variety of viewpoints by inviting guest lecturers from many professions. Experts can offer perspectives on how their field tackles particular challenges, enhancing students' comprehension of the intricacy of real-world concerns.

BENEFITS OF INTERDISCIPLINARY LEARNING FOR HOLISTIC UNDERSTANDING:

Interdisciplinary learning helps students recognize how knowledge is interconnected. Rather than viewing subjects in isolation, they develop a holistic understanding of how different disciplines contribute to a broader understanding of complex issues.

1. **Critical Thinking Skills:** Developing critical thinking abilities involves examining issues from several angles. Students gain the ability to assess data, take into account other points of view, and make well-informed decisions—all of which are critical life skills.
2. **Innovation and Creativity:** Being exposed to a variety of fields fosters innovation. Using a variety of subject areas increases the likelihood that students will come up with creative ideas. The collaborative character of many creative and inventive undertakings in the professional world is reflected in this interdisciplinary approach.
3. **Problem-Solving Skills:** Students who participate in interdisciplinary learning are better prepared to handle challenging issues. By combining knowledge from several disciplines, they provide a thorough toolkit for dealing with problems that cut across disciplinary lines.
4. **Real-World Application:** Multidisciplinary approaches are needed to solve a lot of real-world issues. In their future employment, students who participate in interdisciplinary learning will be better equipped to apply their knowledge to intricate, varied problems.
5. **Better Communication abilities:** Working with people from different fields improves communication abilities. Students gain the ability to communicate difficult concepts to audiences with different degrees of experience, which is crucial in the workplace.
6. **Getting ready for a Dynamic Work Environment:** People with a wide range of talents and the ability to adjust to changing conditions are frequently in high demand in the modern

workforce. Students are better prepared for dynamic contexts where they may need to use knowledge from multiple subjects thanks to interdisciplinary learning.

7. **Global Citizenship:** The growth of global citizens can be facilitated by interdisciplinary education. Students acquire a more sophisticated grasp of the cultural, economic, and environmental elements driving global crises by looking at issues from a variety of angles.
8. **Habits of Lifelong Learning:** Interdisciplinary education cultivates an attitude of inquiry and never-ending learning. When disciplines are integrated, students are more likely to adopt a lifelong learning philosophy and pursue information from a variety of sources throughout their careers.

CHALLENGES

1. **Technical Difficulties:** It might be difficult to coordinate timetables and curriculum alignment among departments. It could be necessary to modify institutional frameworks and regulations to facilitate trans disciplinary endeavours.
2. **Collaboration among Faculty:** Coordinating and coordinating their instructional strategies and content can be difficult for faculty members. For multidisciplinary programs to be successful, faculty collaboration must be supported and encouraged.
3. **Challenges with Assessment:** The multidisciplinary abilities that students learn may not be sufficiently captured by traditional assessment techniques. It is essential to provide efficient evaluation methods that complement multidisciplinary learning goals.
4. **Opposition to Change:** It's possible that both teachers and students will be reluctant to cross established disciplinary lines. Effective communication of the advantages and objectives of multidisciplinary education is necessary to overcome resistance.
5. **Allocation of Resources:** Multidisciplinary programs might need more funding for infrastructure and faculty development. For trans disciplinary projects to be successful, institutions must wisely distribute their resources.

IN CONCLUSION

Interdisciplinary instruction and learning provide a revolutionary method of teaching that equips pupils for the complexity of the outside world. This approach creates a holistic view of information, improves critical thinking and problem-solving abilities, and equips students for success in diverse and dynamic professional situations by dismantling the boundaries between academic fields. Even though there are drawbacks, interdisciplinary education is a wise investment in producing well-rounded, flexible, and creative people. Integrating multidisciplinary approaches will probably become more crucial as education develops further, helping to shape learning in the future and equip students for the opportunities and difficulties of a world that is changing quickly.

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SUSTAINABILITY THROUGH INTERDISCIPLINARY APPROACHES

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1.1 ABSTRACT

Sustainability through an interdisciplinary approach is a holistic methodology that integrates insights and methods from natural sciences, social sciences, humanities, and engineering to address the complex challenges of sustainability. This approach recognizes that sustainability is not solely an environmental issue, but also a social and economic one, requiring a comprehensive understanding of the intricate relationships between human and natural systems. By combining disciplines such as ecology, economics, sociology, politics, and technology, researchers and practitioners can develop innovative solutions that balance environmental protection, social justice, and economic viability. For instance, an interdisciplinary approach to sustainable agriculture might involve integrating agronomy, ecology, sociology, and economics to develop farming practices that not only enhance crop yields but also promote biodiversity, improve rural livelihoods, and reduce environmental degradation. Similarly, an interdisciplinary approach to sustainable urban planning might involve combining architecture, engineering, sociology, and economics to design cities that are not only environmentally sustainable but also socially just and economically resilient. By fostering collaboration and knowledge-sharing across disciplines, an interdisciplinary approach to sustainability can help us develop more effective, equitable, and enduring solutions to the complex sustainability challenges we face. This paper is an attempt to discuss the interdisciplinary framework for holistic sustainability

1.2 INTRODUCTION

An interdisciplinary approach involves integrating knowledge, methods, and perspectives from multiple academic disciplines to address complex issues that cannot be fully understood or solved by a single discipline alone. This approach encourages collaboration among experts from different fields, fostering a more holistic understanding of problems and leading to innovative solutions. By bridging gaps between disciplines, an interdisciplinary approach allows for the exploration of complex questions from diverse viewpoints, making it particularly valuable in tackling real-world challenges such as climate change, public health crises, and social inequality. This methodology promotes flexibility, creativity, and comprehensive problem-solving.

1.3 DEFINITIONS OF THE INTERDISCIPLINARY APPROACH:

- **Newell (2001):** "Interdisciplinary studies are the process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession."
- **Repko (2008):** "Interdisciplinary research is a process of answering a question, solving a problem, or addressing a topic that cannot be adequately understood or solved by a single discipline."
- **Klein (2010):** "Interdisciplinary collaboration involves scholars from different disciplines working together, drawing on their individual disciplinary expertise to generate new knowledge and provide a more comprehensive understanding of complex issues."

- **Gibbons et al. (1994):** "Interdisciplinary involves crossing the boundaries between disciplines to create new knowledge that is not confined to a single disciplinary perspective. This is essential for understanding and addressing complex global issues."
- **Boix Mansilla & Duraisingh (2007):** "Interdisciplinary learning and research refer to the integration of insights, approaches, and methodologies from different disciplines to develop a deeper and more comprehensive understanding of complex problems."

1.4 INTERDISCIPLINARY APPROACHES FOR SUSTAINABILITY

Interdisciplinary approaches for sustainability involve the integration of multiple disciplines to address the complex environmental, social, and economic challenges associated with achieving sustainability. This approach recognizes that sustainability is a multifaceted issue that requires a comprehensive understanding of the inter relationships between human and natural systems. By combining insights and methods from disciplines such as environmental science, economics, sociology, politics, and engineering, interdisciplinary approaches can help develop innovative solutions for sustainable development, such as sustainable agriculture, renewable energy, and eco-friendly technologies. Let us discuss in details-

1.4.1 Integrated Assessment Model (IAM)

An Integrated Assessment Model (IAM) is a computational framework that integrates multiple disciplines and sectors to analyze complex systems and predict future outcomes. IAMs are used to assess the interactions between human and natural systems, and to evaluate the potential impacts of different policy scenarios or future developments.

Key Characteristics of IAMs

- Interdisciplinary: IAMs integrate insights and methods from multiple disciplines, including natural sciences, social sciences, economics, and engineering.
- Systemic approach: IAMs consider the complex interactions and feedback loops within and between different systems, such as energy, water, food, and climate.
- Quantitative analysis: IAMs use mathematical models and computational simulations to analyze complex systems and predict future outcomes.
- Scenario-based analysis: IAMs often use scenario-based analysis to evaluate the potential impacts of different policy scenarios or future developments.
- Uncertainty analysis: IAMs often incorporate uncertainty analysis to quantify the uncertainty associated with different scenarios or outcomes.

COMPONENTS OF AN IAM

- Scenario definition: Definition of the scenarios to be analyzed, including the assumptions and uncertainties associated with each scenario.
- Modeling framework: Development of a modeling framework that integrates multiple disciplines and sectors.
- Data collection and integration: Collection and integration of data from multiple sources, including empirical data, literature reviews, and expert judgments.

- Model calibration and validation: Calibration and validation of the IAM using historical data and other sources of information.
- Scenario analysis: Analysis of the scenarios using the IAM, including the evaluation of the potential impacts of different policy scenarios or future developments.
- Uncertainty analysis: Analysis of the uncertainty associated with the scenarios and outcomes, including the use of sensitivity analysis and Monte Carlo simulations.
- Results interpretation: Interpretation of the results, including the identification of key findings, implications, and recommendations.

Applications of IAMs

- Climate change research: IAMs are widely used in climate change research to evaluate the potential impacts of different greenhouse gas emission scenarios and to analyze the effectiveness of different climate change mitigation and adaptation strategies.
- Sustainable development: IAMs are used to evaluate the potential impacts of different sustainable development scenarios, including the evaluation of the trade-offs between economic, social, and environmental objectives.
- Energy and resource management: IAMs are used to evaluate the potential impacts of different energy and resource management scenarios, including the evaluation of the effectiveness of different energy efficiency and renewable energy technologies.
- Environmental impact assessment IAMs are used to evaluate the potential environmental impacts of different projects or policies, including the evaluation of the potential impacts on biodiversity, water quality, and air quality.

Advantages of IAMs

- Comprehensive analysis: IAMs provide a comprehensive analysis of complex systems, including the evaluation of the interactions and feedback loops between different components.
- Scenario-based analysis: IAMs allow for the evaluation of different scenarios, including the analysis of the potential impacts of different policy scenarios or future developments.
- Quantification of uncertainty: IAMs provide a quantitative assessment of the uncertainty associated with different scenarios and outcomes.
- Communication and stakeholder engagement: IAMs can facilitate communication and stakeholder engagement by providing a common framework for analyzing complex systems and evaluating different scenarios.

Limitations of IAMs

- Complexity and uncertainty: IAMs are often limited by the complexity and uncertainty of the systems being analyzed.
- Data limitations: IAMs are often limited by the availability and quality of data, particularly for certain regions or sectors.
- Model uncertainty: IAMs are often limited by the uncertainty associated with the models and assumptions used to analyze complex systems.

- Interpretation and communication: IAMs require careful interpretation and communication of results, particularly to stakeholders who may not be familiar with the technical details of the models and scenarios.

1.4.2 Systems thinking:

Systems thinking is a holistic approach to understanding complex systems and their interconnected components. It involves analyzing the relationships and interactions between different parts of a system, as well as the system's behavior and dynamics.

Key Principles

- Holism: Systems thinking considers the system as a whole, rather than focusing on individual parts.
- Interconnections: Systems thinking recognizes that components within a system are interconnected and interdependent.
- Feedback loops: Systems thinking identifies and analyzes feedback loops, which are circular causal relationships within a system.
- Non-linearity: Systems thinking acknowledges that systems often exhibit non-linear behavior, meaning that small changes can have large and disproportionate effects.
- Dynamic behavior: Systems thinking considers the dynamic behavior of systems over time, including their stability, resilience, and adaptability.

Systems Thinking Tools and Techniques

- Systems mapping: Creating visual representations of systems and their components to identify relationships and patterns.
- Causal loop diagrams: Identifying and analyzing feedback loops within a system.
- Stock and flow diagrams: Modeling the dynamics of systems using stocks (accumulations) and flows (rates of change).
- System dynamics modeling: Using computer simulations to model and analyze complex systems.
- Scenario planning: Developing and analyzing different scenarios to anticipate and prepare for potential future developments.

Applications of Systems Thinking

- Environmental sustainability: Understanding the complex relationships between human and natural systems to address environmental challenges.
- Public health: Analyzing the interconnected factors that influence health outcomes, such as social determinants, healthcare systems, and environmental factors.
- Economic development: Understanding the complex systems and relationships that drive economic growth and development.
- Social justice: Analyzing the systems and structures that perpetuate social inequality and developing strategies for change.

- Organizational management: Applying systems thinking to understand and improve organizational performance, including strategy, operations, and leadership.

Benefits of Systems Thinking

- Improved problem-solving: Systems thinking helps to identify and address the root causes of complex problems.
- Enhanced collaboration: Systems thinking fosters collaboration and communication among stakeholders with different perspectives and expertise.
- Increased innovation: Systems thinking encourages creativity and innovation by considering the interconnections of different components and systems.
- Better decision-making: Systems thinking provides a more comprehensive understanding of complex systems, leading to more informed decision-making.
- Improved adaptability: Systems thinking helps organizations and individuals to adapt to changing circumstances and to anticipate potential future developments.

1.4.3 Trans-disciplinary Research:

Trans-disciplinary research (TDR) is a research approach that involves collaboration among diverse stakeholders, including researchers from different disciplines, practitioners, policymakers, and community members. TDR aims to address complex, real-world problems by integrating knowledge, methods, and perspectives from multiple disciplines and stakeholders.

Key Principles

- Collaboration: TDR involves collaboration among diverse stakeholders, including researchers, practitioners, policymakers, and community members.
- Interdisciplinary nature: TDR integrates knowledge, methods, and perspectives from multiple disciplines.
- Problem-focused: TDR addresses complex, real-world problems.
- Participatory: TDR involves the active participation of stakeholders in the research process.
- Iterative: TDR involves an iterative process of research, reflection, and adaptation.

Characteristics of TDR

- Complexity: TDR addresses complex, real-world problems.
- Uncertainty: TDR acknowledges and addresses uncertainty and ambiguity.
- Contextuality: TDR considers the specific context and setting of the research.
- Dynamic: TDR involves a dynamic and adaptive research process.
- Reflexive: TDR involves reflection and self-awareness among researchers and stakeholders.

Benefits of TDR

- Improved relevance: TDR addresses complex, real-world problems.
- Increased impact:TDR involves the active participation of stakeholders, leading to increased impact and uptake of research findings.

- Enhanced collaboration: TDR fosters collaboration among diverse stakeholders.
- Improved understanding: TDR integrates knowledge, methods, and perspectives from multiple disciplines, leading to a more comprehensive understanding of complex problems.
- Increased innovation: TDR involves the iterative process of research, reflection, and adaptation, leading to increased innovation and creativity.

Challenges of TDR

- Interdisciplinary communication: TDR requires effective communication among researchers from different disciplines.
- Power dynamics: TDR involves collaboration among stakeholders with different levels of power and influence.
- Methodological challenges: TDR involves integrating different research methods and approaches.
- Funding and resources: TDR often requires significant funding and resources.
- Evaluation and impact assessment: TDR requires effective evaluation and impact assessment methods.

Examples of TDR

- Sustainable development: TDR is used to address complex sustainable development challenges, such as climate change, poverty, and inequality.
- Public health: TDR is used to address complex public health challenges, such as infectious diseases, non-communicable diseases, and mental health.
- Environmental conservation: TDR is used to address complex environmental conservation challenges, such as biodiversity loss, deforestation, and water pollution.
- Urban planning: TDR is used to address complex urban planning challenges, such as transportation, housing, and community development.
- Disaster risk reduction: TDR is used to address complex disaster risk reduction challenges, such as natural disasters, climate change, and human-made disasters.

1.4.4 Participatory Action Research (PAR):

Participatory Action Research (PAR) is a research approach that involves collaborative and participatory methods to identify and address social, economic, or environmental problems. PAR emphasizes the active involvement of stakeholders, including community members, organizations, and policymakers, in the research process.

Key Principles

- Participation: PAR involves the active participation of stakeholders in the research process.
- Collaboration: PAR emphasizes collaboration among stakeholders, including researchers, community members, and policymakers.
- Empowerment: PAR aims to empower stakeholders, particularly marginalized or vulnerable groups, to take control of their own lives and communities.

- Action-oriented: PAR is action-oriented, meaning that it aims to generate knowledge that can be used to inform action and decision-making.
- Cyclical process: PAR involves a cyclical process of planning, action, observation, and reflection.

Characteristics of PAR

- Community-based: PAR is often community-based, meaning that it is conducted in collaboration with community members and organizations.
- Participatory methods: PAR uses participatory methods, such as focus groups, interviews, and surveys, to involve stakeholders in the research process.
- Collaborative analysis: PAR involves collaborative analysis of data, meaning that stakeholders are involved in the analysis and interpretation of data.
- Action planning: PAR involves action planning, meaning that stakeholders work together to develop plans for action and change.
- Reflection and evaluation: PAR involves reflection and evaluation, meaning that stakeholders reflect on the research process and evaluate the outcomes.

Benefits of PAR

- Empowerment: PAR empowers stakeholders, particularly marginalized or vulnerable groups, to take control of their own lives and communities.
- Relevance: PAR ensures that research is relevant and responsive to the needs of stakeholders.
- Validity: PAR increases the validity of research findings by involving stakeholders in the research process.
- Actionability: PAR generates knowledge that can be used to inform action and decision-making.
- Sustainability: PAR promotes sustainability by building capacity and promoting ownership among stakeholders.

Challenges of PAR

- Power dynamics: PAR can be challenging due to power dynamics, particularly when working with marginalized or vulnerable groups.
- Time-consuming: PAR can be time-consuming, particularly when involving stakeholders in the research process.
- Resource-intensive: PAR can be resource-intensive, particularly when involving large numbers of stakeholders.
- Methodological challenges: PAR can be methodologically challenging, particularly when integrating different research methods and approaches.
- Ethical considerations: PAR raises ethical considerations, particularly when working with vulnerable populations.

Examples of PAR

- Community-based health research: PAR is often used in community-based health research to involve community members in the research process.
- Environmental conservation: PAR is used in environmental conservation to involve local communities in conservation efforts.
- Education research: PAR is used in education research to involve teachers, students, and community members in the research process.
- Urban planning: PAR is used in urban planning to involve community members in the planning process.
- Disaster risk reduction: PAR is used in disaster risk reduction to involve local communities in disaster risk reduction efforts.

1.5 SUSTAINABILITY CHALLENGES

Sustainability challenges are multifaceted and interconnected, requiring a comprehensive and holistic approach to address them. Environmental challenges such as climate change, biodiversity loss, water scarcity, and soil degradation threaten the health and well-being of ecosystems and human societies. Social challenges, including poverty and inequality, human rights violations, and limited access to education and healthcare, exacerbate environmental degradation and hinder sustainable development. Economic challenges, such as unsustainable consumption patterns, inefficient resource use, and economic inequality, also undermine sustainability efforts. Furthermore, governance and institutional challenges, including inadequate policy frameworks, insufficient institutional capacity, corruption, and lack of transparency, hinder the effective implementation of sustainability solutions. Addressing these interconnected challenges requires a collaborative and interdisciplinary approach that engages governments, businesses, civil society, and individuals in promoting sustainable development and ensuring a resilient future for all.

1.5.1 Climate change

Climate change is a pressing sustainability challenge that requires immediate attention and action. It is a complex and multifaceted issue that is driven by human activities such as the burning of fossil fuels, deforestation, and land-use changes, which release large amounts of greenhouse gases, such as carbon dioxide and methane, into the atmosphere, leading to global warming and associated impacts such as rising sea levels, more frequent and severe weather events, and changes in precipitation patterns. The consequences of climate change are far-reaching and devastating, from melting glaciers and sea-level rise, to droughts, heatwaves, and extreme weather events, which can have catastrophic impacts on human settlements, agriculture, and ecosystems. Furthermore, climate change has significant social and economic implications, including food and water scarcity, displacement and migration, and negative impacts on human health and well-being. To address this sustainability challenge, it is essential to adopt a multi-faceted approach that involves reducing greenhouse gas emissions through a transition to renewable energy sources, increasing energy efficiency, and promoting sustainable land use practices, as well as adapting to the impacts of climate change by developing and implementing climate-resilient infrastructure, agriculture, and water management practices.

1.5.2 Biodiversity Loss:

Biodiversity loss refers to the decline or disappearance of species, ecosystems, and genetic diversity. This loss is often driven by human activities such as habitat destruction, pollution, overfishing, and climate change. The consequences of biodiversity loss are far-reaching, from the disruption of ecosystem services like pollination and pest control, to the loss of medicinal plants and the decline of fisheries.

One of the primary drivers of biodiversity loss is habitat destruction. The clearance of forests, wetlands, and other ecosystems for agriculture, urbanization, and other purposes has resulted in the loss of habitats for countless species. Additionally, the fragmentation of remaining habitats has made it difficult for species to migrate, find food, and breed. The consequences of habitat destruction are evident in the decline of many iconic species, from the orangutan to the mountain gorilla.

Pollution is another significant driver of biodiversity loss. The release of pollutants like pesticides, herbicides, and industrial chemicals has had devastating impacts on ecosystems. Many species are unable to survive in environments contaminated with these pollutants, leading to population declines and even extinctions. Furthermore, pollution can also have indirect impacts on biodiversity by altering ecosystem processes and disrupting nutrient cycles.

Climate change is also a major driver of biodiversity loss. Rising temperatures, changing precipitation patterns, and increased frequency of extreme weather events are altering ecosystems and disrupting the delicate balance of species interactions. Many species are unable to adapt to these changes, leading to population declines and even extinctions. Additionally, climate change is also altering the distribution of species, leading to the spread of invasive species and the disruption of ecosystem processes.

The consequences of biodiversity loss are far-reaching and devastating. The loss of pollinators, for example, can have significant impacts on food production and security. The decline of fisheries can have major economic and social impacts on communities that depend on them. Furthermore, the loss of medicinal plants can limit our ability to develop new treatments and cures for diseases. It is essential that we take immediate action to address biodiversity loss, from protecting and restoring habitats, to reducing pollution and mitigating the impacts of climate change.

1.5.3 Water Scarcity:

Water scarcity is a pressing sustainability challenge that affects millions of people worldwide. It is defined as the lack of sufficient available water resources to meet the demands of water usage. Water scarcity can be caused by a combination of factors, including climate change, population growth, urbanization, and inefficient water use practices. The consequences of water scarcity are far-reaching, from impacting food production and energy generation, to affecting human health and economic development.

One of the primary drivers of water scarcity is climate change. Changes in precipitation patterns, increased evaporation due to warmer temperatures, and altered water cycles are all contributing to water scarcity. Additionally, climate change is also leading to more frequent and severe droughts and floods, which can have devastating impacts on water resources. It is essential that we take immediate action to address climate change and its impacts on water scarcity.

Population growth and urbanization are also significant drivers of water scarcity. As the global population grows, so does the demand for water. Urbanization also leads to increased water demand, as cities require large amounts of water for drinking, sanitation, and industrial purposes. Furthermore, urbanization often leads to the degradation of water sources, such as rivers and lakes, due to pollution and other human activities.

The consequences of water scarcity are far-reaching and devastating. Water scarcity can impact food production, leading to food insecurity and economic instability. It can also impact energy generation, as many power plants rely on water for cooling. Additionally, water scarcity can have significant impacts on human health, particularly in areas where access to clean water and sanitation is already limited.

To address the sustainability challenge of water scarcity, it is essential that we adopt a multi-faceted approach. This includes increasing water efficiency and conservation, developing new water sources, such as desalination and wastewater reuse, and protecting and restoring natural water sources, such as rivers and lakes. Additionally, we must also address the root causes of water scarcity, such as climate change, population growth, and urbanization. By working together, we can ensure a sustainable future for all.

1.5.4 Food Security:

Food security is a pressing sustainability challenge that affects millions of people worldwide. It is defined as the availability, access, utilization, and stability of food supplies to meet the dietary needs of individuals. Food insecurity can be caused by a combination of factors, including poverty, conflict, climate change, and unsustainable agricultural practices. The consequences of food insecurity are far-reaching, from impacting human health and well-being, to affecting economic development and social stability.

One of the primary drivers of food insecurity is climate change. Changes in temperature and precipitation patterns, increased frequency of extreme weather events, and rising sea levels are all impacting agricultural productivity and food security. Additionally, climate change is also altering the distribution of pests and diseases, which can further exacerbate food insecurity. It is essential that we take immediate action to address climate change and its impacts on food security.

Another significant driver of food insecurity is unsustainable agricultural practices. The use of chemical pesticides and fertilizers, monoculture farming practices, and the degradation of soil health are all contributing to the decline of agricultural productivity and the loss of biodiversity. Additionally, unsustainable agricultural practices are also contributing to water pollution, soil erosion, and climate change. It is essential that we adopt sustainable agricultural practices that promote soil health, biodiversity, and efficient water use.

The consequences of food insecurity are far-reaching and devastating. Food insecurity can impact human health and well-being, particularly in areas where access to nutritious food is already limited. Food insecurity can also impact economic development, as it can limit the availability of food for local markets and export. Additionally, food insecurity can also impact social stability, as it can lead to social unrest and conflict over food resources.

To address the sustainability challenge of food security, it is essential that we adopt a multi-faceted approach. This includes promoting sustainable agricultural practices, improving water management, and reducing food waste. Additionally, we must also address the root causes of food insecurity, such

as poverty, conflict, and climate change. By working together, we can ensure a sustainable food future for all.

1.6 INTERDISCIPLINARY SOLUTIONS:

The world's most pressing sustainability challenges, such as climate change, food insecurity, and water scarcity, require innovative and comprehensive solutions that transcend traditional disciplinary boundaries. Interdisciplinary solutions, which integrate insights and methods from natural sciences, social sciences, humanities, and engineering, offer a powerful approach to address these complex challenges. By combining the strengths of multiple disciplines, interdisciplinary solutions can provide a more nuanced understanding of the complex relationships between human and natural systems, and can inform the development of more effective and sustainable solutions.

1.6.1 Sustainable Agriculture:

- Agroforestry: Integrating trees into agricultural landscapes to promote biodiversity, reduce soil erosion, and increase crop yields.
- Precision Agriculture: Using advanced technologies such as drones, satellite imaging, and sensors to optimize crop management, reduce waste, and promote sustainable water use.
- Organic Farming: Using natural methods to control pests and diseases, and promoting soil health through the use of compost and manure.

Climate Change Mitigation

- Renewable Energy: Transitioning to renewable energy sources such as solar, wind, and hydroelectric power to reduce dependence on fossil fuels and lower greenhouse gas emissions.
- Carbon Capture and Storage: Developing technologies to capture and store carbon dioxide emissions from power plants and industrial processes.
- Sustainable Urban Planning: Designing cities and urban areas to promote energy efficiency, reduce transportation emissions, and increase green spaces.

Water Management

- Water Conservation: Implementing measures to reduce water waste and promote efficient use of water in agriculture, industry, and urban areas.
- Watershed Management: Managing watersheds to prevent pollution, reduce erosion, and promote sustainable water use.
- Desalination and Water Recycling: Developing technologies to desalinate seawater and recycle wastewater for non-potable uses.

Ecosystem Restoration

- Reforestation and Afforestation: Restoring forests and promoting sustainable forest management to sequester carbon, protect biodiversity, and prevent soil erosion.
- Wetland Restoration: Restoring wetlands to promote biodiversity, improve water quality, and provide natural buffers against storms and floods.
- Soil Conservation: Implementing measures to prevent soil erosion, promote soil health, and support sustainable agriculture practices.

Human Health and Well-being

- Environmental Health: Addressing the impacts of environmental pollution on human health, including air and water pollution, and the spread of diseases.
- Sustainable Food Systems: Promoting sustainable food systems that provide access to nutritious food, support local economies, and reduce environmental impacts
- Mental Health and Well-being: Addressing the impacts of environmental degradation on mental health and well-being, including the promotion of green spaces and outdoor recreation.

1.6.2 Renewable energy for sustainability:

Ways to promote Renewable energy for sustainability through interdisciplinary approaches:

- Engineering and Technology: Developing more efficient and cost-effective renewable energy technologies, such as solar panels and wind turbines, through advances in materials science, electrical engineering, and computer science.
- Environmental Science and Ecology: Studying the environmental impacts of renewable energy systems, such as the effects of wind turbines on bird populations, and developing strategies to mitigate these impacts.
- Economics and Finance: Analyzing the economic benefits and costs of renewable energy systems, and developing financial models and incentives to support their adoption.
- Policy and Governance**:** Developing and implementing policies and regulations to support the adoption of renewable energy systems, such as tax credits, net metering laws, and renewable portfolio standards.
- Social Science and Community Engagement: Studying the social and cultural factors that influence the adoption of renewable energy systems, and developing community-based initiatives to promote their adoption.
- Interdisciplinary Research and Development: Collaborating across disciplines to develop new renewable energy technologies and systems, such as building-integrated photovoltaic and community-scale wind energy systems.
- Education and Training: Providing education and training programs for professionals and stakeholders in the renewable energy sector, to support the development and implementation of renewable energy systems.
- International Cooperation and Knowledge Sharing: Collaborating with international partners to share knowledge, technologies, and best practices in renewable energy, and to support the development of renewable energy systems in developing countries.

1.6.3 Eco-infrastructure:

Eco-infrastructure refers to the integrated network of natural, built, and social systems that provide ecosystem services, promote sustainable development, and enhance human well-being. This concept brings together insights from ecology, engineering, architecture, urban planning, sociology, economics, and policy studies to create a holistic understanding of the interconnected systems that support life on Earth.

From an interdisciplinary perspective, eco-infrastructure encompasses:

- Ecological systems_: Natural ecosystems, such as forests, wetlands, and wildlife habitats, that provide essential services like air and water filtration, soil formation, and climate regulation.
- Built systems_: Infrastructure designed and constructed by humans, such as green buildings, renewable energy systems, and sustainable transportation networks.
- Social systems_: Human communities, institutions, and governance structures that shape the way we interact with the environment and each other.
- Economic systems_: Markets, industries, and financial mechanisms that influence the production, consumption, and distribution of resources.

Aims of eco-infrastructure:

- To promote sustainable development_: Balance economic, social, and environmental needs to ensure a livable future.
- To enhance ecosystem services_: Protect and restore natural systems that provide essential services like clean air and water, and soil formation.
- To support human well-being_: Foster healthy, resilient, and thriving communities through access to clean air and water, nutritious food, and green spaces.
- Green infrastructure: Vegetated roofs, walls, and urban spaces that provide insulation, reduce stormwater runoff, and promote biodiversity.
- Water management systems**:** Rain gardens, bioswales, and green streets that manage storm water runoff, improve water quality, and reduce the burden on traditional drainage systems.
- Urban forestry: Planting and maintaining trees in urban areas to provide shade, reduce air pollution, and promote biodiversity.
- Wetland restoration: Restoring and preserving natural wetlands to provide habitat for wildlife, filter pollutants from water, and mitigate the impacts of flooding.
- Soil remediation: Restoring and preserving soil health through the use of green infrastructure, urban agriculture, and other sustainable land use practices.
- Eco-friendly buildings: Designing and constructing buildings that incorporate natural systems, such as green roofs, rainwater harvesting, and passive solar design.
- Urban agriculture: Promoting sustainable food systems through urban agriculture, community gardens, and green spaces.

Benefits of Eco-infrastructure:

- Improved water quality: Reducing stormwater runoff and filtering pollutants from water.
- Mitigated urban heat island effect: Reducing the temperature in urban areas through the use of green infrastructure and urban forestry.
- Increased biodiversity: Providing habitat for wildlife and promoting ecosystem services.
- Improved air quality: Reducing air pollution through the use of green infrastructure and urban forestry.

- Enhanced community engagement: Promoting community involvement and education through urban agriculture, community gardens, and green spaces.

Ways to approach eco-infrastructure as an interdisciplinary solution:

- Engineering and Design: Designing and building eco-infrastructure systems, such as green roofs, rain gardens, and green walls, that integrate natural and built systems.
- Ecology and Conservation Biology: Studying the ecological impacts of eco-infrastructure systems and designing them to promote biodiversity and ecosystem services.
- Urban Planning and Policy: Developing policies and plans that support the integration of eco-infrastructure into urban design and development.
- Architecture and Landscape Architecture: Designing buildings and landscapes that incorporate eco-infrastructure systems and promote sustainable and resilient communities.
- Hydrology and Water Resources: Designing eco-infrastructure systems that manage stormwater runoff, improve water quality, and promote sustainable water use.
- Social Science and Community Engagement: Studying the social and cultural impacts of eco-infrastructure systems and engaging communities in the design and implementation of these systems.
- Economics and Finance: Analyzing the economic benefits and costs of eco-infrastructure systems and developing financial models and incentives to support their adoption.
- Interdisciplinary Research and Development: Collaborating across disciplines to develop new eco-infrastructure technologies and systems that integrate natural and built systems.
- Systems Thinking and Integration: Considering the interactions and interdependencies between different components of eco-infrastructure systems and integrating multiple technologies and approaches to create more efficient and effective systems.

Thus eco-infrastructure is an interdisciplinary concept that recognizes the interconnectedness of natural, built, and social systems, and seeks to promote sustainable development, enhance ecosystem services, and support human well-being.

1.6.4 Sustainable agriculture from an interdisciplinary perspective:

Ecological Perspective

- Biodiversity conservation: Maintaining ecosystem services, such as pollination and pest control, through the use of diverse crop and animal species.
- Soil conservation: Implementing practices like no-till or reduced-till farming, cover cropping, and crop rotation to reduce soil erosion and promote soil health.
- Water management: Using efficient irrigation systems and conservation practices, such as drip irrigation and mulching, to reduce water waste and protect water quality.

Economic Perspective

- Economic viability: Ensuring that sustainable agricultural practices are economically viable for farmers, through the use of cost-effective technologies and market-based incentives.

- Market access: Providing small-scale farmers with access to markets, credit, and other resources to help them compete in the global market.
- Fair labor practices: Promoting fair labor practices, such as fair wages and safe working conditions, to ensure that farmers and farm workers are treated with dignity and respect.

Social Perspective

- Community engagement: Engaging with local communities to promote sustainable agricultural practices and provide education and training on sustainable agriculture.
- Food sovereignty: Supporting local food systems and promoting food sovereignty, which is the right of communities to control their own food systems.
- Cultural sensitivity: Recognizing and respecting the cultural significance of agriculture and food production in different communities.

Technological Perspective

- Precision agriculture: Using technologies like drones, satellite imaging, and precision irrigation to optimize crop yields and reduce waste.
- Organic amendments: Using natural amendments like compost and manure to improve soil health and reduce the use of synthetic fertilizers.
- Renewable energy: Using renewable energy sources like solar and wind power to reduce dependence on fossil fuels and lower greenhouse gas emissions.

Policy Perspective

- Regulatory frameworks: Establishing regulatory frameworks that support sustainable agriculture, such as organic certification programs and sustainable agriculture standards.
- Incentives and subsidies: Providing incentives and subsidies to farmers who adopt sustainable agricultural practices, such as tax credits and grants.
- Research and development: Supporting research and development in sustainable agriculture, including the development of new technologies and practices.

1.6.5 Circular Economy:

The circular economy is a regenerative system in which resources are kept in use for as long as possible, extracting the maximum value from them, and recovering and regenerating materials at the end of their service life. This approach aims to reduce waste and pollution, conserve natural resources, and promote sustainable economic growth. The circular economy is based on three key principles: design out waste and pollution, keep products and materials in use, and regenerate natural systems. From an interdisciplinary perspective, the circular economy requires the integration of insights and methods from engineering and design, economics and business, environmental science and ecology, social science and policy, and computer science and data analytics. Engineers and designers can develop products and systems that are restorative and regenerative by design. Economists and business leaders can create business models that promote sharing, leasing, and product-as-a-service, and that incorporate the costs of externalities. Environmental scientists and ecologists can provide insights into the environmental impacts of different materials and production processes, and can help design systems that mimic nature.

The circular economy offers numerous benefits, including reduced waste and pollution, conservation of natural resources, climate change mitigation, and economic benefits. By designing out waste and pollution, the circular economy can eliminate the environmental impacts associated with the extraction, processing, and disposal of materials. By keeping products and materials in use, the circular economy can conserve natural resources and reduce the need for new raw materials. By regenerating natural systems, the circular economy can promote sustainable agriculture practices, reduce greenhouse gas emissions, and support biodiversity.

The implementation of the circular economy requires a systemic approach that involves governments, businesses, and individuals. Governments can establish policies and regulations that support the transition to a circular economy, such as extended producer responsibility, waste reduction targets, and green public procurement. Businesses can adopt circular business models, such as product-as-a-service, sharing, and leasing, and can design products and systems that are restorative and regenerative by design. Individuals can make informed choices about the products they buy and use, and can adopt circular practices, such as recycling, composting, and sharing.

Thus, the circular economy is a powerful approach to promoting sustainable development and reducing waste and pollution. By adopting a circular economy approach, we can conserve natural resources, promote sustainable economic growth, and support biodiversity. The implementation of the circular economy requires a systemic approach that involves governments, businesses, and individuals, and that integrates insights and methods from multiple disciplines.

1.7 BENEFITS OF SUSTAINABILITY THROUGH AN INTERDISCIPLINARY APPROACH:

1.7.1 Environmental Benefits

- Climate Change Mitigation: An interdisciplinary approach to sustainability can help reduce greenhouse gas emissions and mitigate the impacts of climate change.
- Conservation of Natural Resources: By adopting sustainable practices, we can conserve natural resources, such as water, energy, and land, for future generations.
- Biodiversity Protection: An interdisciplinary approach to sustainability can help protect and preserve biodiversity, which is essential for maintaining ecosystem services and promoting ecological resilience.

1.7.2 Economic Benefits

- Job Creation and Economic Growth: Sustainability can create new job opportunities and stimulate economic growth through the development of sustainable industries and technologies.
- Cost Savings: Implementing sustainable practices can help reduce costs associated with energy consumption, waste management, and resource extraction.
- Increased Competitiveness: Companies that adopt sustainable practices can enhance their brand reputation, increase customer loyalty, and gain a competitive advantage in the market.

1.7.3 Social Benefits

- Improved Public Health: Sustainability can improve public health by reducing air and water pollution, promoting sustainable agriculture practices, and increasing access to clean energy.

- Enhanced Quality of Life: An interdisciplinary approach to sustainability can help create livable and sustainable communities, which can enhance the overall quality of life for citizens.
- Social Justice and Equity: Sustainability can promote social justice and equity by addressing the disproportionate impacts of environmental degradation on vulnerable populations.

1.7.4 Technological Benefits

- Innovation and Entrepreneurship*: An interdisciplinary approach to sustainability can drive innovation and entrepreneurship, leading to the development of new sustainable technologies and products.
- Improved Efficiency and Productivity*: Sustainability can improve efficiency and productivity through the adoption of sustainable technologies and practices, such as renewable energy, energy-efficient buildings, and sustainable agriculture practices.
- Data-Driven Decision Making*: An interdisciplinary approach to sustainability can provide insights into the environmental, social, and economic impacts of different sustainability strategies, enabling data-driven decision making.

1.7.5 Educational Benefits

- Interdisciplinary Learning: An interdisciplinary approach to sustainability can promote interdisciplinary learning, which can help students develop a deeper understanding of the complex relationships between environmental, social, and economic systems.
- Development of Sustainability Literacy: Sustainability education can help develop sustainability literacy, which is essential for promoting sustainable development and addressing global sustainability challenges.
- Preparation for Sustainability Careers: An interdisciplinary approach to sustainability can prepare students for careers in sustainability, which is a rapidly growing field that requires professionals with expertise in multiple disciplines.

1.8 CONCLUSION

The integration of interdisciplinary approaches to sustainability is crucial for addressing the complex and interconnected environmental, social, and economic challenges we face today. By combining insights and methods from natural sciences, social sciences, humanities, and engineering, we can develop a more comprehensive understanding of the complex relationships between human and natural systems. This, in turn, can inform the development of more effective and sustainable solutions that promote environmental stewardship, social justice, and economic prosperity. Furthermore, an interdisciplinary approach to sustainability can foster collaboration and knowledge-sharing among diverse stakeholders, including policymakers, business leaders, civil society organizations, and local communities. By working together and leveraging our collective expertise, we can create a more sustainable and resilient future for all. Ultimately, the success of sustainability efforts depends on our ability to adopt an interdisciplinary approach that recognizes the intricate relationships between human and natural systems, and that seeks to promote a more just, equitable, and sustainable world.

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